Recreational Boating Activity In Miami-Dade County

Final Report

Submitted To:

Miami-Dade Department of Environmental Resources Management
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EXECUTIVE SUMMARY

A one-year study was undertaken in order to characterize recreational boat use and boater compliance with established speed zones in Miami-Dade County. Two project tasks were included. First, a series of countywide aerial surveys were conducted. The primary goal of the aerial survey task was an assessment of countywide boat traffic patterns, including temporal and spatial trends, and the identification of primary traffic corridors and popular boating destinations. Second, four fixed-point boat survey sites were established at selected locations in the County. The goal of fixed point surveys was the site-specific characterization of vessel traffic patterns, along with an assessment of boater compliance with posted regulatory zones at each location.

Aerial surveys were conducted from a fixed-wing aircraft at an altitude of 900 feet and a speed of approximately 90 knots. The single observer/videographer method, used successfully during similar boat surveys in Lee County (Gorzelany, 1998) and Broward County (Gorzelany, 2005) was employed. A total of 20 countywide aerial surveys were conducted between March 2008 and February 2009. Surveys included all coastal waters from the north Miami-Dade County line to Card Sound Road. The linear survey route was approximately 225 nautical miles in length and the area surveyed encompassed approximately 251 square miles. Fixed point survey sites were established at Haulover Park, Pelican Harbor Park, Downtown Miami, and at Black Point Park. A total of eight surveys were conducted over a one-year period at each fixed-point survey site. Survey methodology followed similar techniques used in recent boating characterization studies in other Florida Counties (Gorzelany, 1996, 2005, 2008).

A total of 21,252 vessels in-use were surveyed and evaluated, including 11,809 observations from aerial surveys and 9,443 observations from fixed point surveys. The amount of boat traffic observed was highly variable among aerial survey flights, ranging from as few as 113 vessels in-use to as many as 1,648 vessels in-use during individual flights. Boat traffic also increased significantly on weekends with a weekend / weekday ratio of 4.81–1 - the highest ratio observed in any Florida county. Vessel composition in Miami-Dade County was similar to other east coast Florida counties. While small open motorboats 16-25 feet in length were the most common vessel type, a relatively high proportion of larger vessels, more typical in east coast counties, was observed. A relatively high proportion of commercial vessels was also observed.

A higher proportion of commercial vessel traffic was observed on weekdays, primarily due to large increases in recreational traffic observed on weekends.

Spatial analysis of aerial survey data identified several areas of high boat density in Miami-Dade County. Areas with high concentrations of stationary vessels in-use, indicating popular boating destinations, were identified near Bakers Haulover Inlet, Sands Cut / Elliot Key, and Key Biscayne. High concentrations of higher-speed traffic were observed throughout northern Miami-Dade County, particularly along portions the Intracoastal Waterway, the Port of Miami, Government Cut, and Miami Beach. Lower concentrations of vessel traffic were consistently observed throughout open water areas in lower Biscayne Bay. While the spatial analysis technique used in this study was useful in identifying high-use areas, a closer examination of individual areas may be needed in order to specifically address either wildlife management or human safety issues.

Aerial survey data indicated that regulatory zones in Miami-Dade County may be effective in reducing overall boat speeds in many areas, however observed speeds may still be inconsistent with posted regulatory zones (non-compliant). This was observed in particular in the Downtown Miami area near the entrance to the Miami River, along portions of Key Biscayne, and along the outer portion of the Black Point channel.

Boater compliance in Miami-Dade County was significantly related to vessel size and type. In general, levels of compliance increased with increasing vessel size and levels of blatant non-compliance increased with decreasing vessel size. Among vessel types, personal watercraft had the lowest levels of compliance and highest levels of blatant non-compliance. These trends were consistent with previous compliance studies conducted in other Florida counties. Boater compliance varied significantly among both survey sites and regulatory zones. The proportion of vessels in compliance with posted speed zones was as high as 69% at Haulover Park, and as low as 14% along the Black Point channel. Compared with previous studies, boater compliance at several fixed point locations in Miami-Dade County was relatively low. Less than 50% of all boats were compliant with posted speed zones in three out of the six regulatory zones examined. In addition, more than 20% of all boats were blatantly non-compliant in four out of the six regulatory zones examined. Lowest levels of compliance were typically observed in idle speed zones. While determining the relative proportion of compliant vessels is important, the absolute number of high-speed vessels traveling through a regulatory zone should also be considered. For example, while levels of compliance at the Haulover Park survey site were considered relatively high, the high level of traffic through the area translated into more high-speed boat traffic than was observed at other lower-compliance areas with less boat traffic.

The analyses in this report serve as an effective management tool for understanding countywide recreational boating patterns. Along with this document, the original datasets can also provide individuals with the opportunity to query, filter, and examine specific trends or areas of interest which may assist in the development of effective management decisions for Miami-Dade County.

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BACKGROUND AND RATIONALE

A key element of coastal management in Florida is a better understanding of recreational boating patterns along Florida waterways, and studies of boating activity have been identified as important components for both waterways management and protection of the endangered Florida manatee (USFWS, 2001). In spite of this, information on boating activity has been lacking during the development process of many county-wide manatee protection plans (Gorzelany, 2008). Historically, many counties have relied upon the numbers of registered vessels, the quantity and distribution of boat facilities (marinas, boat ramps, etc), and site-specific activity at these facilities in order to characterize boat use. Information on countywide spatial and temporal patterns of boating use is frequently unavailable. In addition, few studies have been undertaken to investigate the effectiveness of either boating safety zones or manatee speed zones. More recently, comprehensive studies of recreational boat use have been integrated into the development process of countywide boat facility siting plans and manatee protection plans in Broward, Lee, Sarasota, Palm Beach, and Collier Counties (Shapiro, 2001, Gorzelany, 2005, 2006, 2008, PBS&J, 2008). Similar studies have also been used to evaluate boating safety zones in Martin County (PBS&J, 2008). The effectiveness of manatee speed zones has also been examined in Broward, Sarasota, Charlotte, Lee, and Manatee Counties (Morris, 1992, Tyson and Combs, 1999, Gorzelany, 1996, 1998, 2002, 2005, 2007, Flamm and Viera-Atwell, 2006), and vessel data has been collected to address challenges to existing speed zones in Brevard County (FWC 2007, unpublished data).

In 1995, Miami-Dade County completed an approved Manatee Protection Plan (MPP). While the primary purpose of an MPP is to establish protection criteria, provide strategies and initiate management actions for manatee protection, the MPP also addresses issues related to the protection of wetlands and seagrasses, zoning and future land use, future boat facility siting, governmental coordination, education and awareness, and recreational boating use (Dade County, 1995). Along with numerous other Florida counties, Miami-Dade County faces the dilemma of balancing coastal development and recreational use with the conservation and protection of its natural resources, including the Florida manatee. While supporting a significant year-round manatee population, Miami-Dade County also ranks first in the State of Florida in the numbers of registered vessels, first in reportable boating accidents, and second in fatal boating accidents among all Florida counties (FWC Boating Accident Statistics, 2007). Information on boating activity in Miami-Dade County, however, is somewhat limited. The results from a series of mail and ramp intercept surveys conducted between 1988 and 1991 were the only available information on recreational boat use reported in the original 1995 Miami-Dade County MPP (University of Miami, 1991). More recently, a mail / respondent survey was conducted by Futerfas (2003), along with a series of boat traffic and boater compliance surveys from a single location near the mouth of the Miami River. Additional fixed point surveys from the same location were also conducted from 2002-03 (FWC, unpublished data). A more extensive series of aerial surveys were conducted by Ault et.al., (2008), however the survey area was limited to lower Biscayne Bay and did not collect information on vessel speeds or boater compliance in speed regulated areas..

As part of the process to review and update their MPP, the Miami-Dade County is required provide updated information on manatee abundance and distribution, recreational boating use patterns, boating facilities, and overall management/protection strategies. This report provides the results of the first comprehensive countywide study on boating use patterns in Miami-Dade County, along with new information on boater compliance in speed regulated areas.

METHODS

Aerial Surveys

Low-level aerial surveys of recreational boat traffic in Miami-Dade County were conducted from a Cessna 172 or Cessna 182 fixed-wing aircraft at an altitude of 900 feet and a speed of approximately 90 knots. The single observer/videographer method, used successfully during recent boat studies in Broward County (Gorzelany, 2005) and Collier County (Gorzelany, 2008) was employed. For this method, a single observer / videographer was seated in the front passenger seat of the survey aircraft. An electronic image-stabilizing Sony HDR-SR7 hard disk camcorder with date and time imprint was used to record all vessels in-use while flying a standard flight path. A vessel "in-use" was defined as either; 1) a vessel underway, or 2) a stationary vessel in the process of being used. This included activities such as fishing, picnicking, sunbathing, swimming/diving, sightseeing, or similar recreational activities, along with (when identifiable) vessels at short-term dockage or anchorage sites such as waterside restaurants, fuel docks, waterside bait and tackle shops, fishing piers, boat ramps, camp sites, beaches, spoil islands, or sand bars. "In-use" did not include stationary vessels located at long-term storage facilities such as anchorages or mooring fields, wet and dry storage marinas, or yacht clubs. Stationary (moored) vessels located at single family or multi-family residential docks were also not considered "in-use".

A total of 20 aerial surveys were conducted between March 2008 and February 2009, with five surveys (two weekday and three weekend surveys) conducted during each of four survey quarters. Survey quarters were identified as follows:

Spring Quarter:	March 2008 – May 2008
Summer Quarter:	June 2008 – August 2008
Fall Quarter:	September 2008 – November 2008
Winter Quarter:	December 2008 – February 2009

All coastal waters from the north Miami-Dade County line (near Gulfstream Park) south to Card Sound Road were included in survey flights. Surveys extended out to, but did not include, the Atlantic Ocean. The upper Miami River also was not included in the survey route due to air traffic restrictions. The survey start time, along with starting and ending locations within Miami-Dade County, were varied between flights. A GPS track was created from each survey flight in order to aid in boat sighting accuracy. A typical survey flight track is provided in **Figure 1**. The linear survey track length was approximately 225 nautical miles, and the area of coastal water surveyed (shown in **Figure 2)** encompassed approximately 251 square miles (650 km^2).

Once completed, original video footage was transferred from hard disk camcorder to DVD-R format for analysis. Vessels in-use identified from video footage were then hand-plotted directly onto a series of high resolution digital orthophotos (Albers 2004, NAD 83) using ArcMap® 9.3 GIS software. Attributes for each identified vessel in-use included the date and time of sighting (military time), vessel type, size, activity, mapped GIS location, relative speed, and direction of travel (if any).

Vessel type categories were identified as:
- Barge / Cargo
- Cabin Motorboat
- High Performance / Racer
- Inflatable
- Jon Boat
- Kayak / Canoe
- Open Motorboat
- Pontoon Boat
- Personal Watercraft
- Sailboat
- Tugboat / Tender
- Sightseeing / Tour

Each vessel type was further classified as Private/Recreational, Commercial, or Enforcement..

Vessel size categories were taken from standard Florida Fish and Wildlife Conservation Commission (FWC) Law Enforcement size classes, and designated as:

- Less than 16 feet
- 16 feet - 25 feet
- 26 feet – 39 feet
- 40 feet – 64 feet
- 65 feet – 109 feet
- greater than 110 feet

Vessel activity was identified as:

- Anchor / Drift
- Travel
- Milling
- Ski / Tubing
- Recreational
- Fishing (Possible or Probable)

Vessel speeds were identified as:

- Anchor / Drift
- Human-Powered (Oar/Paddle)
- Under Sail
- Idle / Slow
- Plowing
- Cruising
- Planing

Speed definitions for vessels under power were taken from Gorzelany (1999, 2000) and were originally adapted from the Florida Administrative Code 62N-22. Individual speed categories were defined as follows:

- Idle Speed: The minimum speed that maintains steerage of a vessel, or the speed at which a vessel is normally docked. Little or no displacement of water is observable from either the bow or stern, and the vessel remains level in the water at all times. This typically corresponds to a speed of less than 5 miles per hour (Gorzelany, 1998).

- Slow Speed: The speed at which all vessels are completely off plane and fully settled in the water. Some minimal water displacement at either the bow or stern (or both) may be observed. Because this will vary greatly from vessel to vessel, this speed has also been defined as approximately 5 to 9 miles per hour (Gorzelany, 1998).

- Plowing Speed: An intermediate speed between slow speed and planing speed; the bow of the vessel typically rides higher than the stern, and substantial displacement of water occurs. Depending on the size and type of vessel, plowing may occur at a variety of speeds, but is most often observed between 10 and 20 miles per hour (Gorzelany, 2000). This speed designation is used specifically for vessels with planing-type hulls.

- Cruising Speed: A qualitative speed designation uniquely applied to a relatively fast-moving vessel with a non-planing-type hull (e.g.; a pontoon boat or displacement hull vessel). It is identified by noticeable water displacement from the bow and/or stern and an observed speed faster than the previously defined slow speed designation. Similar to those at plowing speed, vessels at cruising speed most often travel at speeds between 10-20 miles per hour (Gorzelany, 2000).

- Planing Speed: A vessel traveling at sufficient speed to partially raise the vessel out of the water during travel. Vessel planing speeds vary widely depending upon vessel size and hull design; however the majority of planing vessels typically travel at speeds in excess of 15 miles per hour (Gorzelany, 1996).

Because differences between idle speed and slow speed were difficult to distinguish during aerial surveys, these two speed categories were combined and identified as "Idle/Slow".

Physical data were also recorded, including the pre-flight National Weather Service marine forecast, boating and weather conditions, wind speed and direction, air and water temperature, tide phase, and sea surface conditions. For quality assurance, a minimum of 20% of all mapped GIS data was rechecked against the original video footage for accuracy. Along with DVD-R disks, archival copies of all original video footage were maintained on an external hard disk drive.

Fixed Point Surveys

Four land-based fixed point survey sites were established at selected areas within Miami-Dade County. These sites were surveyed over a one-year period in order to evaluate daily traffic patterns and assess boater compliance within posted regulatory zones at each site. Survey sites were located at Haulover Park, Pelican Harbor Park, Downtown Miami, and Black Point (**Figure 3**). Individual site descriptions are as follows:

Haulover Park

The Haulover Park survey site was located along the Intracoastal Waterway between Bakers Haulover Inlet and Haulover Beach Park Marina. All boat traffic traveling to/from the Atlantic Ocean, along with all north-south boat traffic along the Intracoastal Waterway (ICW), was surveyed from this location. All boat traffic traveling to/from Oleta State Park and Sandspur Island was also surveyed. Because this area is also a popular boating destination, all significant movement of vessels within the inlet was also recorded. The entire survey area was located within a year-round slow speed zone *(68C-022.025(1)(A)5,* F.A.C) (**Figure 4**).

Pelican Harbor Park

The Pelican Harbor survey site was located along the 79th Street Causeway adjacent to the Pelican Harbor Boat Ramp. This location provided a view of all boat traffic traveling to/from Pelican Harbor Park, all north-south traffic along the ICW, and all boats entering/exiting the Little River. This entire survey area was located within a year-round slow speed zone *(68C-022.025(1)(A)7,* F.A.C) (**Figure 5**).

Downtown Miami

The Downtown Miami survey site was located at the mouth of the Miami River, across from Brickell Key. This location provided a view of all vessels traveling to/from the Miami River, along with all north-south boat traffic along the ICW. Boat traffic traveling to/from the east between the ICW and Fishermans Channel was also recorded. Two regulatory zones were located within the survey area, including an idle speed zone within the Miami River *(68C-022.025(1)(C)4 F.A.C).*, and a slow speed zone directly outside the Miami River along the ICW *(68C-022.025(1)(A)10, F.A.C) (***Figure 6***).*

Black Point Park

The Black Point survey site was located along the Black Point Channel facing southward between channel markers #23 and #25. This location provided a view of all east-west boat traffic traveling between Black Point Marina and Biscayne Bay, and also of vessels departing the channel to the south. Two regulatory zones were located within the survey area; these included an idle speed zone within the marked boat channel *(68C-022.025(1)(C)6, F.A.C),* and an adjacent slow speed zone immediately to the south of the marked boat channel *(68C-022.025(1)(C)13, F.A.C) (***Figure 7***).*

Eight survey days (four weekday surveys and four weekend surveys) were conducted at each survey site between April 2008 and April 2009. Surveys were conducted over six consecutive hours with start times varying between 0800 hours and 1100 hours. The same survey intervals were conducted at each site. Data collection consisted of the recording of each vessel transitioning along an established viewing area. For each observation the time of day (military time), vessel type, size, origin, destination, and qualitative speed were recorded on standard field data sheets.

Because the same vessel may have been observed multiple times, vessel counts were expressed as "vessel passes", in order to more accurately describe the number of times which any vessel (whether the same or not), transitioned through (or within) the survey area. Vessel registration and/or identifiable name were also recorded whenever possible.

Vessel attributes were similar to those discussed under the Aerial Survey Task. During fixed point surveys, however, vessels traveling at idle speed and slow speed were distinguished. Because all fixed point survey sites were established within one or more regulatory zones, vessel compliance was also determined for each surveyed vessel. Standard definitions for boater compliance (Gorzelany, 1996) were as follows:

- Compliance: Any vessel in-use that was observed to maintain a speed that was consistent with the posted speed restriction within the survey area.

- Technical Non-Compliance: A vessel that was observed to be in violation of the posted speed at a study site, as defined by:

  1) A vessel transitioning at one speed category faster than the posted speed limit (Example: a vessel traveling at slow speed within an idle speed zone, or a vessel traveling at plowing or cruising speed in a slow speed zone); or

  2) A vessel at any excessive speed, but only for a relatively short distance within the posted area (Example: a speeding vessel which extends a short distance into a slow speed zone or idle speed zone before settling off plane, or a vessel which accelerates out of a slow speed zone or idle speed zone before leaving the posted area).

- Blatant Non-Compliance: A vessel transitioning at a speed greater than one speed category faster than the posted limit through a significant portion of a speed-restricted area (Example: a vessel traveling at planing speed in a slow speed zone or a vessel traveling at plowing or planing speed through an idle speed zone).

Clear distinctions between boat speeds were difficult in certain instances due to the subjective nature of these definitions. When the vessel speed category was unclear, the more conservative, slower speed was typically chosen. This provided a potential underestimate rather than an overestimate of non-compliance (Gorzelany, 1996).

At the Haulover Park and Pelican Harbor survey sites, vessel compliance was determined based upon the posted regulatory zone at each site. At the Downtown Miami and Black Point survey sites, vessel compliance was determined for each regulatory zone that the survey vessel entered. If the same vessel transitioned through more than one regulatory zone, the vessel's speed and compliance were recorded in both areas.

Along with vessel attribute data, environmental conditions including weather, wind speed and direction, and wave height were also recorded. Boating conditions were also qualitatively evaluated as Poor, Fair, Good, or Excellent. Additional comments related to vessel identification, type, or specific activity were also recorded as needed.

Data Management and Analysis

At the completion of each sampling event, all original field data was reviewed for accuracy and completeness. All field data was entered in spreadsheet format, sorted, tabulated, and analyzed graphically using Microsoft Excel®. After the completion of data entry, a minimum of 20 percent of data from each survey site was rechecked against the original data sheets in order to ensure accuracy in computer data entry. Backup copies of all data were maintained. Original field data sheets were also archived for future reference.

RESULTS

A total of 21,252 vessels in-use were surveyed and evaluated, including 11,809 observations from aerial surveys and 9,443 observations from fixed-point surveys. Results from the aerial survey task and the fixed point survey task are discussed separately, as follows:

Aerial Surveys

A total of 11,809 vessels in-use were documented during 20 aerial surveys of Miami-Dade County. Boating conditions were evaluated as either "Good" or "Excellent" during 17 survey flights. Conditions were evaluated as "Fair/Good" during three survey flights. Weekend flights were conducted on both Saturdays and Sundays. At least one survey was flown on every weekday. Two holiday weekend surveys were also conducted over Memorial Day Weekend and Labor Day Weekend. A summary of survey dates, start times, boating conditions, and vessel counts is provided in **Table 1**.

An average of 203 vessels in-use (+/- 52) was observed in Miami-Dade County during weekday surveys. Weekday counts ranged from a low of 113 (October 10, 2008) to a high of 279 (May 5, 2008). Higher variation among survey flights was observed on weekends, with an average of 849 vessels in-use observed (+/- 374). Weekend counts ranged from a low of 440 (March 9, 2008) to a high of 1,648 (June 8, 2008). Variation in survey counts yielded a weekend/weekday ratio of 4.81–1. Lowest vessel counts corresponded to survey dates which were evaluated as "Fair/Good". Vessel counts were somewhat higher for surveys which were initiated later in the day, though no clear pattern specifically related to time of day was observed. Because of the high level of variability among survey dates, no clear seasonal pattern was apparent (**Figure 8**). In general, the volume of weekend boat traffic was higher during the summer, and the volume of weekday boat traffic was higher in the winter and spring. Weekday / weekend traffic volume was most similar between winter and spring surveys. Lowest vessel counts were generally observed during surveys conducted in the fall.

Vessel Composition

A summary of vessel composition by size category from aerial survey data is provided in **Table 2**.

Vessels in the 16-25 foot size category were most common, comprising greater than 50% of all vessels in-use observed during both weekend and weekday surveys. The numbers of smaller vessels (less than 26 feet in length) increased on weekends, along with their relative proportion of all boats observed. Larger vessels (greater than 39 feet in length) increased in numbers during weekends, however their relative proportion decreased. Largest vessels (greater than 109 feet in length) decreased in both numbers and relative proportion on weekends.

A summary of vessel composition by type category from aerial survey data is provided in **Table 3**. The five most common vessel types observed during aerial surveys were open motorboat (51% of all vessels observed), cabin motorboat (22% of all vessels observed), sailboat (14% of all vessels observed), personal watercraft (5% of all vessels observed), and kayak / canoe (3% of all vessels observed). All other vessel types comprised less than 5% of all vessels in-use observed. The relative abundance of the three most common vessel types (open motorboat, cabin motorboat, and sailboat) was essentially the same between weekday and weekend surveys. The relative abundance of personal watercraft was noticeably higher on weekends. The relative abundance of kayaks / canoes was higher on weekdays.

A summary of aerial survey data by vessel class is provided in **Table 4**. Private recreational vessels comprised greater than 98% of all vessels in-use observed. Commercial vessel traffic comprised a significantly smaller proportion of all vessel traffic on weekends (vs. weekdays), primarily due to the large increases in the amount of recreational boat traffic observed. Enforcement vessels comprised less than 1% of all traffic observed and a significantly smaller proportion of all vessel traffic on weekends.

<u>Spatial Distribution</u>

A composite map depicting all documented vessels in-use from all 20 aerial survey flights is shown in **Figures 9 and 10**. The overall spatial distribution of vessels in Miami-Dade County shows numerous areas of aggregation, including the main boating channels in northern Biscayne Bay, travel corridors to/from the Atlantic Ocean along the various tidal inlets, the coastal waters west of both Miami Beach and Key Biscayne, and the coastal waters inside Sands Key and Elliot Key, including Sands Cut. Common boating travel routes can also be seen near Black Point, Bayfront Park and along the ICW in south Biscayne Bay. Throughout the central portion of Biscayne Bay vessels were more widely dispersed and travel routes were less conspicuous.

Expanded views of traffic patterns at key locations are shown in **Figures 11-14**. In the vicinity of Bakers Haulover Inlet **(Figure 11),** large aggregations of stationary vessels were observed both inside the inlet and along Sandspur Island. Primary north-south travel routes can also be seen along the ICW between Sandspur Island and the inlet, along with additional east-west traffic to/from Oleta State Park. Aggregations of boats to/from the Haulover Park Boat Ramp can also be seen. In the vicinity of the Port of Miami, most boat traffic remains within or in proximity to marked navigation channels **(Figure 12).** With the exception of some aggregations of stationary vessels observed inside Government Cut and near Flagler Memorial Island, most vessels in this area were traveling to/from offshore or to/from other areas within the county.

Identifiable boating corridors can be seen along Key Biscayne, along navigation channels leading to/from Dinner Key and Matheson Hammock, and along the ICW channel directly south of the Rickenbacker Causeway (**Figure 13**). Vessel traffic in open water areas, however, becomes widely dispersed and travel corridors are less well-defined. Largest aggregations of stationary vessels in this area were observed along the Rickenbacker Causeway and Key Biscayne, including Cape Florida State Park. Concentrations of boats near Dinner Key and in the central portion of the Bay were associated with special boating events, including sailing regattas and poker runs.

Along the southern portion of the survey route, large aggregations of stationary vessels were observed inside Sands Key and Elliot Key **(Figure 14)**. Additional aggregations were observed along the Turkey Point Power Plant barge canal. Traffic corridors to/from both Black Point and Bayfront Park were well-defined, along with the primary north-south travel route along the ICW.

An attempt to identify fishing activity from aerial survey data was also conducted. A subset of vessels identified as either “possible fishing” or “probable fishing” are shown in **Figure 15**. Highest concentrations were observed along the eastern perimeter of Biscayne Bay from Key Biscayne south to Key Largo. Fishing activity was also observed along Government Cut, the Rickenbacker Causeway between Virginia Key and Key Biscayne, along the Turkey Point Power

Plant barge canal, and along the outer portions of the Bayfront Park and Black Point channels. Additional vessels identified as fishing were also observed sporadically throughout the County.

Spatial Analysis

The spatial distribution of vessels throughout Miami-Dade County was also examined quantitatively by overlaying a series of 314 equal-sized 1 mile radius polygons over the entire survey area (**Figure 16**). Within each polygon, the total area of water was calculated (areas not surveyed, including the Atlantic Ocean, were not calculated as part of the water area). The number of vessels observed within each polygon was then totaled, and the boat density within each polygon was calculated and expressed as the number of vessels per square kilometer of water. Using ArcGIS ®, the relative density of vessels within each polygon was then determined using a multi-class numerical classification method (Jenks natural breaks classification scheme). This technique determines the best classification of values by comparing the sums of the squared difference between observed values within each class and class mean (James et. al., 2004, TerraSeer, 2008). By setting the number of natural breaks to 5, boat density within each polygon was then identified as Low, Low-Moderate, Moderate, Moderate-High, or High.

Results, separated into northern and southern regions for detail, are provided in **Figures 17-30.** The spatial distribution for all 11,809 vessels in-use (weekdays and weekends combined) is shown in **Figures 17 and 18**. Highest overall boat densities in Miami-Dade County were located in areas with nearby access to/from the Atlantic Ocean. These areas included Bakers Haulover Inlet, Government Cut, portions of Key Biscayne, and Sands Cut / Elliot Key. Moderate levels of boating activity were observed in several locations throughout northern Miami-Dade County, including the coastal waters near the Port of Miami, Miami Beach, Virginia Key, and along the Intracoastal Waterway north of the Miami River. Additional areas with moderate levels of traffic were observed farther south near Dinner Key, Matheson Hammock, Boca Chita Key, and Angelfish Creek. Lowest concentrations of vessels were observed throughout the majority of open water areas in lower Biscayne Bay and central portions of upper Biscayne Bay. While some variations were observed, the spatial distribution of vessels was similar during weekday and weekend surveys (**Figures 19-22**), though relative concentrations of vessels near Sands Cut were greater on weekends, and the relative concentrations of vessels between the Miami River and

Government Cut were greater on weekdays.

Figures 23 and 24 show the distribution of stationary (anchored or drifting) vessels-only throughout Miami-Dade County (weekday and weekend surveys, which did not show a noticeable difference in spatial distribution, were combined). The highest concentrations of stationary vessels were observed near Bakers Haulover Inlet, Sands Cut / Elliot Key, and along portions of Key Biscayne. Moderate concentrations of vessels were observed at several other access points to/from the Atlantic Ocean near Virginia Key, Key Biscayne, Old Rhodes Key, and Key Largo. Additional areas with moderate concentrations of stationary vessels were also observed near Flagler Memorial Island and along the Intracoastal Waterway between the MacArthur Causeway (US 41) and the 79th Street Causeway (SR 934). The lowest concentrations of stationary vessels were observed in open water areas throughout lower Biscayne Bay.

The spatial distribution of slow-moving (idle speed or slow speed) vessel traffic is displayed in **Figures 25 and 26**. Highest concentrations were observed near Bakers Haulover Inlet. Moderate to high densities were observed near the Port of Miami, Government Cut, Miami Beach, and along portions of Key Biscayne. Moderate concentrations were observed in numerous areas associated with marked navigation channels in northern Miami-Dade County, and also along several boating access / destination locations in southern Miami-Dade County, including Matheson Hammock, Black Point, Bayfront Park, and Sands Cut. Lowest concentrations of slower-moving traffic occurred in open water areas, primarily in lower Biscayne Bay.

The relative densities for higher-speed vessels (traveling at plowing, cruising, or planing speed) are shown in **Figures 27 and 28**. High densities of higher-speed traffic were observed throughout northern Miami-Dade County, particularly near Bakers Haulover Inlet, Government Cut, and along the Intracoastal Waterway. Lowest densities were again observed in lower Biscayne Bay, particularly in open water areas.

Relative densities of the highest-speed traffic (planing vessels-only) are displayed in **Figures 29 and 30**. Highest concentrations of planing vessels were once again observed in the northern portions of the county, particularly near Bakers Haulover Inlet, Government Cut and in areas associated with high-speed boat channels and waterways near Miami Beach. Lowest concentrations of planing vessels were observed in lower Biscayne Bay, though low to moderate levels of high-speed traffic were observed along portions of the Intracoastal Waterway and between major boat access points such as Black Point and Bayfront Park. A single area with moderate to high concentrations of high-speed traffic was also identified along northern Key Largo near Angelfish Key / Angelfish Creek.

An expanded view of vessel distribution by speed in selected areas is shown in **Figures 31-34 (**for references to corresponding regulatory zones, also see **Appendix A**). Inside Bakers Haulover Inlet, observed vessel speeds were predominantly idle/slow or plow/cruise within the area designated as a year-round slow speed zone (**Figure 31**). To the south where vessel speed limits increase to 30 mph, the numbers of vessels observed at planing speed also increased. A similar trend is observed north of the inlet, where speed limits also increase to 30 mph year-round. Observed vessel speeds also increased within the inlet itself. Along the Intracoastal Waterway near the entrance to the Miami River, observed boat speeds within posted year-round idle speed and slow speed zones were generally slower than in adjacent unregulated areas; however numerous vessels traveling at higher speeds were also observed (**Figure 32**). A higher proportion of high-speed traffic was also observed in both unregulated and high-speed channels and watersports areas inside Miami Beach and along Government Cut. Numerous high-speed vessels were also observed outside high-speed channels in adjacent year-round slow speed zones north of the Port of Miami. South of the Rickenbacker Causeway, boat traffic is more widely dispersed and observed speeds were generally higher in unregulated open water areas (**Figure 33**). In lower Biscayne Bay, higher-speed traffic was commonly observed in open, unregulated areas and slower traffic was observed within idle speed / slow regulated areas near Black Point, Bayfront Park, and inside Sands Cut **(Figure 34**). A general increase in boat speeds within the Black Point and Bayfront Park navigation channels with increasing distance from shore was also observed.

Fixed Point Surveys

A total of 9,443 vessel observations were made from the four fixed point survey sites, including 1,641 observations from Black Point, 1,963 observations from Downtown Miami, 1,858 observations from Pelican Harbor, and 3,981 observations from Haulover Park. A summary of sampling dates, survey intervals, vessel observations, and boating conditions are provided in **Table 5**. Levels of boat traffic were highly variable at each survey site. Daily observations ranged from 59 to 421 at the Black Point site, from 122 to 457 at the Downtown Miami site, from 56 to 460 at the Pelican Harbor site, and from 81 to 1,153 at the Haulover Park site. The highest traffic volume was observed at the Haulover Park site, with an average of greater than 130 vessel passes per hour during weekend surveys. Weekday versus weekend comparisons in boat traffic at each survey site are shown in **Table 6**. The survey sites with the greatest differences between weekday and weekend traffic were Haulover Park and Black Point. Traffic volume increased more than four times on weekends at these sites. The survey site with the smallest difference between weekdays and weekends was the Downtown Miami site, where traffic increased just slightly more than two times on weekends.

Vessel Composition

Vessel composition (size, type, class) also varied among survey sites. Vessel composition by size class for each fixed point survey site is shown in **Figure 35**. Vessels observed at the Black Point site were predominantly in the 16-25 foot and 26-39 foot size categories. These two vessel sizes comprised 97% of all vessels observed at this site. The Black Point site also had the fewest number of both smaller vessels (less than 16 feet) and larger vessels (greater than 39 feet) of all survey sites. The largest proportion of large vessels (greater than 39 feet) was observed at the Downtown Miami survey site. The largest proportion of small vessels (less than 16 feet) was observed at the Haulover Park site, though relative proportion of vessel sizes at Pelican Harbor and Haulover Park were very similar.

Open motorboats and cabin motorboats were the two most common vessel types observed at each survey site, though their relative abundance varied (**Figure 36**). At Black Point, these two vessel types comprised 95% of all vessels observed. Open motorboats and cabin motorboats comprised a smaller percentage of traffic at the Downtown Miami site and additional vessel types, particularly sailboats and personal watercraft, were more common. The distribution of vessel types was again similar between the Pelican Harbor and Haulover Park survey sites. Proportions of open motorboats and cabin motorboats at these sites were similar. Personal watercraft were also most common at these two sites. The only significant observations of kayaks / canoes were at the

Haulover Park site, comprising 4% of all vessels observed.

The distribution of vessel classes, separated into Private/Recreational, Commercial, and Enforcement, is shown in **Figure 37**. Private / recreational vessels were the most common vessel class at all four survey sites, comprising as much as 97% of all vessels observed at the Black Point and Pelican Harbor sites. Commercial vessels were most common at the Downtown Miami survey site. Enforcement vessels comprised 2% of all vessels observed at the Haulover Park site, and 1% of all vessels at other survey sites.

Patterns Of Travel

In order to identify primary travel corridors, the direction of travel (vessel origin and destination) was also examined at each survey site.

The following trends were observed at the Haulover Park site:

- 18.2% of all vessel passes involved transitional north-south travel along the ICW (a higher proportion was observed on weekdays).
- 64.3% of all vessel passes involved travel either to/from the north.
- 38.3% of all vessel passes involved travel either to/from the south.
- 17.5% of all vessel passes involved travel either to/from the west toward Oleta State Park and Sandspur Island (a higher proportion was observed on weekends).
- 43.9% of all vessel passes involved travel either to/from offshore through Bakers Haulover Inlet.
- 22.9% of all vessel passes involved traffic remaining within the survey area (a higher proportion was observed on weekends).

A summary of origin / destination information from the Haulover Park survey site is shown in **Table 7.**

The following trends were observed at the Pelican Harbor Park site:

- 35.1% of all vessel passes involved transitional north-south travel along the ICW (a higher proportion was observed on weekdays).
- 17.0% of all vessel passes involved travel to/from the Little River.
- 4.3% of all vessel passes involved travel to/from the east toward North Bay Village.
- 41.6% of all vessel passes involved travel either to/from Pelican Harbor Park.
- 16.7% of all vessel passes involved travel from Pelican Harbor Park to the north.
- 21.2% of all vessel passes involved travel from Pelican Harbor Park to the south (a higher proportion was observed on weekends).
- 3.7% of all vessels observed traveled from Pelican Harbor Park to the east.

A summary of origin / destination information from the Pelican Harbor Park survey site is shown in **Table 8.**

The following trends were observed at the Downtown Miami site:

- 39.6% of all vessel passes involved transitional north-south travel along the ICW (a higher proportion was observed on weekends).
- 37.3% of all vessel passes involved travel to/from the Miami River.
- 13.3% of all vessel passes involved travel from the Miami River to the south (a higher proportion was observed on weekdays).
- 10.7% of all vessel passes involved travel from the Miami River to the north.
- 13.3% of all vessel passes involved travel from the Miami River to the east (a higher proportion was observed on weekdays).

A summary of origin / destination information from the Downtown Miami survey site is shown in **Table 9.**

The following trends were observed at the Black Point site:

- 93.7% of all vessel passes involved transitional east-west travel within the marked navigation channel (a higher proportion was observed on weekends).
- 0.7% of all vessel passes involved transitional east-west travel outside the marked navigation channel.
- 5.4% of all vessel passes involved boats which exited/entered the marked navigation channel to / from the south (a higher proportion was observed on weekends).

A summary of origin / destination information from the Black Point survey site is shown in **Table 10.**

Daily Variation

A summary of hourly boat activity (to/from all directions) at the Haulover Park survey site is shown in **Figure 38.** Haulover Park exhibited the highest volume of boat traffic of all four survey sites. On weekends, boating activity generally increased throughout the morning and early afternoon, peaking at an average of 179 vessel passes per hour between 1300 to 1359 hours. Later in the day (1400 to 1659 hours), the volume of boat traffic generally decreased but remained relatively high (greater than 100 vessel passes per hour). Similar patterns were observed, though greatly reduced, during weekday surveys. Peak levels of boating activity on weekdays also occurred between 1300 and 1359 hours, though traffic volume was only 38 vessels per hour. Hourly variations in boat traffic to/from the Atlantic Ocean through Bakers Haulover Inlet are shown in **Figure 39**. Overall, the highest volume of boat traffic traveling to the ocean occurred between 0800 and 0859 hours (65 vessel passes per hour). The highest volume of boat traffic returning from the ocean occurred between 1200 and 1259 hours (58 vessel passes per hour). The number of boats traveling to the ocean decreased and boats returning from the ocean increased throughout the morning). Between 1100 and 1159 hours, the volume of boat traffic was essentially the same in both directions. Later in the day, both the numbers of boats traveling to the ocean and returning from the ocean gradually decrease, though there is a slight increase in boats returning between 1600 and 1659 hours.

Hourly variations in boat traffic at the Pelican Harbor site are shown in **Figure 40**. Weekend boat traffic generally increased throughout the morning and early afternoon, with highest amount of traffic occurring between 1300 and 1359 hours (87 vessel passes per hour). Relatively low amounts of traffic occurred on weekdays, with levels remaining between 8 and 18 vessel passes per hour throughout the day. Hourly traffic patterns associated with the Pelican Harbor Park boat ramp are shown in **Figure 41**. Vessels departing from Pelican Harbor Park generally increased throughout the morning and early afternoon, peaking at 30 vessel passes per hour between 1300 and 1359 hours. Later in the afternoon (1600 to 1659 hours), boats traveling from the ramp decreased to an average of 6 vessel passes per hour. Boat traffic returning to the Pelican Harbor Park ramp increased throughout the day, peaking at 24 vessel passes per hour between 1600 and 1659 hours. The number of vessels entering and exiting Pelican Harbor Park was essentially the same between 1500 and 1559 hours.

The volume of weekend boat traffic at the Downtown Miami survey site generally increased throughout the day, peaking at 82 vessel passes per hour between 1500 and 1559 hours (**Figure 42**). A similar trend occurred on weekdays, though the volume of traffic is substantially lower; peaking at 31 vessel passes per hour between 1500 and 1559 hours. Between 0900 and 0959 hours, the volume of traffic observed on weekdays and weekends was essentially the same (approximately 16 vessel passes per hour). Later in the day, however, traffic volume on weekends exceeded weekday volume by more than 50 vessel passes per hour. Boat traffic specifically associated within the Miami River was also examined (**Figure 43**). The amount of boat traffic entering and exiting the river generally increased throughout the day. The highest levels of traffic entering the Miami River occurred between 1400 and 1459 hours (28 vessel passes per hour). The highest levels of traffic exiting the Miami River occurred between 1600 and 1659 hours (26 vessel passes per hour). In general, the volume of traffic entering and exiting the river was similar throughout the day, though there is more variation in abundance later in the afternoon.

On weekends, vessel traffic generally increased throughout the day at the Black Point survey site, peaking at 71 vessel passes per hour between 1600 and 1659 hours (**Figure 44**). Traffic volume remained relatively low throughout the day on weekdays, ranging from 7 to 15 vessel passes per hour with no noticeable daily pattern. Variations in vessel traffic to and from Black Point Marina are shown in **Figure 45**. The numbers of vessels traveling eastbound from the marina to Biscayne Bay increased throughout the morning, peaking between 1000 and 1159 hours (58 vessel passes per hour). The number of vessels then decreased throughout the afternoon to less than 10 vessel passes per hour between 1600 and 1659 hours. The number of vessels returning westbound from Biscayne Bay towards Black Point Marina increased throughout the day, peaking at 68 vessel passes per hour between 1600 and 1659 hours.

Vessel Speed and Boater Compliance

Observed boat speed and corresponding compliance evaluation was recorded for each vessel transitioning through a posted regulatory zone. Two regulatory zones (year-round idle speed and year-round slow speed) were located at both the Downtown Miami and Black Point survey sites. A single year-round slow speed zone exists at both the Haulover Park and Pelican Harbor survey sites. A summary of observed vessel speeds for each site and regulatory zone is provided in **Table 11**. The highest proportion of higher-speed (plowing / cruising / planing) boat traffic was observed at the Black Point survey site. The lowest proportion of higher-speed traffic was observed at the Haulover Park site.

For all vessels surveyed at the four fixed point survey sites, 52% were observed to be in compliance with posted speed zones, 29% were technically non-compliant, and 19% were blatantly non-compliant. Levels of compliance varied significantly, however, among survey sites and regulatory zones (**Figure 46**). At the Haulover Park site, 69% of boaters were in compliance within the posted slow speed zone – the highest rate of compliance among all survey sites. Blatant non-compliance was 7% - the lowest rate of blatant non-compliance among all survey sites. In contrast, the proportion of vessels in compliance within the idle and slow speed regulatory zones at Black Point was 14% and 34% respectively, with corresponding rates of blatant non-compliance at 47% and 60%. Compliance in different regulatory zones at the same survey site also varied greatly. At the Downtown Miami site, a 61% rate of compliance and 9% rate of blatant non-compliance were observed for vessel traffic traveling through the slow speed zone along the Intracoastal Waterway outside of the Miami River. Within the idle speed zone inside the Miami River, however, a 22% rate of compliance and 34% rate of blatant non-compliance were observed. In general, higher rates of boater compliance were observed in slow speed versus idle speed zones. The Black Point site was the exception with relatively low levels of compliance in both regulatory zones, and lower levels of compliance observed for vessels exiting the marked navigation channel south into the adjacent slow speed zone.

Similar patterns in boater compliance were observed between weekdays and weekends, though levels of compliance were slightly higher and levels of blatant non-compliance were slightly lower on weekends at most survey sites (**Figure 47**). The one exception was once again at Black Point, which had lower levels of compliance and higher levels of blatant non-compliance within the idle speed navigation channel on weekends. Slightly higher levels of both compliance and blatant non-compliance were observed within the ICW channel at the Downtown Miami site on weekends.

Boater compliance associated with specific directions of travel at each survey site was also examined. At Haulover Park, slightly lower levels of compliance were observed for vessels originating from offshore, and slightly higher levels of blatant non-compliance were observed for vessels originating from the south. Overall, however, levels of compliance were similar for all four primary directions of travel (**Figure 48**). A greater variation in compliance with direction of travel was observed at the Pelican Harbor survey site (**Figure 49**). Noticeably higher levels of compliance (69%) and lowest levels of blatant non-compliance (11%) were observed for vessels exiting the Little River. Lower levels of compliance (45%) and higher levels of blatant non-compliance (26%) were observed for boat traffic originating from the south along the ICW. Compliance in association with direction of travel also varied at the Downtown Miami site (**Figure 50**). Highest levels of compliance (69%) were observed for vessels originating from the north along the ICW. Lowest levels of blatant non-compliance were observed for vessels originating from the east (8%) and from the north (9%). Significantly lower levels of compliance were observed for vessels entering the Miami River (28%) and exiting the Miami River (16%). Higher levels of blatant non-compliance were also observed for vessels traveling both to and from the River (36% and 32% respectively). Along with differences between regulatory zones, levels of compliance also differed by direction of travel within the same regulatory zone at the Black Point site. Overall levels of compliance was significantly lower for westbound traffic returning to Black Point Marina compared with eastbound traffic departing from Black Point Marina (**Figure 51**)

Finally a comparison of boater compliance by vessel size and type was performed, with survey data from all four fixed point sites pooled together. Results comparing compliance with vessel size are shown in **Figure 52**. A distinct trend toward decreasing levels of compliance with decreasing boat size was observed. In addition, increasing levels of blatant non-compliance with decreasing boat size was also observed. A comparison of compliance and vessel type is provided in **Figure 53**. The vessel type with the lowest levels of compliance was personal watercraft (38% compliance, 40% blatant non-compliance). Highest levels of compliance were observed by sailboats under power (87% compliance, 3% blatant non-compliance), cabin motorboats (56% compliance, 12% blatant non-compliance), and high performance boats (60% compliance, 12% blatant non-compliance). Levels of compliance were similar between commercial and recreational vessels (both = 52% compliance overall), though commercial vessels had slightly higher levels of technical non-compliance (33% vs. 29%) and recreational vessels had slightly higher levels of blatant non-compliance (19% vs. 15%).

<u>Enforcement Presence</u>

Enforcement vessels were observed at all four survey sites, though their frequency and levels of activity varied among sites. At the Black Point survey site, enforcement vessels were observed on seven out of eight survey dates, however vessels were typically transitioning through the area rather than remaining within the survey area to actively enforce speed zones. Similarly, enforcement vessels were observed on six out of eight survey dates at the Downtown Miami River site, however all sightings were of vessels transitioning through the area. No active enforcement of speed zones was observed. Enforcement vessels were observed on seven out of eight survey days at Pelican Harbor and on eight out of eight survey days at Haulover Park. At both sites, enforcement vessels from multiple agencies were observed actively enforcing speed zones. Law enforcement agencies observed included the Bal Harbor Police Department, Bay Harbor Islands

Police Department, the Florida Fish and Wildlife Conservation Commission, Hallandale Beach Police Department, Indian Creek Police Department, Indian Shores Police Department, Miami-Dade Police Department, North Miami Police Department, Sunny Isles Beach Police Department, U.S. Coast Guard, and U.S. Customs and Border Protection. Several observations of unmarked law enforcement vessels were also noted.

<u>Incidental Manatee Sightings</u>

Sightings of manatees were documented at three out of four survey sites. At the Downtown Miami and Black Point survey sites, manatees were observed during six out of eight survey days. All manatee sightings at the Downtown Miami site were within the Miami River. A total of eight separate sightings were made in the Miami River on December 6, 2008 and six separate sightings were made on January 17, 2009. All sightings of manatees at the Black Point survey site were within the Black Point channel. Four separate sightings were made on January 12, 2009. A single manatee sighting was recorded at the Pelican Harbor site on July 10, 2008. No manatee sightings were recorded at the Haulover Park site. Observations of manatees were considered incidental and only provide supplemental information. They were not intended to represent actual abundance or distribution of manatees at fixed point survey sites.

DISCUSSION

The amount of boat traffic observed in Miami-Dade County varied greatly, particularly during weekend surveys. While aerial survey counts were fairly consistent among weekday flights (ranging from 113 to 279 vessels per survey), weekend survey counts varied substantially. For example, two weekend survey flights conducted in the same month (June 2008) differed by more than 1,000 observed vessels. Similar high levels of variability in weekend boat traffic among aerial survey flights have also been reported in previous studies (Gorzelany, 1998, 2005, 2006, 2008). Significant increases in vessel traffic on weekends were also observed. In Miami-Dade County, a weekend-weekday ratio of 4.81–1 was observed; substantially higher than weekend-weekday ratios observed in other Florida counties including Collier County (1.59-1), Lee County (2.08-1), Sarasota County (2.13-1), and Broward County (2.51-1). Commercial vessels comprised a larger proportion of vessel traffic on weekdays. This was observed from both aerial and fixed point survey data. At the Downtown Miami fixed point survey site, for instance, commercial vessels comprised 21% of all observations on weekdays but only 9% of all observations on weekends. This was primarily the result of large increases in the amount of recreational boat traffic observed on weekends.

Though no clear seasonal pattern was observed, higher levels of recreational boat use were generally observed in the spring, which was consistent with results from recent boat studies (Gorzelany, 1998, 2006, 2008, Sidman et al., 2004, 2006). Seasonal trends in recreational traffic were somewhat difficult to assess due to the relatively small sample size (20 survey flights) and high variability in recreational boat use among flights. The abundance and distribution of recreational boat use in coastal waters can be influenced by a variety of factors, including the time of day, weather conditions, wind speed and direction, air and water temperature, and in some cases, tide phase. Boating activity may also be influenced by weather advisories and forecasts on any given day. Abundance and distribution may be further affected by special events (regattas, boat shows, poker runs, fishing tournaments, etc.). During the Miami-Dade boat study, certain local events were specifically avoided (Columbus Day Regatta, lobster mini season) because of the uncharacteristic boat traffic volume and patterns that are known to occur. Other factors may also have influenced boating activity throughout the course of the study. Fuel prices, for instance, exceeded $5.00 per gallon in Miami-Dade County during the summer of 2008, then dropped below $2.75 per gallon during the winter of 2009. The impact which fuel prices, along with the general economic downturn, affected boat use throughout the study is uncertain. As a result, a sample size of 20 survey flights is probably insufficient to capture all aspects of temporal variability including hourly, daily, and seasonal trends, though general patterns can still be assessed.

The distribution of vessel sizes throughout Miami-Dade County is consistent with findings from previous Florida boating studies (Gorzelany 2005, 2006, 2007, 2008, PBS&J 2008), with vessels less than 26 feet in length as the most common vessel size. This is also consistent with previous studies conducted in Miami-Dade County. 79% of respondents to a mail survey conducted in Miami-Dade County indicated that they owned vessels from 16 to 26 feet length (University of Miami, 1991). Smaller vessels (less then 30 feet in length) comprised between 50-80% of all vessels identified in aerial surveys of Biscayne National Park conducted in 2003-04 (Ault et.al, 2008). While higher proportions of larger vessels were observed in field studies conducted by Futerfas (2003) and by FWC (unpublished data, 2002-03) these surveys were limited to the downtown Miami area, where larger vessel traffic was more common. Miami-Dade County has particularly similar boating characteristics to other Florida east coast counties including Broward, Palm Beach, Martin, and Brevard Counties (Gorzelany 2005; PBS&J, 2008; FWC unpublished data, 2007). While boat traffic in these counties is predominantly smaller vessels (less than 26 feet in length), Florida east coast counties (including Miami-Dade) also have a higher proportion of larger vessels in-use (**Table 12**). Larger vessels (greater than 39 feet in length) comprised greater than 10% of all boat traffic observed in Miami-Dade, Broward, Palm Beach, Martin, and Brevard Counties. By comparison, larger vessels comprised less than 5% of all vessels in-use observed in Florida west coast counties (Collier, Lee, Charlotte, and Sarasota). With the exception of differences in small versus large powerboats already discussed, the relative distribution of various vessel types among Florida east coast and west coast counties was less distinct (**Table 13**). While Miami-Dade County had the highest proportion of sailboats of all counties previously surveyed (14%), other common vessel types, including personal watercraft and kayaks / canoes were in similar proportion. Relative proportions of recreational versus commercial boat traffic showed a similar disparity between east coast versus west coast counties (**Table 14**). Higher proportions of commercial vessels were typically observed in east coast counties, particularly Broward, Martin, Miami-Dade, and Brevard Counties. In Broward, Brevard, and Miami-Dade Counties, this was likely influenced by increased commercial activity near established shipping ports such as Port Canaveral, Port Everglades, and the Port of Miami. In addition, a well-established water transportation network exists in Broward County. No comparable commercial operations exist in Collier, Lee, Charlotte, or Sarasota Counties. If boating surveys were conducted in Hillsborough County, however, the relative proportion of commercial traffic might be expected to more closely compare with east coast counties due to the influence from the Port of Tampa and commercial activity in the downtown Tampa area.

An attempt to identify recreational fishing was included as part of this study by identifying vessels engaged in fishing activity from aerial survey video footage. This information was displayed in **Figure 15**. This information should be considered as a conservative estimate for several reasons. First, the identification of "fishing activity" from various other stationary activities including sightseeing, sunbathing, swimming/snorkeling, and picnicking, may be unreliable from aerial survey footage. Secondly, fishing may be only one of a number of activities that take place on a typical recreational boating trip. What constitutes "fishing" as the identifiable activity for a specific boat may be difficult to determine. Also, the number of vessels underway whose ultimate purpose may be fishing can not be determined from aerial footage, and these vessels were simply recorded as "traveling" (the 1991 boating study conducted by the University of Miami also found a significant number of boaters reporting offshore destinations for recreational activities, including fishing). Finally, fishing was identified as among the most frequent boating activities by more than 50% of all respondents in previous mail surveys conducted in Miami-Dade County (Futerfas, 2003, University of Miami, 1991), suggesting that fishing activity probably occurs more commonly than reported in this study. As a result, while information collected on fishing activity from aerial survey data may accurately depict the spatial distribution of typical fishing destinations in Biscayne Bay and inshore waters, the overall level of activity is probably underestimated. Similarly, the number of commercial vessels identified from aerial survey footage may also be underestimated. While the most obvious types of commercial vessels were readily recognized (tugboats, towboats, tenders, barges, cargo ships, sightseeing / dinner cruises, etc.), other types of commercial vessels may not be consistently identified from aerial video footage, including smaller commercial fishing boats, fishing guides and charters, and small dive boats. While we expect that the relative proportions of recreational and commercial vessels is reasonably accurate (similar levels of commercial traffic were observed from both aerial and fixed point surveys), the actual number of countywide commercial vessels in-use identified from aerial survey data may be underestimated. Likewise, sightings of law enforcement vessels may be underestimated for the same reason. Similar findings on commercial and enforcement activity have been reported in recent boating studies conducted in Southwest Florida (Gorzelany, 2004, 2006, 2008).

Boat traffic corridors in northern Miami-Dade County (north of the Rickenbacker Causeway) were commonly associated with established navigation channels (**Figures 11, 12**). South of the Rickenbacker Causeway, however, boat traffic becomes more widely dispersed (**Figures 13, 14**). This is probably due in part to fact that there is sufficient water depth for vessels of all sizes, so boats are less inclined to remain within marked navigation channels. Another reason for the reduction in visible boating corridors is that aerial survey data includes observations from a variety of special boating events, including numerous sailing regattas and poker runs. Along with boating corridors, numerous aggregations of stationary boats identifying popular destinations can also be seen. These locations include Bakers Haulover Inlet, Sandspur Island, Flagler Memorial Island, the Rickenbacker Causeway, Key Biscayne, and Sands Cut / Elliot Key.

The spatial analysis of aerial survey data was successful in identifying several high-use boating areas in Miami-Dade County. Popular boating destinations, represented by high concentrations of anchored or drifting vessels, were identified in several areas including Bakers Haulover Inlet, Sands Cut / Elliot Key, and along portions of Key Biscayne (**Figures 23, 24**). Relatively high densities of moving vessels (all speeds) were also observed near Bakers Haulover Inlet (**Figures 25, 27, 29**), indicating that this area is both a popular boating destination and significant boating corridor. Relatively high proportions of high-speed boat traffic were identified along the Downtown Miami area, the Port of Miami, Government Cut, and the coastal waterway behind Miami Beach. Many of these areas include significant portions of unregulated waterway. North of Bakers Haulover Inlet, however, moderate to high densities of higher-speed traffic were also identified along portions of coastal waterway currently designated as year-round slow speed zones. Lower Biscayne Bay can be characterized by low overall densities of boat traffic throughout most open water areas, well-defined access channels along the western shore

(Matheson Hammock, Black Point and Bayfront Park) and a popular recreational boating destination at Sands Cut / Elliot Key. A similar distribution of boat traffic in lower Biscayne Bay, particularly near Sands Cut and Elliot Key, was also observed by Ault et. al., (2008). Lower overall densities of boat traffic throughout much of lower Biscayne Bay (all categories) may be a function of both lower levels of boat use and the sheer size of the waterway (portions of lower Biscayne Bay are more than 10 nautical miles wide). Boating access points such as Black Point Marina and Bayfront Park can be identified by slightly higher levels of boat density, however boat traffic quickly becomes dispersed throughout lower Biscayne Bay (**Figure 18**). While management issues may still occur on a smaller scale at places such as Black Point and Bayfront Park, overall it does not appear that significant issues related to boat traffic abundance or areas of congestion occur in lower Biscayne Bay. Vessel speed also may not be a significant management issue near popular boating destinations such as Sands Cut and Elliot Key since only low to moderate densities of high-speed traffic were observed (**Figures 28, 30**). The presence of a slow speed minimum wake zone established by the National Park Service is likely a contributing factor to reduced speeds in this area.

From aerial survey data, an overall reduction in high-speed boat traffic was observed in regulated areas such as Bakers Haulover Inlet, Downtown Miami, and along access points in lower Biscayne Bay such as Black Point and Bayfront Park (**Figures 31-34).** In these areas, observed speeds were generally lower than in adjacent unregulated areas. Slower-moving vessels, however, were not necessarily in compliance with regulatory zones. For instance, somewhat slower speeds (fewer boats observed at planing speed) were observed along the entrance to the Miami River (**Figure 32**). Numerous vessels traveling at plowing or cruising speed were still observed, however, and are still considered non-compliant with posted slow speed and idle speed regulatory zones in this area. Similarly, fewer boats at planing speed were observed along the Black Point Channel than in adjacent areas (**Figure 34**), however numerous observations of vessels traveling at plowing or cruising speed, which was still considered as blatantly non-compliant within the Black Point channel, were observed.

While the spatial analysis technique used in this study is useful in examining countywide recreational boating trends, it has some inherent limitations and some of the results should be approached with caution. Along with the number of vessels observed, a critical component in the determination of boat density is the amount of water within each calculated area. Because the calculation of boat density is dependent upon the area of water within each polygon, areas with relatively small amounts of water will significantly influence density values. An example can be found in lower Biscayne Bay along Angelfish Creek (**Figures 28, 30**). Densities of high-speed traffic in this area were considered "Moderate to High" in spite of the fact that relatively few vessels (less than 50) were observed in the area during the entire study. This is due to the fact that this location also had a relative small calculated water area. The opposite trend can also occur. Greater than 50 boats were observed in several open water areas in lower Biscayne Bay, however due to the large associated area of water, boat densities were determined to be "Low". For this reason, the spatial analysis technique used in this study is useful as a guide in identifying high traffic areas however a closer examination of individual areas is needed in order to specifically address either wildlife management or human safety issues. Ultimately the areas of greatest management interest will have; 1) High numbers of powerboats in-use, 2) High densities of powerboats relative to available water area, and 3) a significant number of boats traveling at higher speeds. Areas which meet these criteria are primarily located in northern Miami-Dade County, including the Downtown Miami area, the Intracoastal Waterway immediately north and south of the Miami River, the Port of Miami including Government Cut, and the Intracoastal Waterway immediately north and south of Bakers Haulover Inlet. (**Figures 27, 29**).

The identification of relatively high concentrations of boat traffic in itself does not necessarily suggest a management or regulatory response. Several other factors should also be examined. As mentioned previously, Miami-Dade County is among the leading Florida counties in both reportable boating accidents and fatal boating accidents. While the nature of these incidents may be site-specific, the new information on recreational boating activity may provide additional insight on issues involving risk assessment. Similarly, the information from this study may serve as an important management tool regarding manatee protection. By merging information on boating activity with information on parameters such as manatee distribution and / or watercraft-related manatee mortality, assessments of relative risk can be developed which may decrease the likelihood of boat-manatee interaction.

Fixed point surveys provided valuable supplemental information on boating activity in selected important areas of Miami-Dade County. The collection of boat survey data in the Downtown Miami area was particularly important due to the inability to access the upper Miami River during aerial surveys. Fixed point surveys also provide the opportunity to collect information on speed zone effectiveness within specific areas of concern. While compliance with speed zones can be estimated from aerial surveys, vessel speeds can be determined more precisely with boat- or land-based observations. Differences between idle speed and slow speed, for instance, can be fairly subtle particularly when viewed from aerial footage. Fixed point surveys also provide the ability to evaluate the same vessel as it transitions through different regulatory zones, or between unregulated and regulated areas. A brief summary of information collected from each fixed point survey site is provided below:

The Haulover Park survey area functions as a significant travel corridor for both north-south boat traffic along the Intracoastal Waterway and for traffic to/from offshore through Bakers Haulover Inlet. In addition, this area is a significant boating destination (also documented by aerial surveys), with as many as 150-200 boats observed anchored on the shoal inside the Inlet. This survey site had the largest volume of traffic of all fixed point sites, with greater than two times the volume of traffic observed at any other site. A unique characteristic of this site was the relatively high proportion of kayaks and canoes which were observed in the survey area, presumably due to proximity to Oleta State Park. Vessels transitioning through the area travel within a year-round slow speed zone, which had the highest levels of boater compliance and lowest levels of blatant non-compliance of all fixed point survey sites. This may be due in part to the large volume of traffic observed at times, which can create a self-regulating effect (Gorzelany, 2000) due to high amounts of congestion. A strong relationship between boater compliance and law enforcement presence has also been documented in previous studies (Gorzelany, 2001, 2007) and both a relatively high number of enforcement vessels and enforcement activity were noted in the area. Most boat traffic in the area originates from the north, which is also the direction of the nearest marina, fuel dock, and boat ramp. Presumably a significant number of vessels originating from the north use the Haulover Park ramp, however they could not be distinguished from other traffic originating from farther north along the ICW due to distance between the observation site and the ramp. Boating activity near this ramp was also captured by the aerial survey data (**Figure 11**).

Daily traffic patterns indicated that vessel activity increases throughout the morning and early afternoon, then decreases later in the afternoon. A slight increase in the volume of traffic at the end of the day is probably the result of boat traffic returning to the area from offshore.

The Pelican Harbor site had many similar characteristics to Haulover Park. Vessel size distribution and the relative proportion of the most abundant vessel types (open fishermen, cabin motorboat, and personal watercraft) were similar between the two sites. Daily traffic patterns were also similar between the two sites. This is presumably due in part to the fact that the two survey sites are in relatively close proximity to each other compared with any other pairings of fixed point sites. Several boating corridors were observed at this site, including vessels traveling to/from the Pelican Harbor boat ramp, vessels transitioning north-south along the ICW, and vessels traveling to/from the Little River. Compliance was generally lower than Haulover Park, and also lower than ICW traffic at the Downtown Miami site. There was a high level of variability in compliance for different directions of travel, however. Vessels traveling to/from the Little River had the highest levels of compliance (69%). Other primary travel corridors were similar to each other, though higher levels of compliance were observed for vessels traveling to/from the Pelican Harbor ramp, and higher levels of blatant non-compliance were observed for vessels traveling to/from the south along the ICW. Higher compliance values for vessels traveling to/from the north are likely influenced by proximity to the 79th Street Causeway. This was also demonstrated for boat traffic traveling to/from the Pelican Harbor Ramp. For all vessels departing Pelican Harbor to the north under the 79th Street Causeway, 78% were evaluated as compliant, 11% were technically non-compliant, and 11% were blatantly non-compliant. For vessels departing Pelican Harbor to the south, 53% were compliant, 20% were technically non-compliant, and 27% were blatantly non-compliant. Still lower values were observed for vessels departing Pelican Harbor and turning back to the southeast towards North Bay Village (54% compliance, 12% technical non-compliance, 35% blatant non-compliance). Compliance results from different directions of travel within the same survey site and regulatory zone again indicates a high level of variability in boater behavior and compliance from place to place.

The Downtown Miami survey site was comprised of two different regulatory zones; a slow speed zone outside the Miami River along the Intracoastal Waterway, and an idle speed zone within the

Miami River. While vessel composition was similar between the two regulatory zones, boater compliance was noticeably different. Lower levels of boater compliance and higher levels of blatant non-compliance were observed within the Miami River. This is primarily due to the more restrictive idle speed zone within the River. In fact, the relative proportion of various boat speeds within the Miami River was slower than for vessels outside the River. A higher proportion of vessels traveling at idle speed (22% vs. 14%) and a lower proportion of vessels traveling at planing speed (3% vs. 9%) were observed within the River. Vessels traveling at slow speed, plowing speed, and cruising speed were similar in both areas. A relatively high proportion of commercial vessels were observed at the Downtown Miami site, including commercial tug boats and tenders, commercial fishing boats, barges, cargo ships, sightseeing / dinner cruises, and commercial towboats. Presumably the high level of commercial activity was influenced by proximity to both the Port of Miami and the downtown Miami area. While more commercial activity was observed, law enforcement vessels were observed much less frequently than at either Haulover Park or Pelican Harbor Park. Sightings of law enforcement vessels were essentially limited to observations of vessels transitioning through the survey area. No enforcement of speed zones was observed throughout the eight survey days at this site. Another unique characteristic of this site was the relatively low weekend / weekday ratio of vessel traffic compared with the other three survey sites. This is presumably due at least in part to the higher level of commercial activity at this site. Boat traffic originating from the north along the ICW near the Miami River exhibited slightly higher levels of compliance and slightly lower levels of blatant non-compliance than for boats traveling in the opposite direction (from south). This may be due to the fact that vessels from the north were transitioning through a series of idle speed boating safety zones prior to entering the survey area, which may have influenced their speed.

Boat data from the Downtown Miami site was also compared to previous observational studies conducted from Brickell Key by Futerfas (2003) and FWC (2002-03; unpublished data). Vessel attribute data was similar, though some variation in the relative proportion of vessel types, a higher proportion of smaller boats, and a lower proportion of commercial boats were observed. These previous studies did not survey boats within the Miami River, however, where a larger proportion both commercial vessels and larger vessels originated. In addition, these studies were only conducted on weekends, which may have influenced the relative proportion of different user groups observed, including levels of commercial use. These studies also noted a higher proportion of faster-moving boat traffic along the ICW, with a higher proportion of vessels at plowing / cruising speed. Because the survey site used for these studies was located on Brickell Key (farther south than the location used for this studies, this may suggest that north-south vessels transitioning this area may travel at faster speeds with increasing distance from the downtown area. This trend was also indicated in the aerial survey data (**Figure 32**), where somewhat faster speeds were observed along the ICW channel south of the Miami River.

Like the Downtown Miami survey site, two different regulatory zones were located within the survey area at Black Point; an idle speed zone within the marked channel and an adjacent slow speed zone outside the marked channel. The slow speed zone was used relatively infrequently, representing only 100 out of 1,641 vessel observations (6.1%). The primary reason may be that the area outside of the marked navigation channel is limited by water depth, particularly at low tide; forcing most vessels to remain within the channel. Boater compliance in this area was generally low. Within the marked idle speed channel, only 14% of all boats were compliant and 48% were blatantly non-compliant. Unlike the Downtown Miami site, compliance along the adjacent slow speed zone was slightly better (34%), but blatant non-compliance was worse (60%). Vessels attempting to leave a deeper, more restrictive boat channel as a "short cut" to their destination have been observed in other studies (Gorzelany, 2000). Such areas are typically associated with poor compliance and high levels of blatant non-compliance, as boaters attempt to achieve higher speeds in order to reduce draft and travel over shallow areas. Another aspect of boater behavior in this area is that levels of compliance varied noticeably by direction of travel within the same speed zone. Within the idle speed channel, eastbound traffic (vessels departing Black Point Marina toward Biscayne Bay) had higher levels of compliance and lower levels of blatant compliance than westbound traffic (**Figure 51**). This same trend was also observed in aerial survey data, with observations of increasing vessel speeds within the Black Point channel with increasing distance from Black Point Marina (**Figure 34**). This is likely a boater behavior issue, largely due to the length of the idle speed zone at Black Point (greater than 1 mile) and the time necessary to transition through the zone in order to access the higher-speed unregulated portions of Biscayne Bay. Presumably levels of compliance would change depending upon where along the Black Point channel fixed point surveys were conducted. If surveys were conducted closer to Black Point Marina, compliance would probably be higher. If farther from Black Point Marina, compliance may be even lower. This may also be true in the Miami River, where the idle speed zone extends several miles upriver. Compliance may improve farther upriver, and tend to decrease as vessels approach open, unregulated areas beyond the mouth of the River.

An additional factor in low levels of compliance may be related to less enforcement activity in the area. Similar to the Downtown Miami site, numerous sightings of law enforcement vessels were made, however sightings were of vessels transitioning through the area – none were observed remaining in the area to enforce speed zones. Speed zone signage may be another issue. While no significant problems were observed, one discrepancy in signage was observed at Black Point; Among a series of idle speed markers along the Black Point channel, a slow speed marker was also observed at a significant distance from the study area (at channel marker #29). Along the ICW immediately north of the Miami River, a series of idle speed boating safety zones and signs were observed within the state manatee slow speed zone. While there may be some confusion as to whether idle or slow speed is required in this area, boater compliance at the Downtown Miami survey site was evaluated based upon the faster slow speed zone and should not have been a factor in compliance evaluation.

Several fixed point survey sites in Miami-Dade County had substantially higher levels of non-compliance than has been observed in previous studies (**Table 15**). In Broward County, for instance, levels of blatant non-compliance in slow speed zones with similar characteristics was much lower (1-4%). In other counties, levels of blatant non-compliance were typically less than 10% of all vessels observed in a particular area. In Miami-Dade County, however, levels of blatant non-compliance were greater than 20% in four of the six regulatory zones examined. While compliance is typically lower in idle speed zones, the highest levels of blatant non-compliance observed in similar studies was 16%. In Miami-Dade County, levels of blatant non-compliance were 34% in the Miami River and 47% within the Black Point channel. If the effectiveness of a regulatory zone is measured by the relative proportion of vessels in compliance, these may be areas of particular concern.

A strong correlation between boater compliance and vessel size was observed, with levels of compliance decreasing with decreasing vessel size (**Figure 52**). Increasing levels of blatant non-compliance with decreasing vessel size was also observed. This trend was observed in previous boating studies (Gorzelany, 1996, 1998, Shapiro, 2001). The vessel type identified with the highest observed levels of non-compliance were personal watercraft. Vessel types with the highest levels of compliance were typically associated with larger vessels, such as cabin motorboats, or vessels with limited propulsion such as sailboats under power. High levels of non-compliance among personal watercraft have been noted in numerous boating studies (Morris, 1994, Gorzelany, 1996, 1998, 2000, 2003, 2006, Tyson, 1999, Shapiro, 2001). Somewhat unexpected results were observed for vessels identified as “High Performance”, which are essentially comprised of high-speed racing-style vessels with elongated bows and larger inboard engines. These vessels actually had higher levels of compliance than larger cabin motorboats, and lower levels of blatant non-compliance than smaller open motorboats (**Figure 53**). This is contrary to some previous boat studies (Gorzelany, 1996, 2000).

The absence of active law enforcement mentioned in certain areas such as Black Point and the Miami River is not intended to imply that enforcement does not occur in these areas; only that no enforcement activity was documented during the study. This may indicate that these areas are not enforced as regularly as other areas. Given the fact that surveys were conducted over a relatively small number of days, it is also possible that enforcement activity simply took place on days when surveys were not conducted. The data does indicate, however, that areas where less enforcement was observed were also areas where compliance levels were the lowest (Black Point and the Miami River), and areas where compliance was relatively high (Haulover Park) were areas were enforcement presence and activity was more regularly observed. This trend has also been observed in other recent boater compliance studies conducted in both Lee and Sarasota Counties (Gorzelany 1998, 2002). Clearly law enforcement agencies do an extraordinary job and are overburdened by limited on-water resources and large areas of coverage. Along with the enforcement of speed zones, enforcement agencies must deal with a variety of human safety issues on waterways, and must prioritize and allocate their resources accordingly. This is particularly apparent in counties such as Miami-Dade, with hundreds of square miles of coastal water and perhaps thousands of recreational vessels distributed throughout the County at any given time.

The definitions of technical non-compliance and blatant non-compliance are directly related to the level of speed zone restriction. Boater compliance generally tends to be lower within idle speed zones such as those surveyed at Black Point and within the Miami River because these zones are more restrictive. As an example, vessels remaining at slow speed are considered compliant within the slow speed zone outside the Miami River, but are considered technically non-compliant when they enter the idle speed zone within Miami River. Similarly, vessels remaining at either plowing or cruising speed are technically compliant outside the Miami River, but become blatantly non-compliant when they enter the river. Because vessel speed plays a significant role in risk to manatees (Calleson and Frohlich, 2007), the ultimate question becomes, "at what speed do boats pose a significant threat? While "slow speed" as defined by the Florida Administrative Code may not pose a significant threat to manatees in most circumstances, the relative risk of significant injury likely increases for vessels traveling at plowing or cruising speed due to that fact that vessels are both traveling at a faster speed (i.e., less reaction time) and have a deeper draft into the water. As a result, a vessel in technical non-compliance within a slow speed zone (plowing or cruising) can be potentially as hazardous to a manatee as a vessel in blatant non-compliance within an idle speed zone. A re-examination of **Table 11** illustrates the complexity in understanding and managing boater compliance issues. The total number of vessels observed traveling at higher speeds (plowing, cruising, or planing) in the slow speed zone outside of the Black Point channel (an area identified as having "poor" compliance) over eight survey days was 63. Within the Miami River (another area identified as having "poor" compliance), the total number of vessels observed traveling at higher speeds over the same number of days was 270. At the Haulover Park survey site (an area identified as having relatively "good" compliance) the number of vessels traveling at higher speeds over the same number of days was 1,195. In another example, while levels of compliance were considered "poor" within the Black Point channel, a total of only 19 boats were observed at planing speed in eight days. By comparison, in areas with "moderate" to "good" compliance such as Pelican Harbor and Haulover Park, a total of 386 and 256 planing vessels were observed respectively. The question therefore becomes, "which area is of greater management concern?" The key consideration may be the determination of what levels of non-compliance (expressed as either the relative proportion or absolute numbers of non-compliant vessels) an area can sustain before risk to manatees, or other natural resources, becomes a serious management issue. This will likely vary from location to location and involve additional site-specific factors. The same is also true of areas with human safety concerns.

The information provided in this report may serve as an effective management and reference tool for better understanding countywide recreational boating patterns. These data may also serve as a benchmark on levels of recreational boating activity within Miami-Dade County from which future studies may be compared While the results from this study provide a number of examples of the various analyses that can be examined, the associated datasets also provided with this report can provide agencies with the opportunity to query, filter, and examine specific trends or areas of interest which may assist in the development of effective waterway management decisions for Miami-Dade County.

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Table 1. Summary of Miami-Dade County aerial survey data collection.

Aerial Survey Date	Survey Start	Boating Conditions	Vessels In-Use
09-Mar-08	1116 hrs	Fair/Good	440
13-Mar-08	1010 hrs	Excellent	212
19-Apr-08	1025 hrs	Good	973
05-May-08	1138 hrs	Excellent	279
24-May-08	1031 hrs	Good	1,135
08-Jun-08	1147 hrs	Good	1,648
28-Jun-08	0906 hrs	Excellent	578
22-Jul-08	0903 hrs	Good	186
03-Aug-08	0959 hrs	Good	810
26-Aug-08	1022 hrs	Good	156
06-Sep-08	1113 hrs	Excellent	713
01-Oct-08	1225 hrs	Good	113
08-Nov-08	1108 hrs	Good	771
14-Nov-08	1118 hrs	Good	224
23-Nov-08	1105 hrs	Good	495
12-Dec-08	1029 hrs	Fair/Good	205
23-Jan-09	1050 hrs	Excellent	250
24-Jan-09	1108 hrs	Excellent	705
07-Feb-09	1034 hrs	Fair/Good	529
22-Feb-09	1126 hrs	Excellent	1,387
Total Vessels Observed			**11,809**

Table 2.. Aerial survey data – relative abundance by vessel size category. All survey dates are combined.

Total Vessels Observed

Vessel Size Category	Weekday	Weekend	Total
less than 16 feet	155	1,265	1,420
16 - 25 feet	818	5,772	6,590
26 - 39 feet	324	2,036	2,360
40 - 64 feet	186	816	1,002
65 - 109 feet	114	277	391
greater than 109 feet	28	18	46
Total	**1,625**	**10,184**	**11,809**

Percentage

Vessel Size Category	Weekday	Weekend	Total
less than 16 feet	9.5%	12.4%	12.0%
16 - 25 feet	50.3%	56.7%	55.8%
26 - 39 feet	19.9%	20.0%	20.0%
40 - 64 feet	11.4%	8.0%	8.5%
65 - 109 feet	7.0%	2.7%	3.3%
greater than 109 feet	1.7%	0.2%	0.4%
	100.0%	**100.0%**	**100.0%**

Table 3. Aerial survey data – relative abundance by vessel type category. All survey dates are combined.

Total Vessels Observed

Vessel Type Category	Weekday	Weekend	Total
Open Motorboat	746	5,269	6,015
Closed Cabin	342	2,270	2,612
Pontoon Boat	10	47	57
Sail Boat	249	1,396	1,645
Personal Watercraft	27	501	528
Jon Boat	10	45	55
Inflatable	14	78	92
Houseboat	0	5	5
High Performance	21	71	92
Kayak / Canoe	83	278	361
Commercial Fish	16	30	46
Commercial Transport	19	50	69
Commercial Barge	52	72	124
Commercial Tug / Tender	14	12	26
Commercial Other	5	28	33
Enforcement	17	32	49
Total	**1,625**	**10,184**	**11,809**

Percentage

Vessel Type Category	Weekday	Weekend	Total
Open Motorboat	45.9%	51.7%	50.9%
Closed Cabin	21.0%	22.3%	22.1%
Pontoon Boat	0.6%	0.5%	0.5%
Sail Boat	15.3%	13.7%	13.9%
Personal Watercraft	1.7%	4.9%	4.5%
Jon Boat	0.6%	0.4%	0.5%
Inflatable	0.9%	0.8%	0.8%
Houseboat	0.0%	0.0%	0.0%
High Performance	1.3%	0.7%	0.8%
Kayak / Canoe	5.1%	2.7%	3.1%
Commercial Fish	1.0%	0.3%	0.4%
Commercial Transport	1.2%	0.5%	0.6%
Commercial Barge	3.2%	0.7%	1.1%
Commercial Tug / Tender	0.9%	0.1%	0.2%
Commercial Other	0.3%	0.3%	0.3%
Enforcement	1.0%	0.3%	0.4%
	100.0%	**100.0%**	**100.0%**

Table 4. Aerial survey data – relative abundance by vessel class. All survey dates are combined.

Total Vessels Observed

Vessel Class	Weekday	Weekend	Total
Private	1,534	10,059	11,593
Commercial	79	112	191
Enforcement	12	13	25
Total	**1,625**	**10,184**	**11,809**

Percentage

Vessel Class	Weekday	Weekend	Total
Private	94.4%	98.8%	98.2%
Commercial	4.9%	1.1%	1.6%
Enforcement	0.7%	0.1%	0.2%
	100.0%	**100.0%**	**100.0%**

Table 5. Summary of data collection from fixed point survey sites.

HAULOVER PARK

Survey Date	Survey Interval	Vessels	Conditions
24-Apr-08	0800 - 1400 hrs	229	Good
18-May-08	0800 - 1400 hrs	999	Excellent
19-Jul-08	0900 - 1500 hrs	1153	Excellent
28-Aug-08	1100 - 1700 hrs	186	Excellent
6-Nov-08	0900 - 1500 hrs	203	Excellent
7-Dec-08	1000 - 1600 hrs	418	Good
4-Feb-09	1000 - 1600 hrs	81	Fair
7-Mar-09	1100 - 1700 hrs	712	Good
Total		**3981**	

PELICAN HARBOR

Survey Date	Survey Interval	Vessels	Conditions
25-Apr-08	0800 - 1400 hrs	126	Good
17-May-08	1000 - 1600 hrs	460	Excellent
10-Jul-08	0900 - 1500 hrs	83	Good
20-Jul-08	0800 - 1400 hrs	414	Excellent
17-Sep-08	1000 - 1600 hrs	56	Excellent
6-Dec-08	1100 - 1700 hrs	291	Good
8-Mar-09	0900 - 1500 hrs	313	Good
30-Mar-09	1100 - 1700 hrs	115	Excellent
Total		**1858**	

DOWNTOWN MIAMI

Survey Date	Survey Interval	Vessels	Conditions
7-May-08	1000 - 1600 hrs	137	Excellent
22-Jun-08	0800 - 1400 hrs	330	Excellent
26-Jul-08	0900 - 1500 hrs	334	Good
29-Aug-08	0800 - 1400 hrs	122	Fair
6-Dec-08	1100 - 1700 hrs	457	Good
13-Jan-09	0900 - 1500 hrs	144	Fair
17-Jan-09	1000 - 1600 hrs	257	Good
11-Mar-09	1100 - 1700 hrs	182	Good
Total		**1963**	

BLACK POINT

Survey Date	Survey Interval	Vessels	Conditions
21-Jun-08	0900-1500 hrs	228	Good
11-Jul-08	0900-1500 hrs	106	Excellent
20-Jul-08	0800-1400 hrs	370	Good
2-Oct-08	1000-1600 hrs	65	Excellent
12-Jan-09	1100 - 1700 hrs	59	Good
15-Feb-09	1100 - 1700 hrs	421	Good
12-Mar-09	0800-1400 hrs	59	Excellent
4-Apr-09	1000-1600 hrs	333	Good
Total		**1641**	

Table 6.. Comparison of weekday versus weekend observations from fixed point survey sites.

	Haulover Park	Pelican Harbor	Downtown Miami (River)	Downtown Miami (ICW)	Black Point (channel)	Black Point (south)
Weekday Surveys						
Total Observations (All Directions)	675	380	262	567	263	25
Mean # Observations / Hr	28.1	15.8	10.9	23.6	11.0	1.0
Weekend Surveys						
Total Observations (All Directions)	3128	1478	532	1310	1266	70
Mean # Observations / Hr	130.3	61.6	22.2	54.6	52.8	2.9
Weekend / Weekday Ratio	**4.63 - 1**	**3.89 - 1**	**2.03 - 1**	**2.31 - 1**	**4.81 - 1**	**2.80 - 1**

Table 7. Summary of vessel origin – destination information from the Haulover Park survey site.

Haulover Park Survey Site

Vessel Passes	**Weekday**	**Weekend**	**Total**
North to/from Ocean	199	781	980
South to/from Ocean	80	391	471
West to/from Ocean	16	56	72
North to/from South	223	503	726
North to/from West	49	370	419
South to/from West	13	72	85
West to/from West	7	117	124
South to/from Inlet (shoal)	32	216	248
North to/from Inlet (shoal)	37	400	437
Ocean to/from Inlet	14	213	227
All Other Routes	29	163	192
Total	**699**	**3282**	**3981**

Percent	**Weekday**	**Weekend**	**Total**
North to/from Ocean	28.5%	23.8%	24.6%
South to/from Ocean	11.4%	11.9%	11.8%
West to/from Ocean	2.3%	1.7%	1.8%
North to/from South	31.9%	15.3%	18.2%
North to/from West	7.0%	11.3%	10.5%
South to/from West	1.9%	2.2%	2.1%
West to/from West	1.0%	3.6%	3.1%
South to/from Inlet (shoal)	4.6%	6.6%	6.2%
North to/from Inlet (shoal)	5.3%	12.2%	11.0%
Ocean to/from Inlet	2.0%	6.5%	5.7%
All Other Routes	4.1%	5.0%	4.8%
	100.0%	**100.0%**	**100.0%**

Table 8. Summary of vessel origin – destination information from the Pelican Harbor survey site.

Pelican Harbor Site

Vessel Passes	**Weekday**	**Weekend**	**Total**
North to/from South (ICW)	150	503	653
Pelican Harbor Ramp to/from North (ICW)	63	247	310
Pelican Harbor Ramp to/from South (ICW)	57	337	394
Little River to/from South	33	102	135
Little River to/from North	38	111	149
Pelican Harbor Ramp to/from East	19	50	69
East to/from North (ICW)	6	42	48
Little River to/from East	5	26	31
All Other Routes	9	60	69
Total	**380**	**1478**	**1858**

Percent	**Weekday**	**Weekend**	**Total**
North to/from South (ICW)	39.5%	34.0%	35.1%
Pelican Harbor Ramp to/from North (ICW)	16.6%	16.7%	16.7%
Pelican Harbor Ramp to/from South (ICW)	15.0%	22.8%	21.2%
Little River to/from South	8.7%	6.9%	7.3%
Little River to/from North	10.0%	7.5%	8.0%
Pelican Harbor Ramp to/from East	5.0%	3.4%	3.7%
East to/from North (ICW)	1.6%	2.8%	2.6%
Little River to/from East	1.3%	1.8%	1.7%
All Other Routes	2.4%	4.1%	3.7%
	100.0%	**100.0%**	**100.0%**

Table 9. Summary of vessel origin – destination information from the Downtown Miami survey site.

Downtown Miami Survey Site

Vessel Passes	Weekday	Weekend	Total
Miami River to/from South (ICW)	91	170	261
Miami River to/from North (ICW)	59	151	210
Miami River to/from East	97	165	262
North (ICW) to/from South (ICW)	195	582	777
South (ICW) to/from East	70	145	215
North (ICW) to/from East	56	106	162
All Other Routes	23	53	76
Total	**591**	**1372**	**1963**

Percent	Weekday	Weekend	Total
Miami River to/from South (ICW)	15.4%	12.4%	13.3%
Miami River to/from North (ICW)	10.0%	11.0%	10.7%
Miami River to/from East	16.4%	12.0%	13.3%
North to/from South (ICW)	33.0%	42.4%	39.6%
South (ICW) to/from East	11.8%	10.6%	11.0%
North (ICW) to/from East	9.5%	7.7%	8.3%
All Other Routes	3.9%	3.9%	3.9%
	100.0%	**100.0%**	**100.0%**

Table 10. Summary of vessel origin – destination information from the Black Point survey site.

Black Point Survey Site

Vessel Passes	**Weekday**	**Weekend**	**Total**
East to/from West (in channel)	263	1275	1538
East to/from West (outside channel)	2	10	12
East to/from South (outside channel)	13	18	31
West to/from South (outside channel)	10	47	57
All Other Routes	1	2	3
Total	**289**	**1352**	**1641**

Percent	**Weekday**	**Weekend**	**Total**
East to/from West (in channel)	91.0%	94.3%	93.7%
East to/from West (outside channel)	0.7%	0.7%	0.7%
East to/from South (outside channel)	4.5%	1.3%	1.9%
West to/from South (outside channel)	3.5%	3.5%	3.5%
All Other Routes	0.3%	0.1%	0.2%
	100.0%	**100.0%**	**100.0%**

Table 11. Summary of vessel speed data from each fixed point survey site and regulatory zone.

Vessel Passes

Survey Site	Oar / Paddle	Under Sail	Idle	Slow	Plowing	Cruising	Planing	Total
Haulover Park	166	8	530	2082	888	51	256	3981
Pelican Harbor	13	8	237	761	406	47	386	1858
Downtown Miami (ICW)	5	24	266	875	507	57	173	1907
Downtown Miami (River)	3	0	176	348	220	30	20	797
Black Point (Inside Channel)	3	4	213	590	692	15	19	1536
Black Point (Outside Channel)	9	1	11	21	6	0	57	105

Percent Composition

Survey Site	Oar / Paddle	Under Sail	Idle	Slow	Plowing	Cruising	Planing	Regulatory Zone
Haulover Park	4.2%	0.2%	13.3%	52.3%	22.3%	1.3%	6.4%	Slow
Pelican Harbor	0.7%	0.4%	12.8%	41.0%	21.9%	2.5%	20.8%	Slow
Downtown Miami (ICW)	0.3%	1.3%	13.9%	45.9%	26.6%	3.0%	9.1%	Slow
Downtown Miami (River)	0.4%	0.0%	22.1%	43.7%	27.6%	3.8%	2.5%	Idle
Black Point (Inside Channel)	0.2%	0.3%	13.9%	38.4%	45.1%	1.0%	1.2%	Idle
Black Point (Outside Channel)	8.6%	1.0%	10.5%	20.0%	5.7%	0.0%	54.3%	Slow

Table 12. Comparison of vessel size categories from recent aerial survey studies. (Source – Gorzelany 2005, 2006, 2007, 2008, PBS&J 2008).

County	Size Category					
	< 16'	**16' - 25'**	**26' - 39"**	**40' - 64'**	**65' - 109'**	**>109'**
Broward (2004-05)	7%	56%	21%	11%	4%	1%
Lee (2005-06)	8%	78%	10%	3%	1%	0%
Sarasota (2005-06)	14%	71%	11%	3%	1%	0%
Charlotte (2005-06)	7%	79%	11%	3%	0%	0%
Palm Beach (2007)	10%	66%	13%	6%	4%	1%
Martin (2006-07)	9%	65%	13%	8%	4%	1%
Brevard (2006-07)	13%	68%	11%	6%	2%	0%
Collier (2006-07)	12%	77%	8%	2%	1%	0%
Miami-Dade (2008-09)	12%	56%	20%	8%	3%	0%

Table 13. Comparison of vessel type categories from recent aerial survey studies. (Source – Gorzelany 2005, 2006, 2007, 2008, PBS&J 2008).

Vessel Types

County	Small Power	Large Power	Personal Watercraft	Sailboat	Kayak / Canoe	Barge	Other
Broward (2004-05)	55%	32%	2%	7%	2%	1%	1%
Lee (2005-06)	79%	10%	2%	4%	4%	1%	0%
Sarasota (2005-06)	71%	11%	3%	9%	5%	1%	0%
Charlotte (2005-06)	80%	8%	1%	8%	2%	0%	1%
Palm Beach (2007)	68%	21%	4%	4%	2%	1%	0%
Martin (2006-07)	64%	17%	4%	9%	3%	3%	0%
Brevard (2006-07)	71%	11%	4%	10%	3%	1%	0%
Collier (2006-07)	79%	8%	3%	3%	5%	1%	1%
Miami-Dade (2008-09)	54%	24%	4%	14%	3%	1%	0%

Table 14. Comparison of vessel classes from recent aerial survey studies. (Source – Gorzelany 2005, 2006, 2007, 2008, PBS&J 2008).

	Vessel Class		
County	**Recreational**	**Commercial**	**Enforcement**
Broward (2004-05)	95%	5%	< 0.5%
Lee (2005-06)	98%	2%	< 0.5%
Sarasota (2005-06)	99%	1%	< 0.5%
Charlotte (2005-06)	99%	1%	< 0.5%
Palm Beach (2007)	98%	2%	< 0.5%
Martin (2006-07)	96%	4%	< 0.5%
Brevard (2006-07)	97%	3%	< 0.5%
Collier (2006-07)	99%	1%	< 0.5%
Miami-Dade (2008-09)	97%	3%	< 0.5%

Table 15. Comparison of levels of boater compliance from recent fixed point boating studies. (Source – Gorzelany 1998, 2005, 2006, 2007)

Survey Site	County	Compliance	Technical Non-Compliance	Blatant Non - Compliance	Speed Zone
Haulover Park (2008-09)	Miami-Dade	69%	25%	7%	Slow
Pelican Harbor (2008-09)	Miami-Dade	54%	25%	21%	Slow
Miami River (2008-09)	Miami-Dade	61%	30%	9%	Slow
Miami River (2008-09)	Miami-Dade	22%	44%	34%	Idle
Black Point (2008-09)	Miami-Dade	14%	39%	47%	Idle
Black Point (2008-09)	Miami-Dade	34%	6%	60%	Slow
John Lloyd State Park (2004-05)	Broward	59%	39%	2%	Slow
Colee Hammock Site (2004-05)	Broward	78%	22%	1%	Slow
Hugh Taylor Birch State Park (2004-05)	Broward	50%	46%	4%	Slow
Orange River (1997-98)	Lee	68%	24%	8%	Idle
Shell Island (1997-98)	Lee	58%	33%	8%	Slow
Beautiful Island (1997-98)	Lee	39%	50%	11%	Idle
New Pass (2005-06)	Sarasota	47%	37%	16%	Idle
Venice Inlet (2005-06)	Sarasota	71%	20%	8%	Slow
Terra Ceia Bay (2006-07)	Manatee	66%	26%	8%	Slow

Figure 1. Typical GPS track of flight path (red) from the June 8, 2008 Miami-Dade County aerial boat survey.

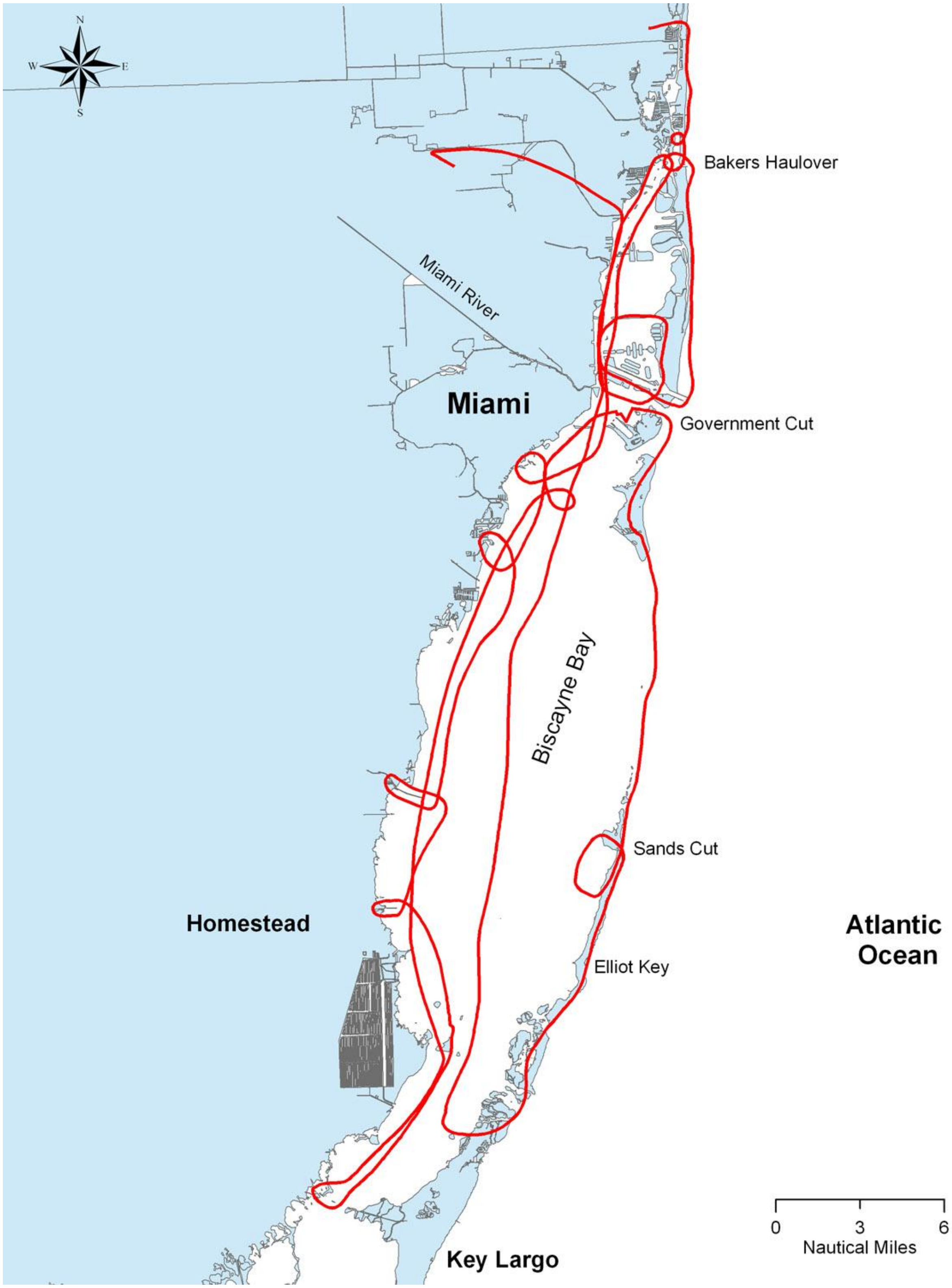


Figure 2. Map of Miami-Dade County coastal waters showing aerial survey area (red).

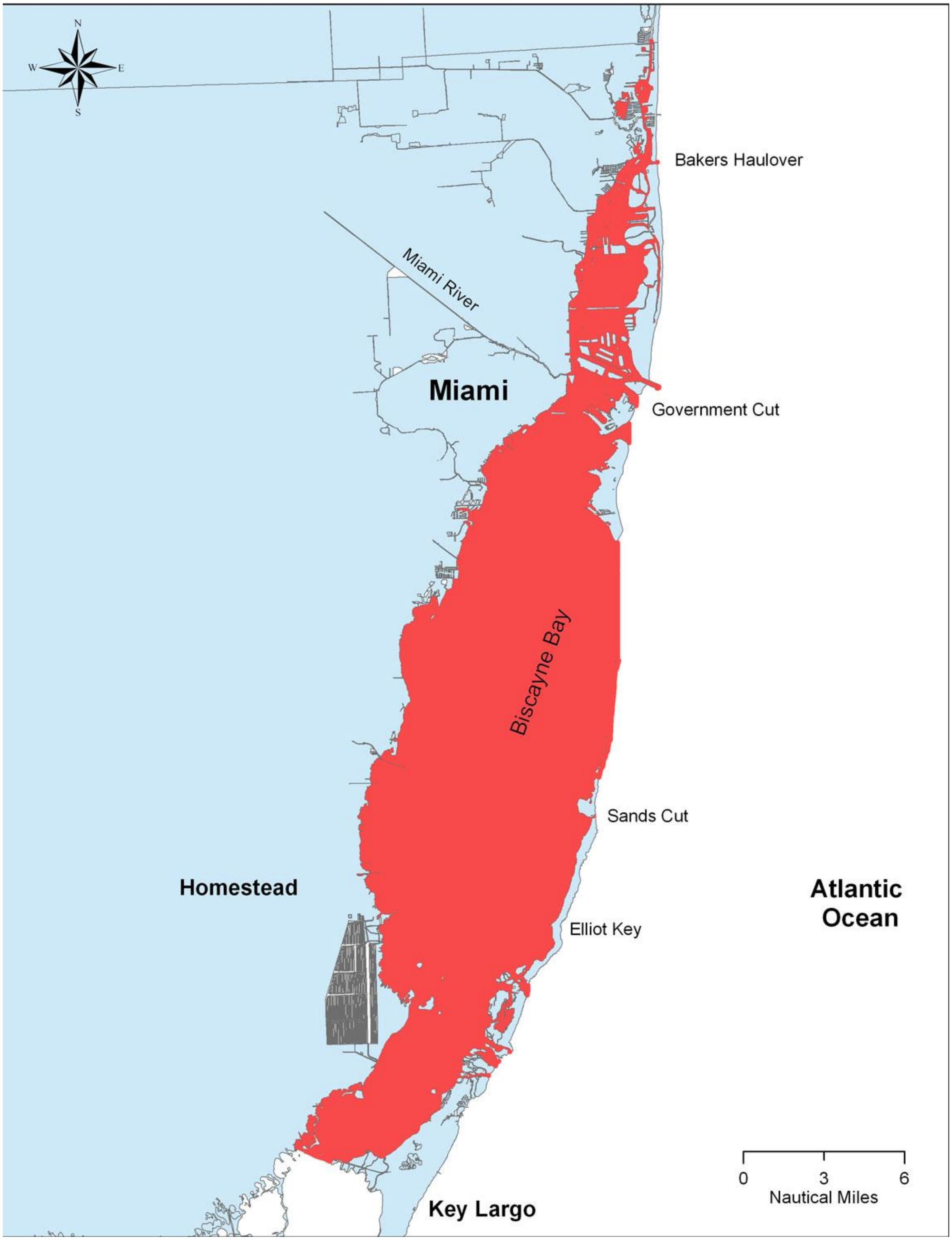


Figure 3. Location of four land-based fixed point boat survey sites.

Figure 4. Location of the fixed point survey site at Haulover Park (red dot), along with corresponding regulatory zones.

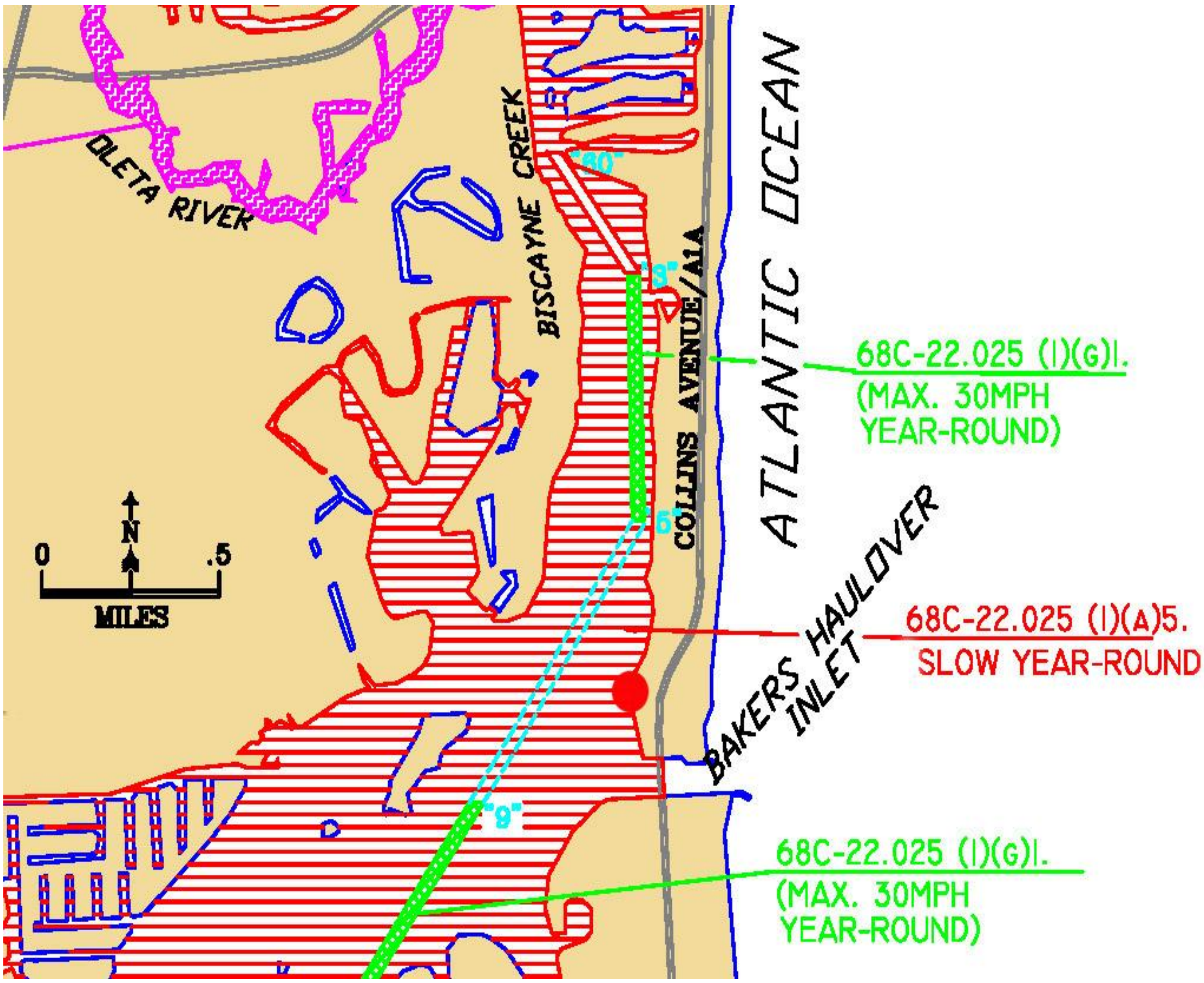


Figure 5. Location of the fixed point survey site at Pelican Harbor Park (red dot), along with corresponding regulatory zones.

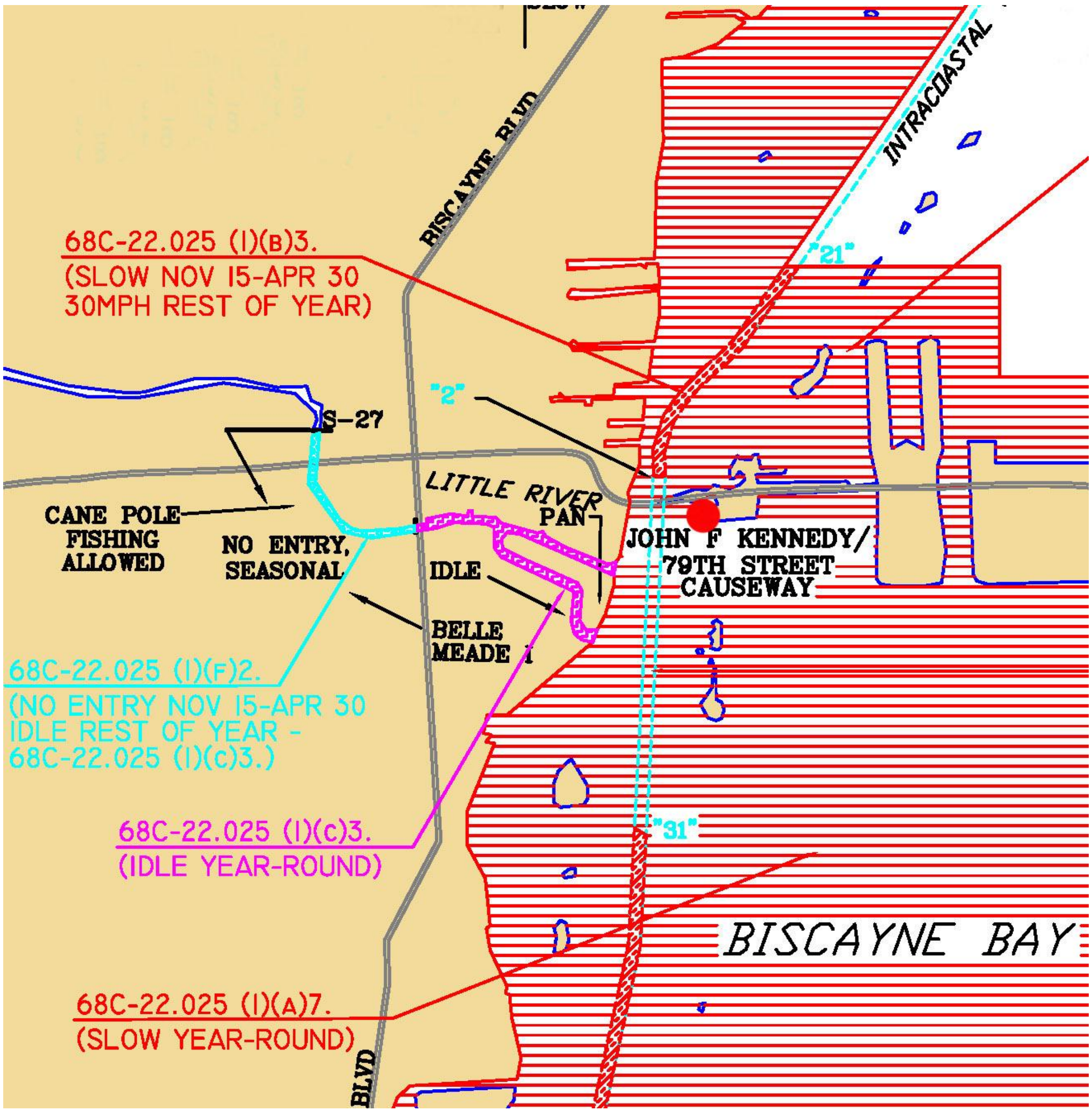


Figure 6. Location of the Downtown Miami fixed point survey site (red dot), along with corresponding regulatory zones.

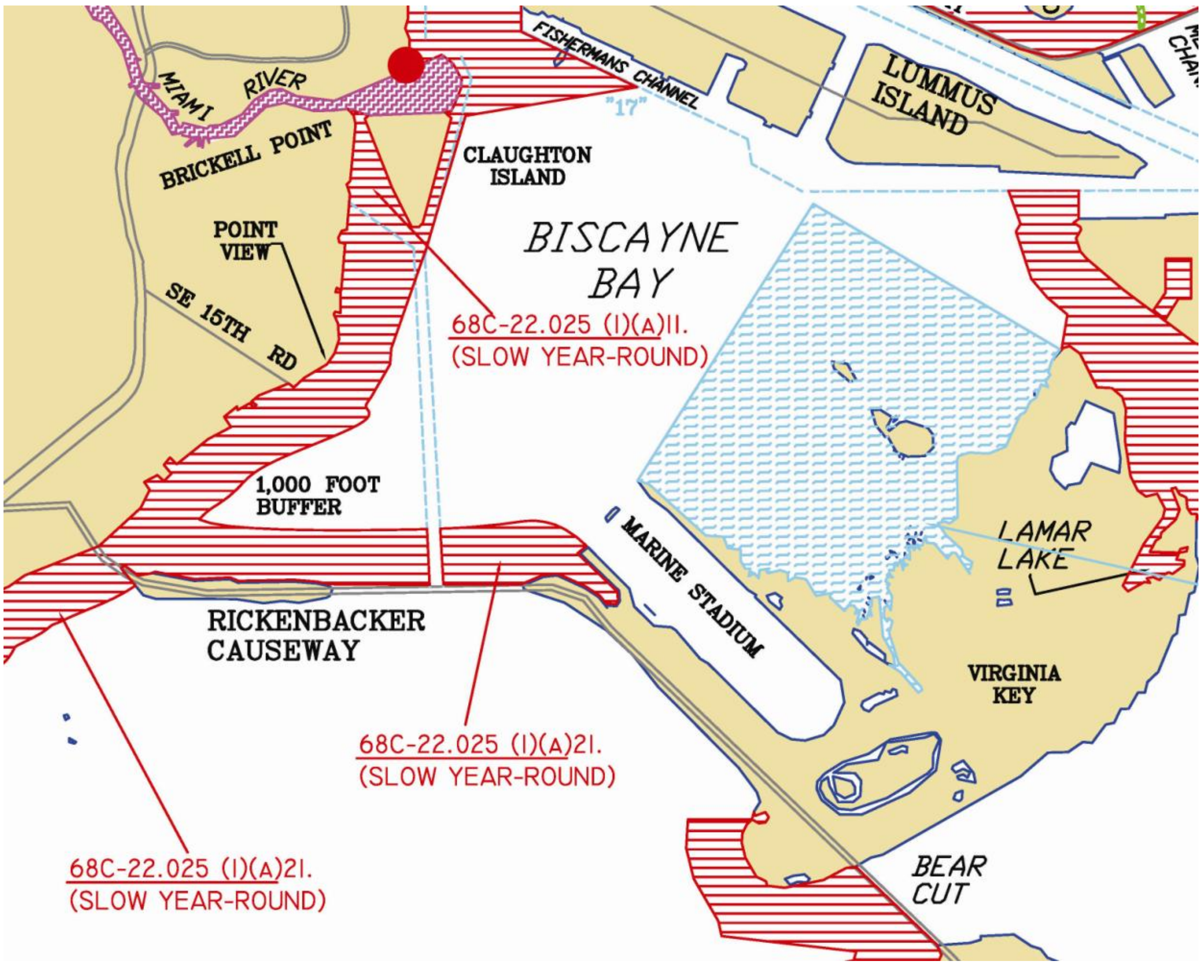


Figure 7. Location of the fixed point survey site at Black Point (red dot), along with corresponding regulatory zones.

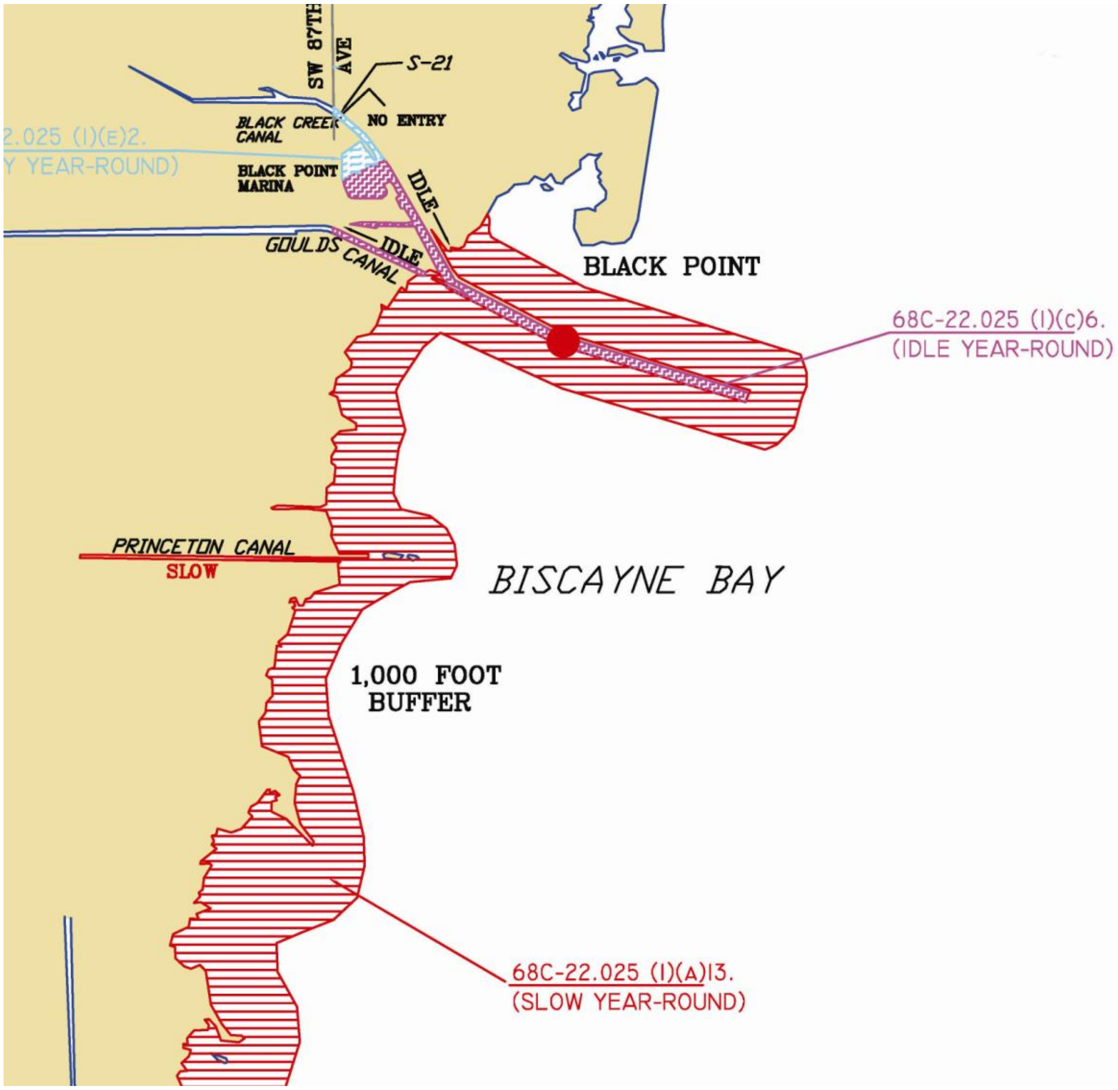


Figure 8. Summary of aerial data by survey flight. Dark green bars refer to weekday surveys. Light green bars refer to weekend surveys. Yellow bars refer to surveys flown over holiday weekends.

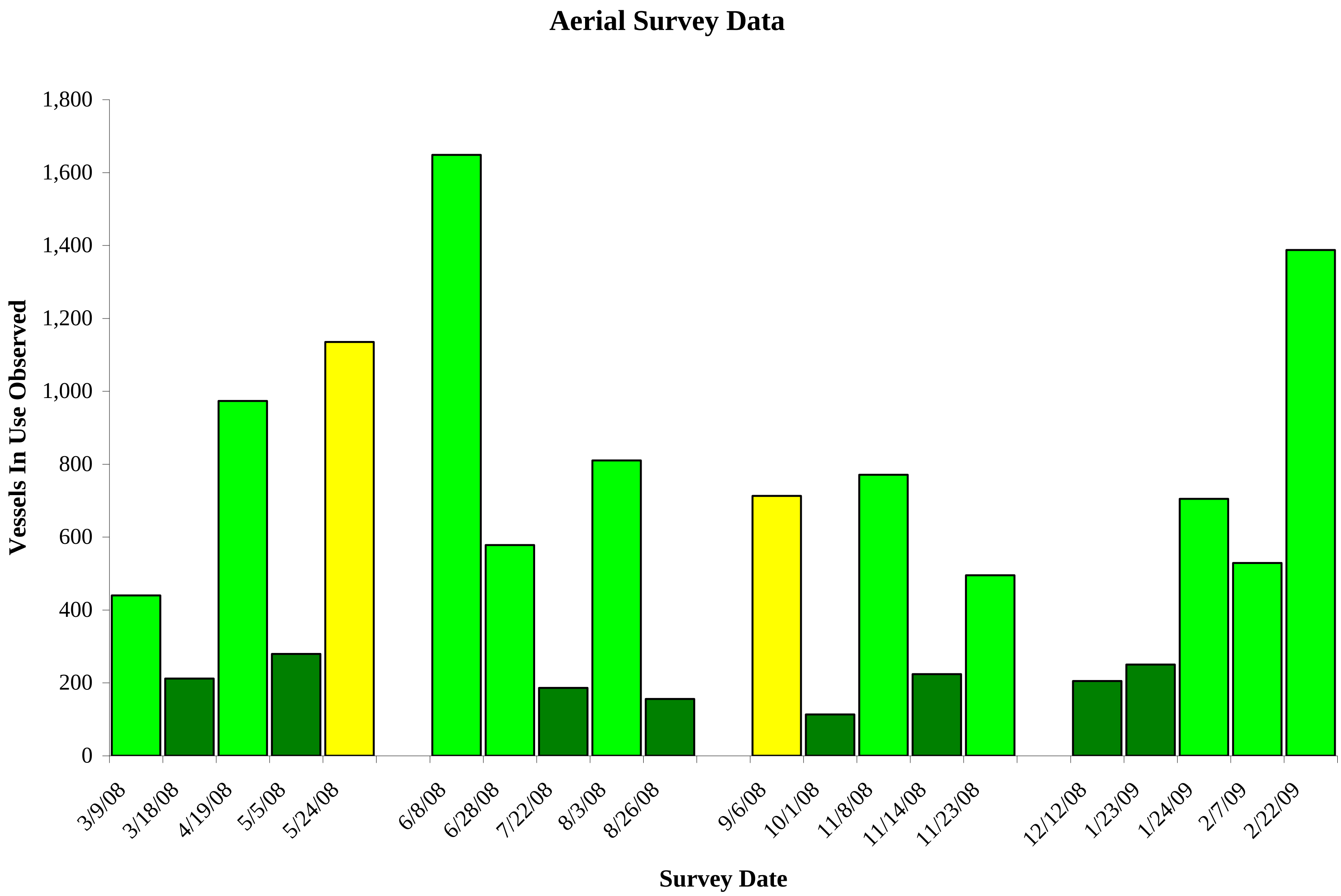


Figure 9. Composite map of all vessels in-use documented from 20 aerial survey flights. Northern portion of survey route.

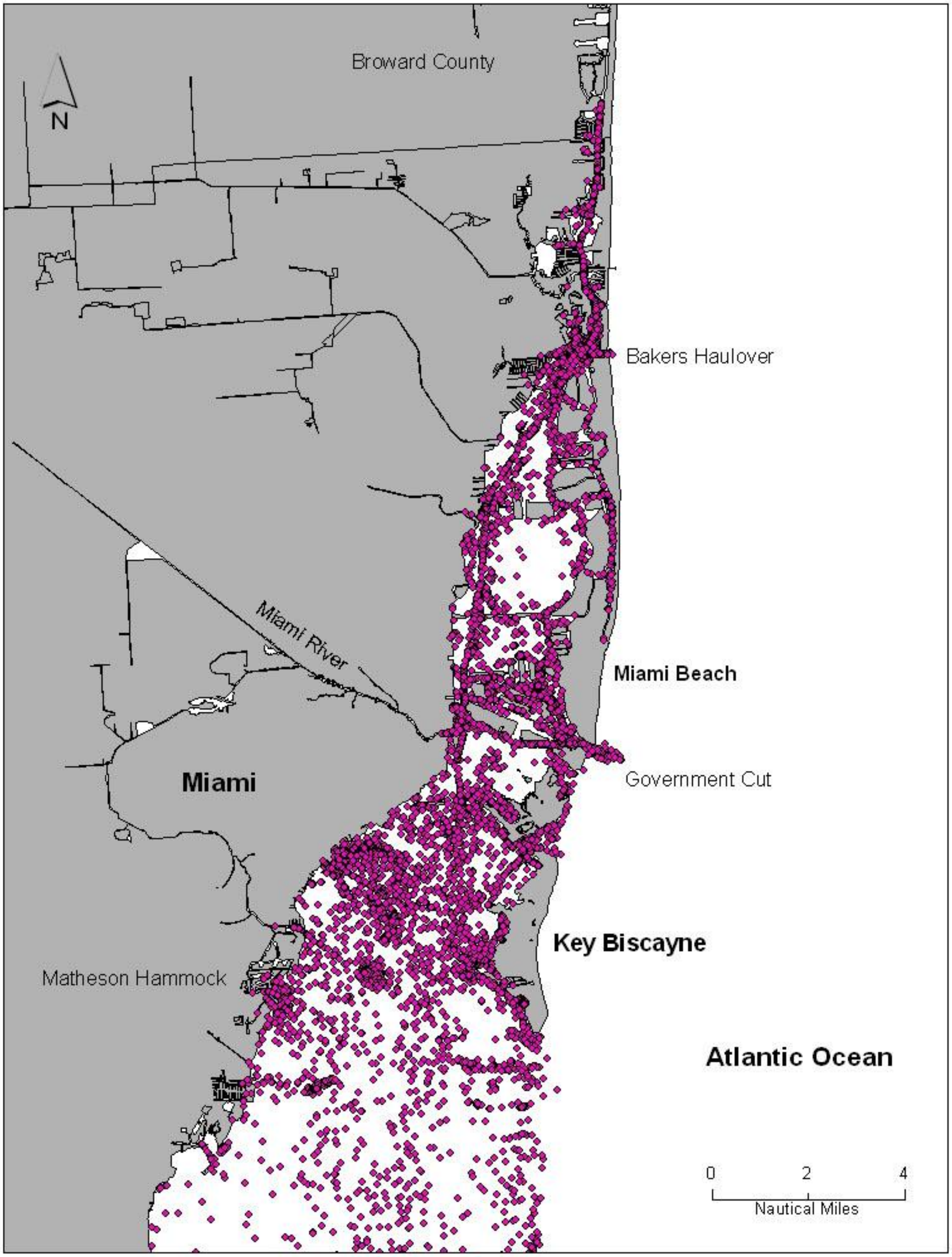


Figure 10. Composite map of all vessels in-use documented from 20 aerial survey flights. Southern portion of survey route.

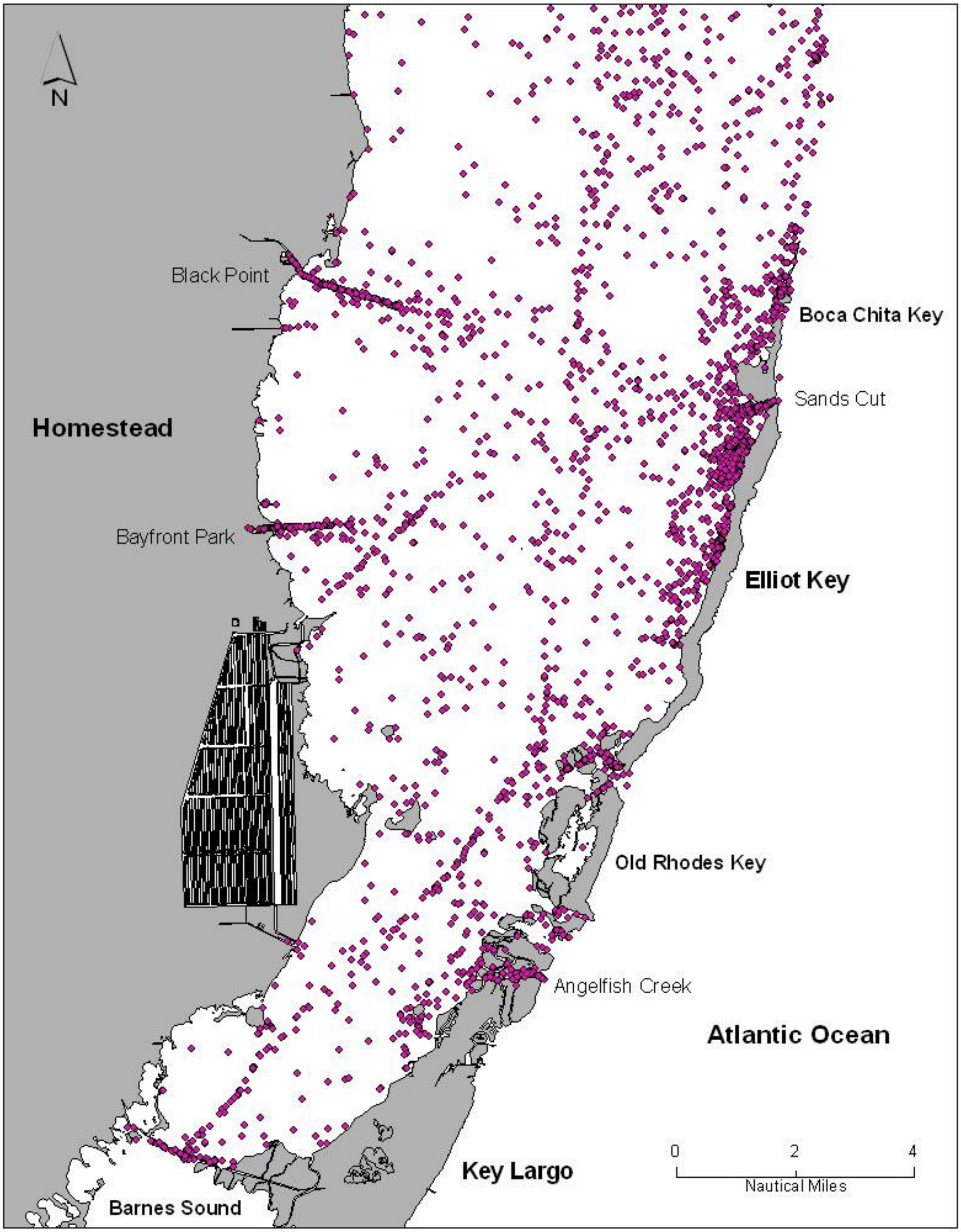


Figure 11. Composite view of vessel traffic in the vicinity of Bakers Haulover Inlet. Data from all 20 aerial survey flights are combined. Green arrows indicate vessels underway. Red dots indicate stationary vessels.

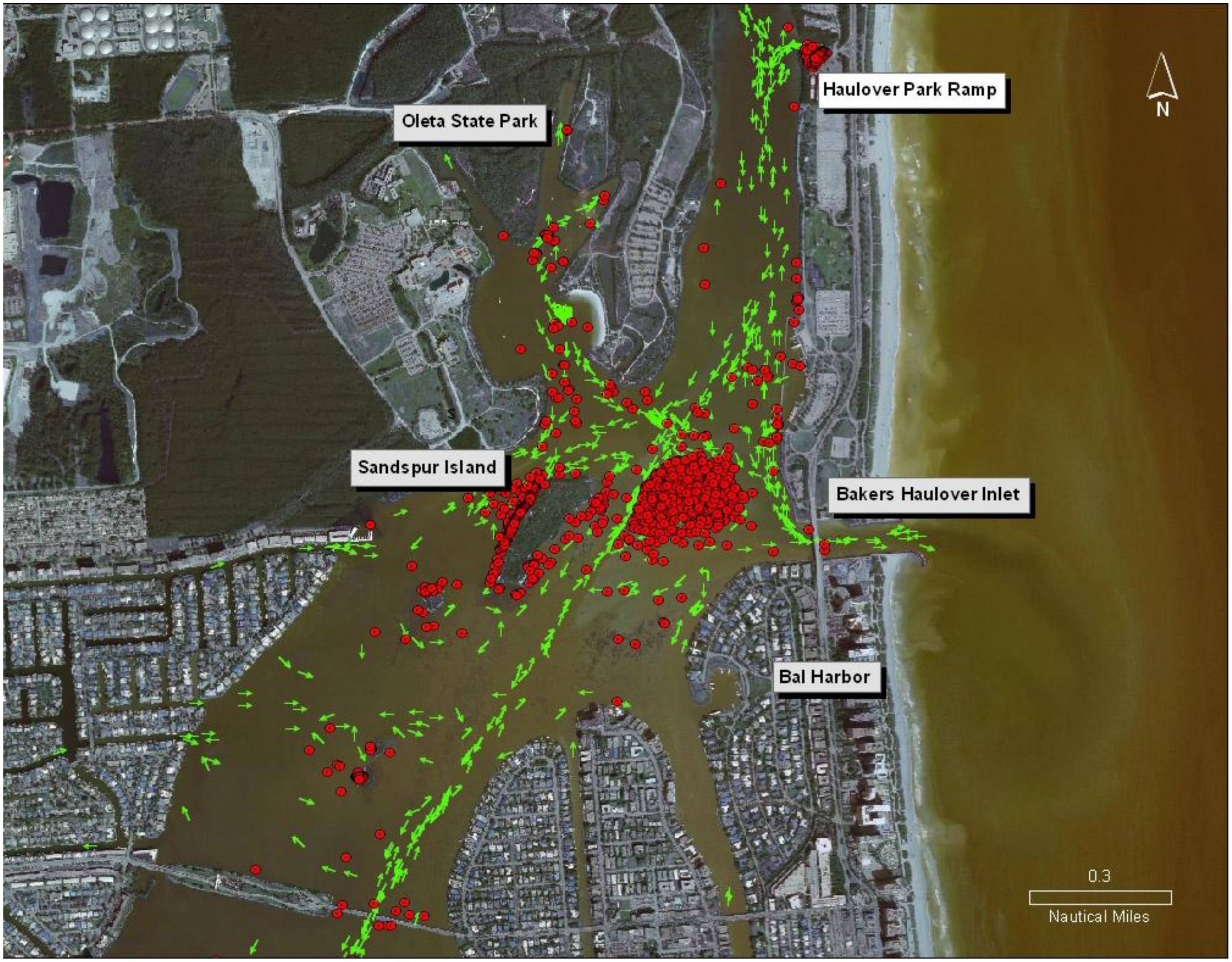


Figure 12. Composite view of vessel traffic in the vicinity of the Port of Miami. Data from all 20 aerial survey flights are combined. Green arrows indicate vessels underway. Red dots indicate stationary vessels.

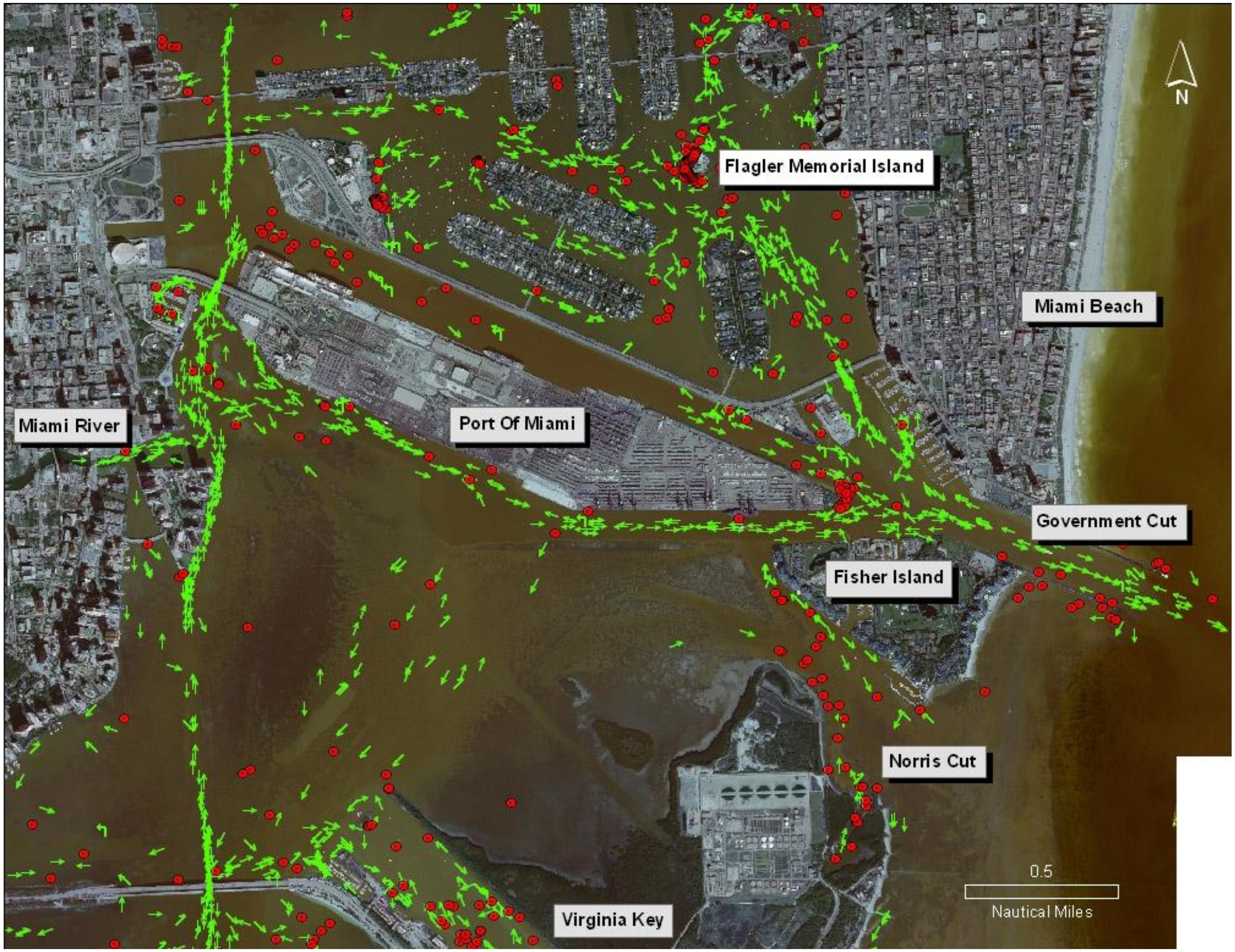


Figure 13. Composite view of vessel traffic in the vicinity of the Key Biscayne. Data from all 20 aerial survey flights are combined. Green arrows indicate vessels underway. Red dots indicate stationary vessels.

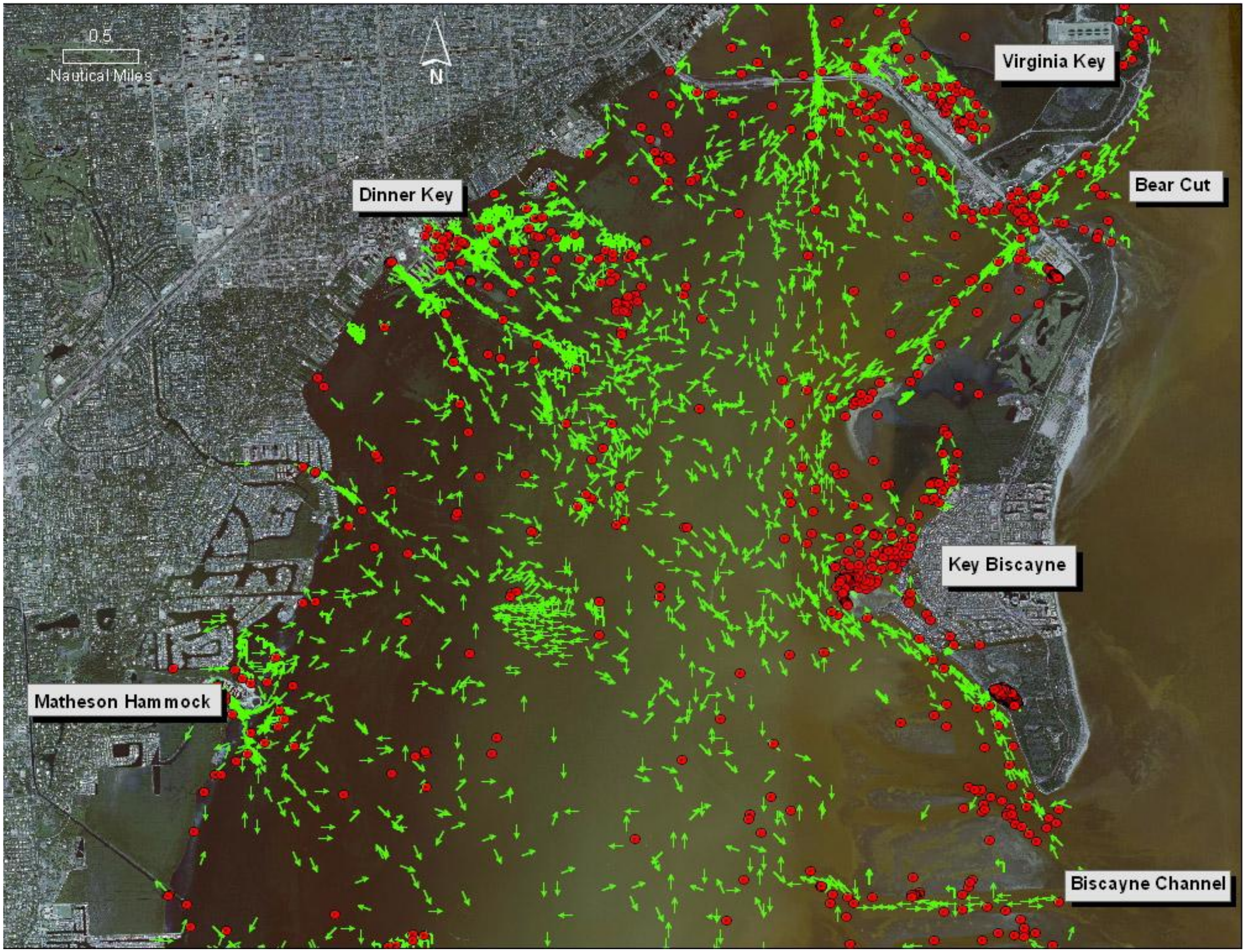


Figure 14. Composite view of vessel traffic along the southern portion of the aerial survey route. Data from all 20 aerial survey flights are combined. Green arrows indicate vessels underway. Red dots indicate stationary vessels.

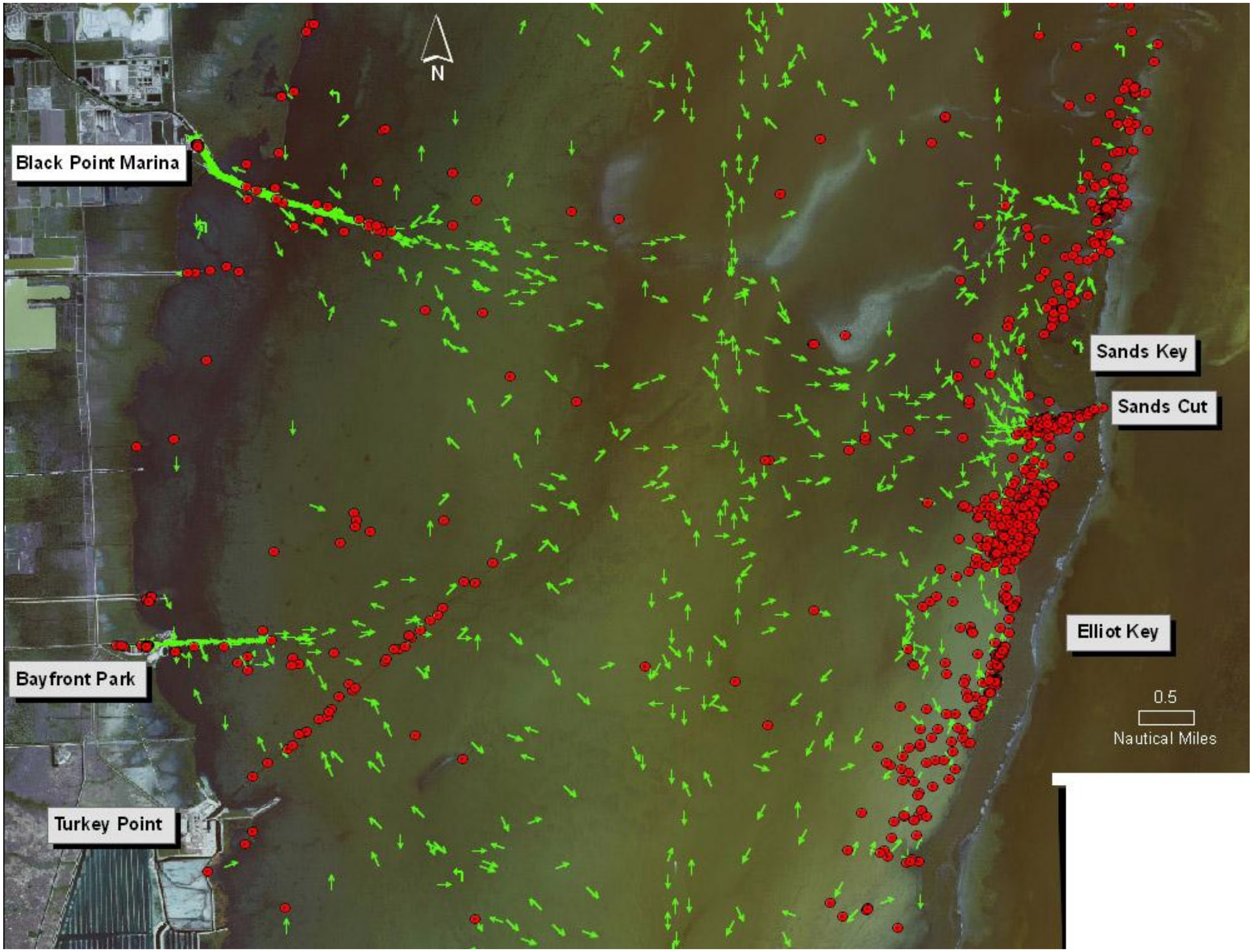


Figure 15. Composite map of all vessels in-use whose activity was identified as either possible or probable fishing.

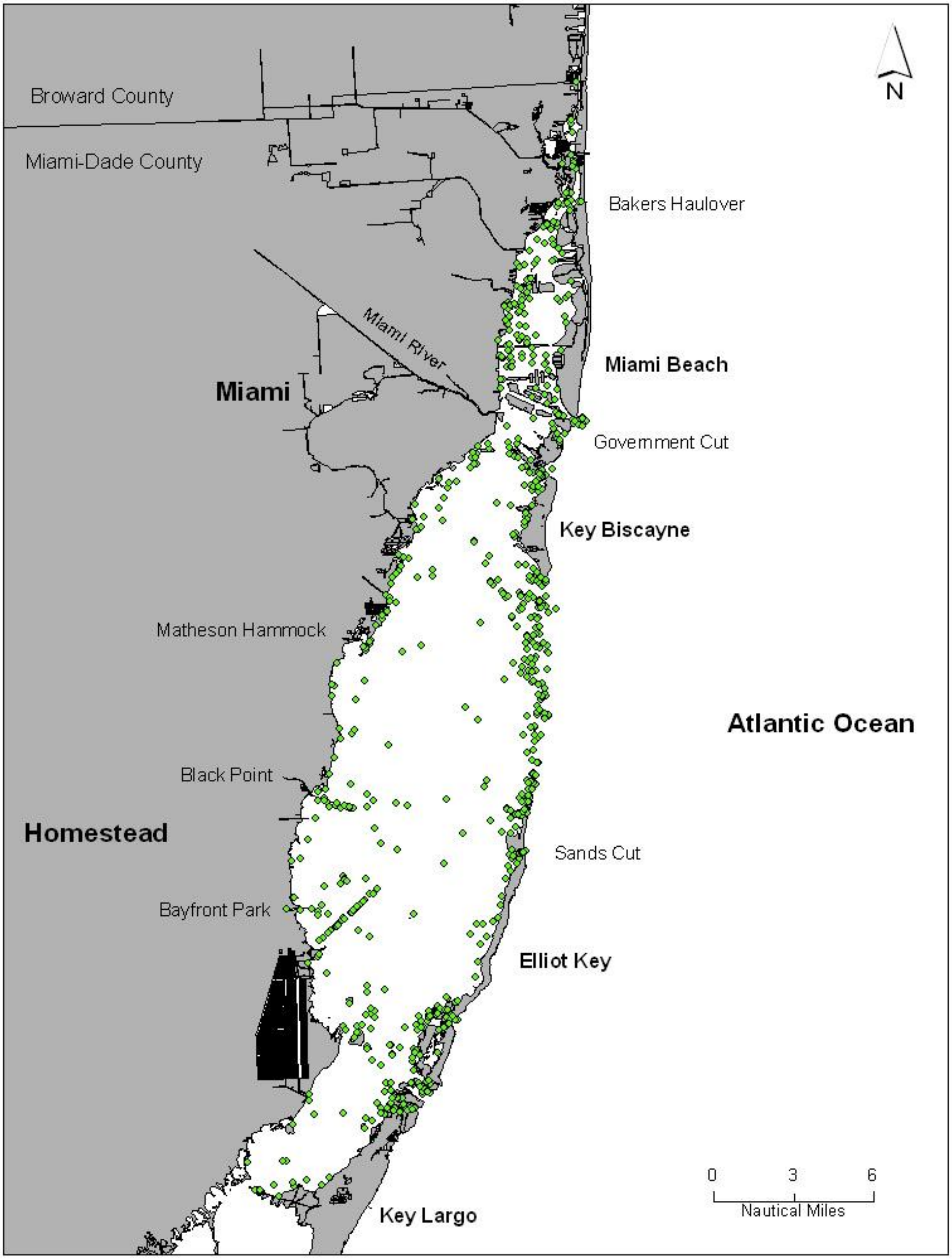


Figure 16. A series of 314 computer-generated polygons used for spatial analysis, covering the entire Miami-Dade County survey area.

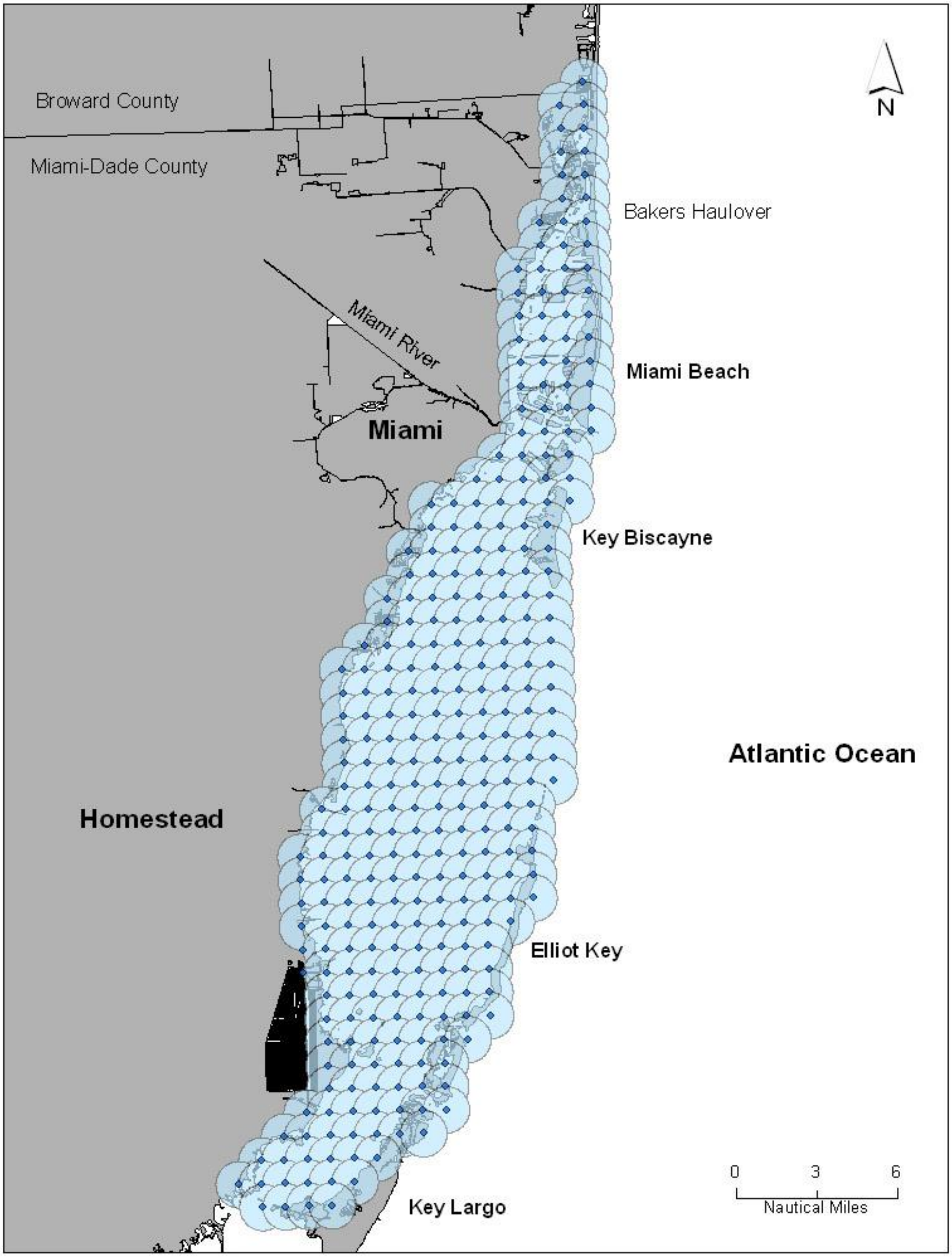


Figure 17. Spatial analysis results, expressed as areas of relative density, for all vessels in-use along the northern portion of the aerial survey route.

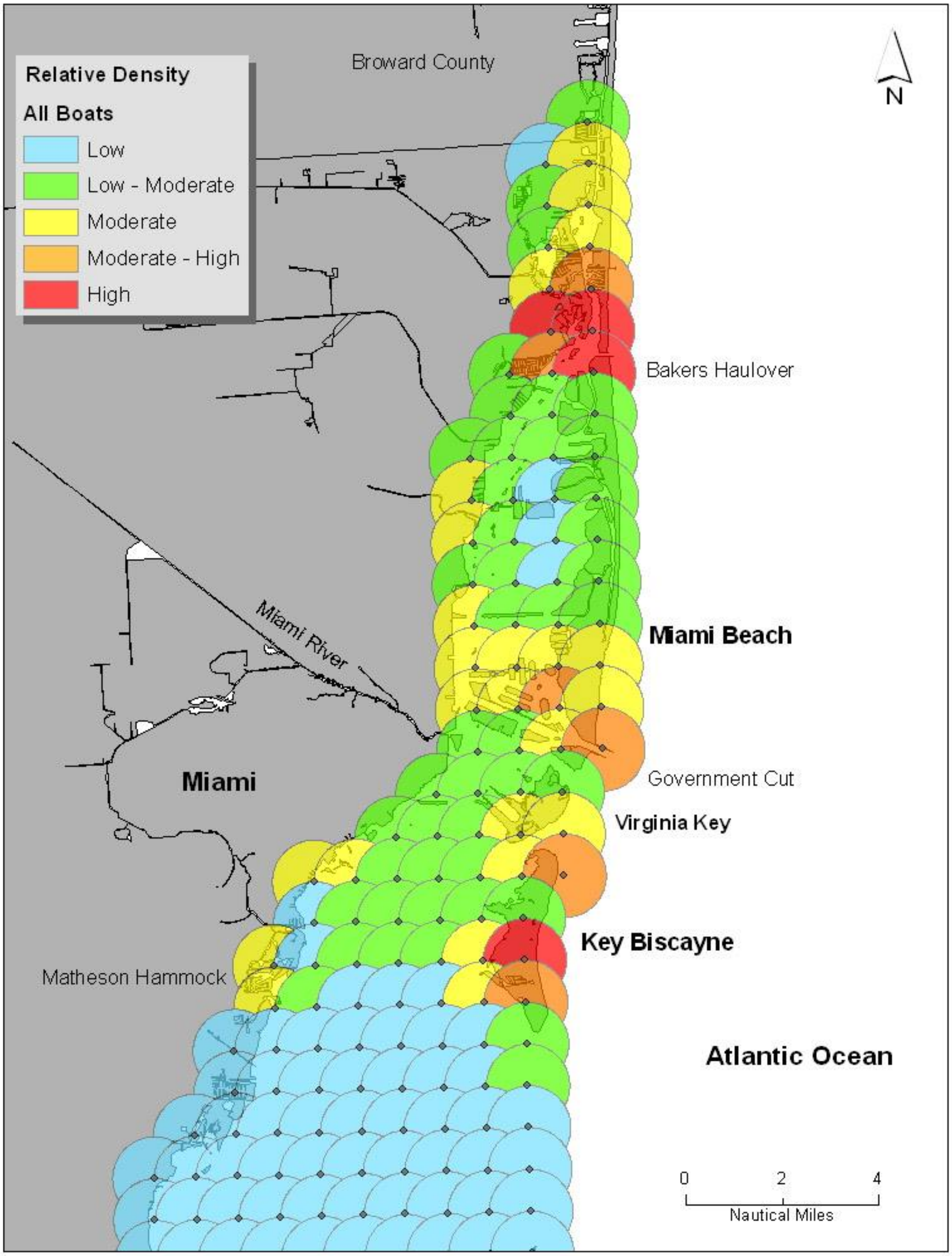


Figure 18. Spatial analysis results, expressed as areas of relative density, for all vessels in-use along the southern portion of the aerial survey route.

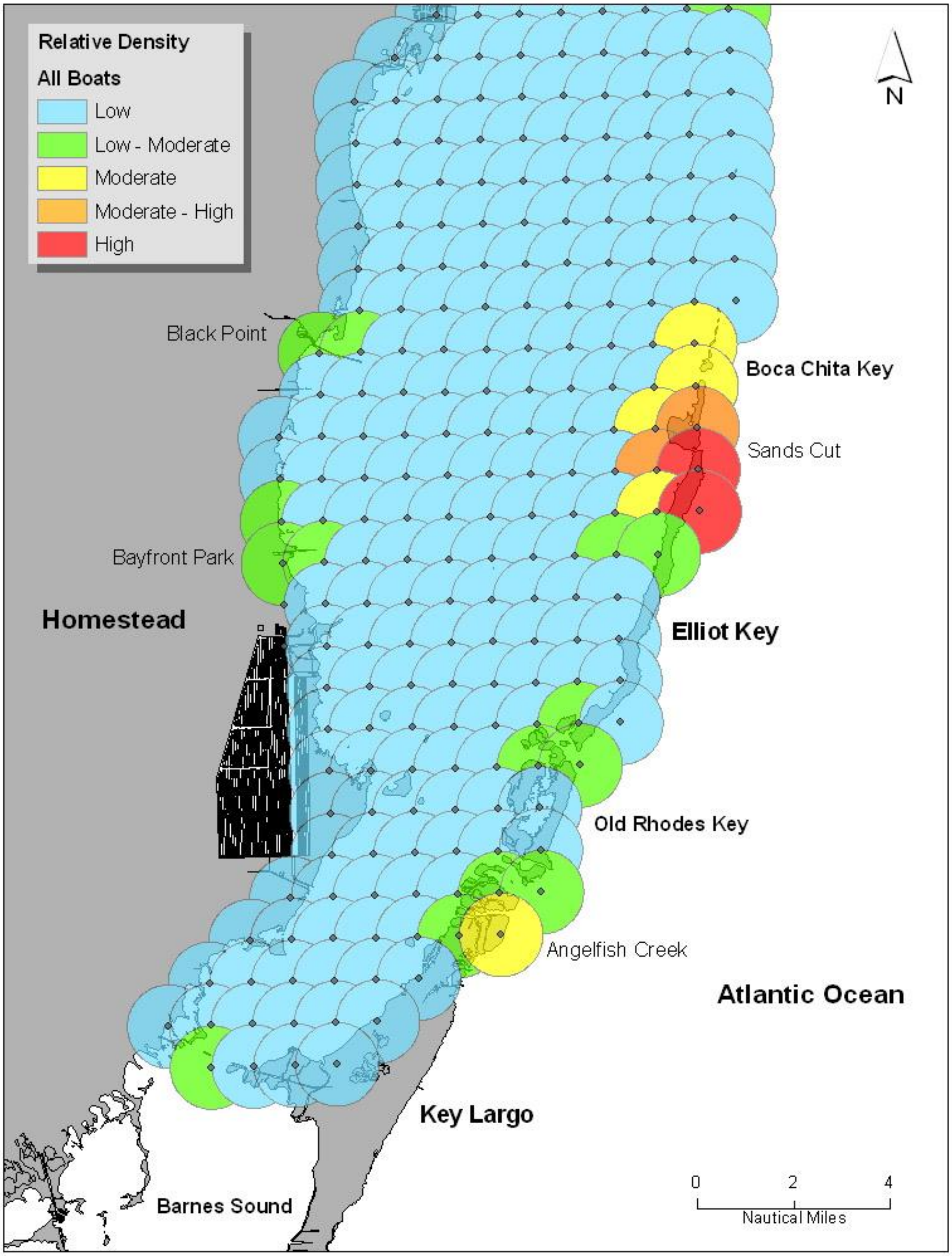


Figure 19. Spatial analysis results, expressed as areas of relative density, for all vessels in-use along the northern portion of the aerial survey route. Weekday surveys only.

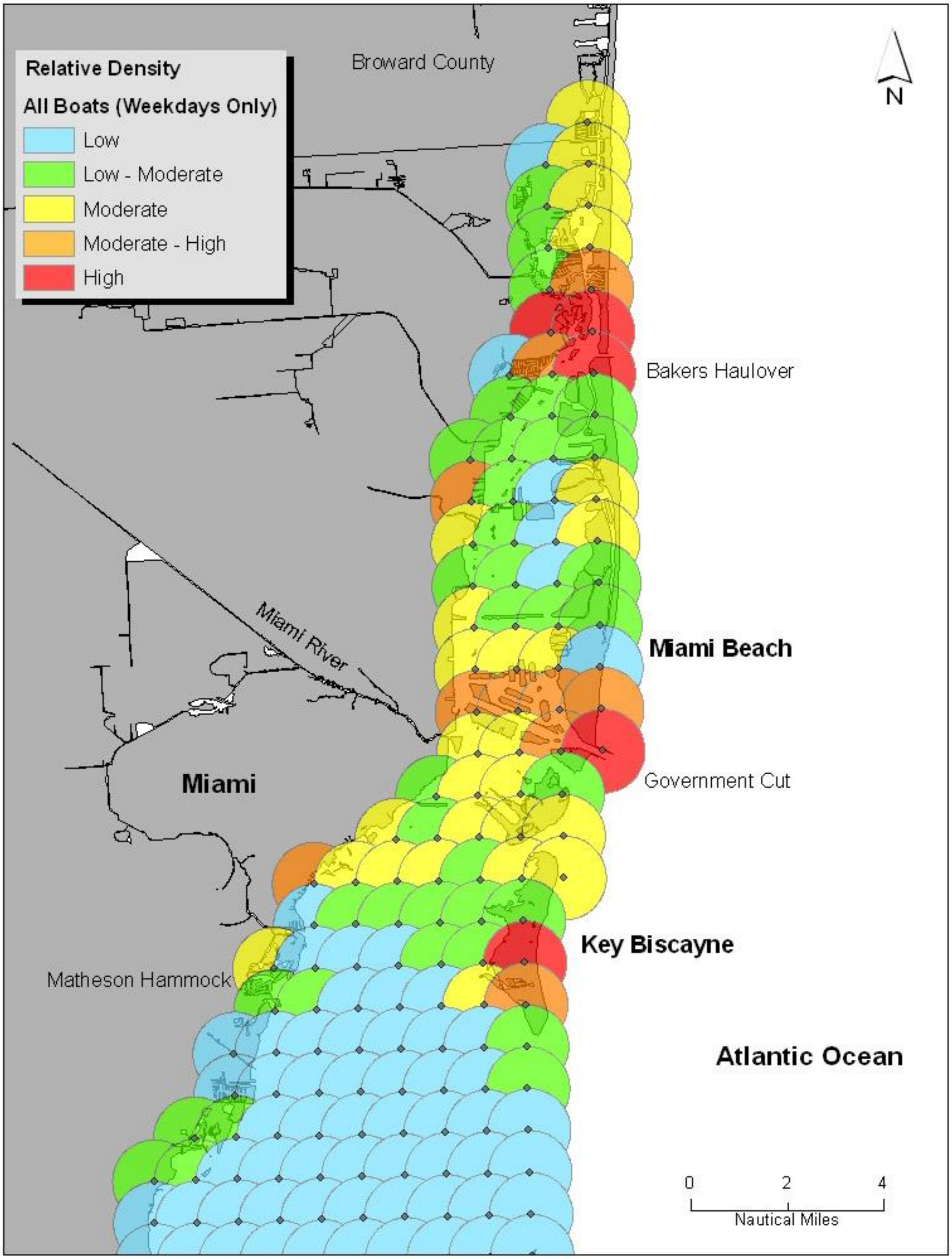


Figure 20. Spatial analysis results, expressed as areas of relative density, for all vessels in-use along the southern portion of the aerial survey route. Weekday surveys only.

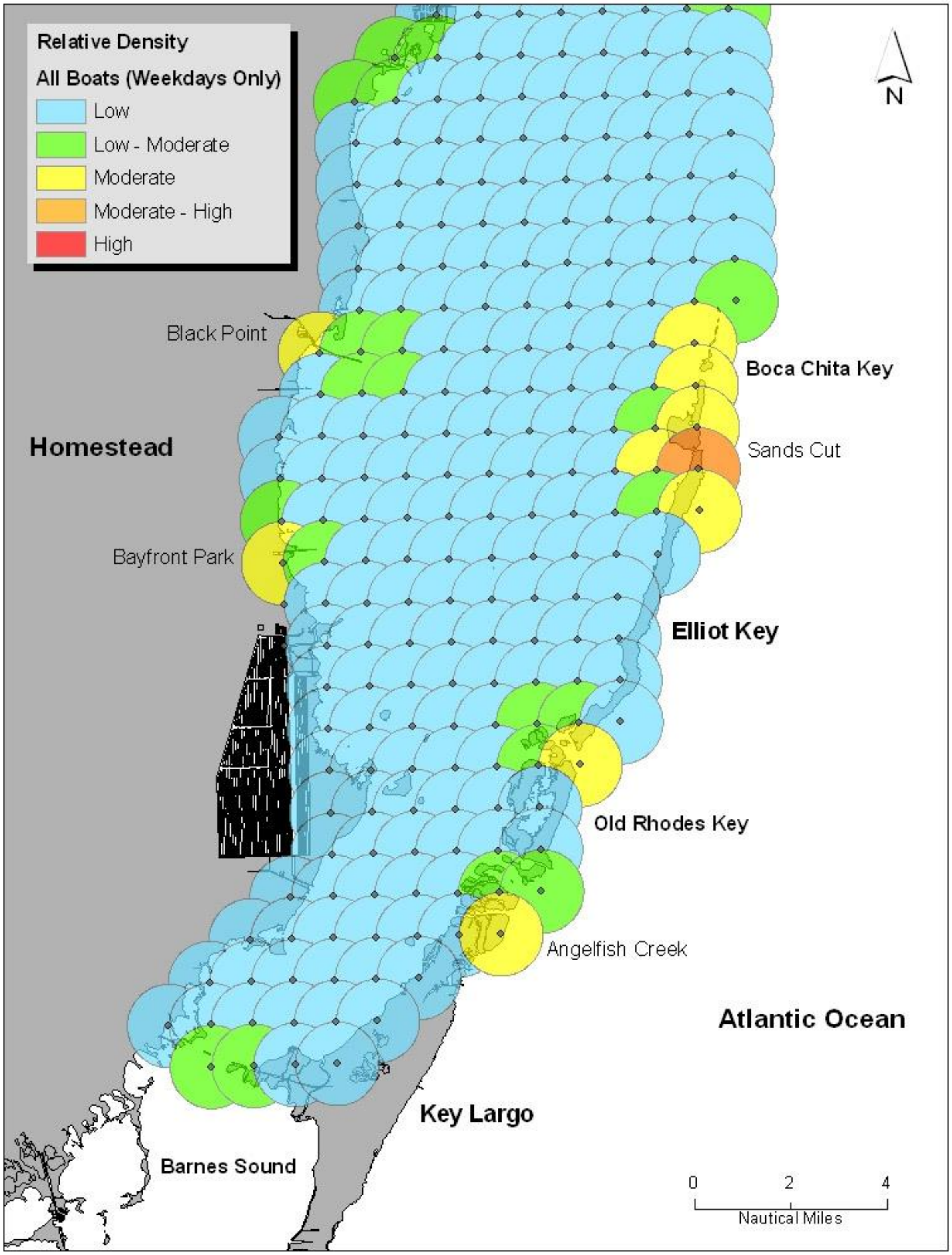


Figure 21. Spatial analysis results, expressed as areas of relative density, for all vessels in-use along the northern portion of the aerial survey route. Weekend surveys only.

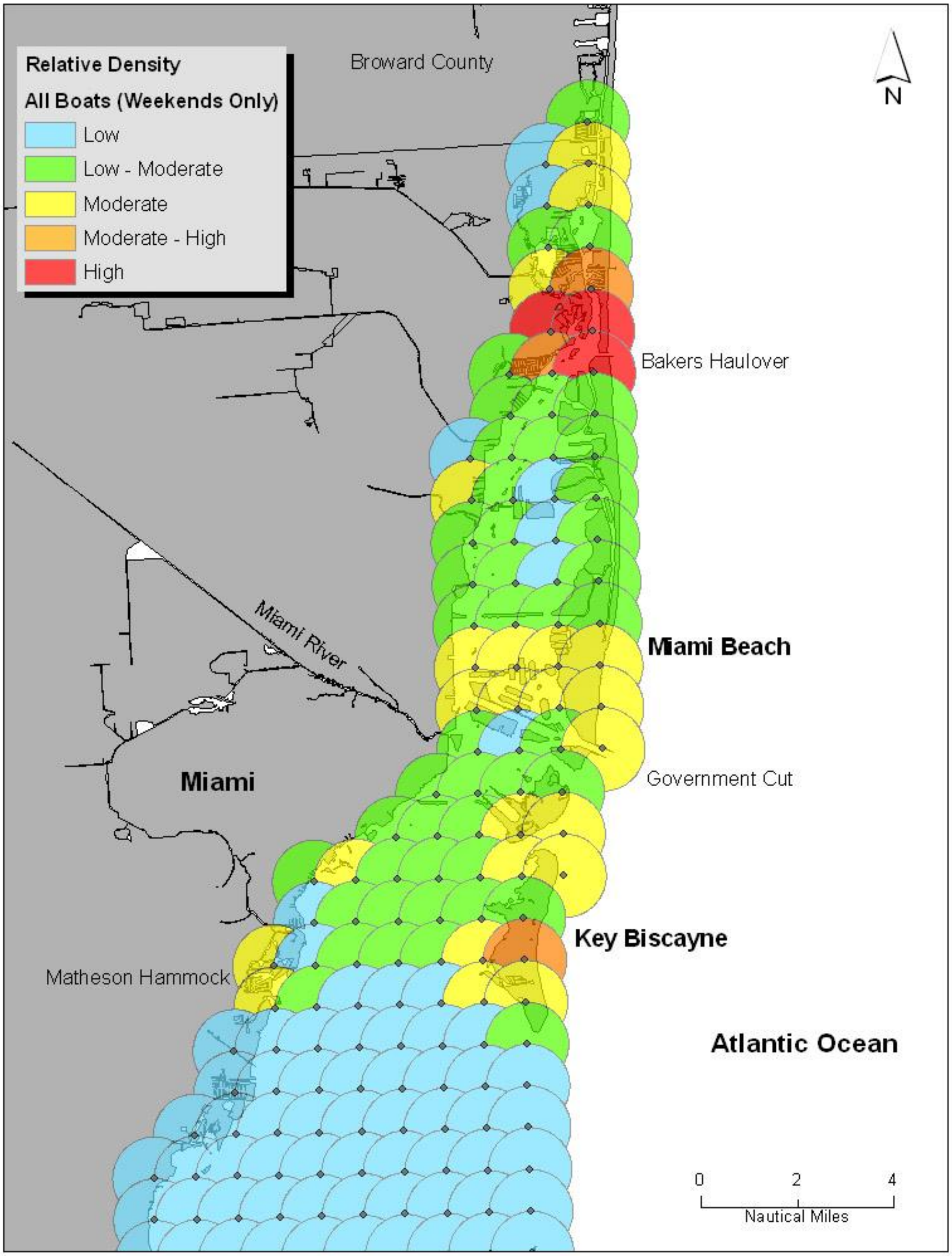


Figure 22. Spatial analysis results, expressed as areas of relative density, for all vessels in-use along the southern portion of the aerial survey route. Weekend surveys only.

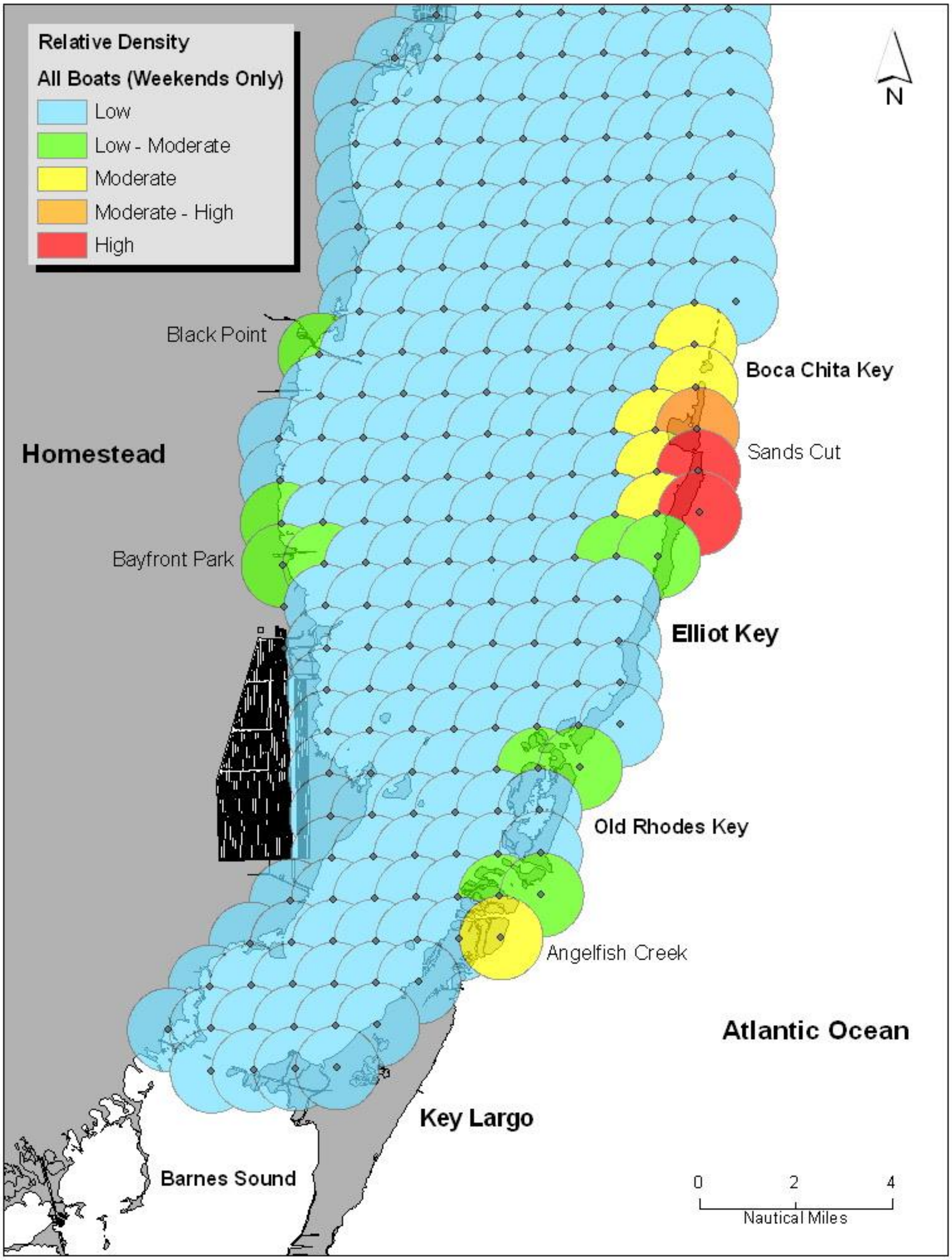


Figure 23. Spatial analysis results, expressed as areas of relative density, for all stationary vessels in-use observed along the northern portion of the aerial survey route. Weekday and weekend surveys are combined.

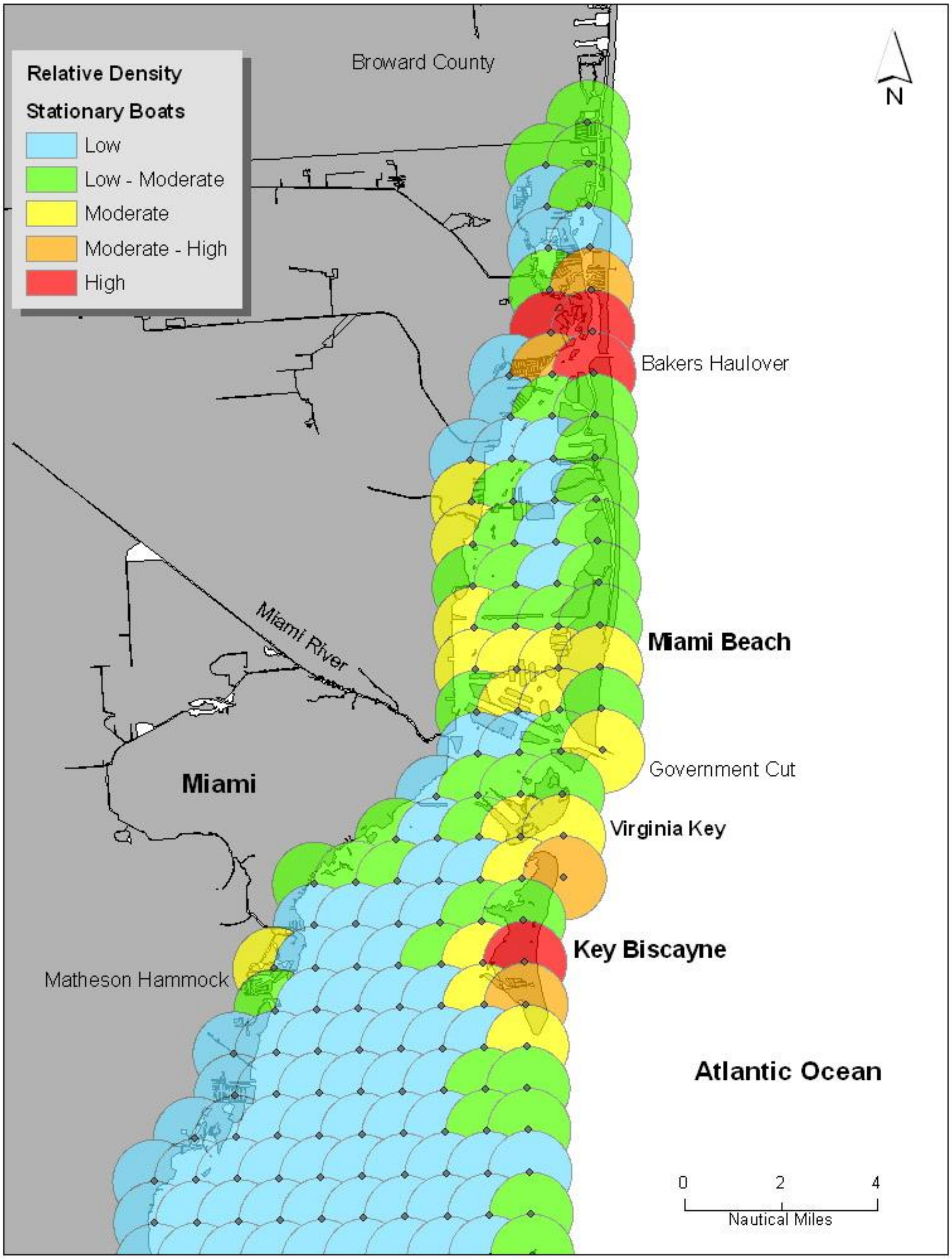


Figure 24. Spatial analysis results, expressed as areas of relative density, for all stationary vessels in-use observed along the southern portion of the aerial survey route. Weekday and weekend surveys are combined.

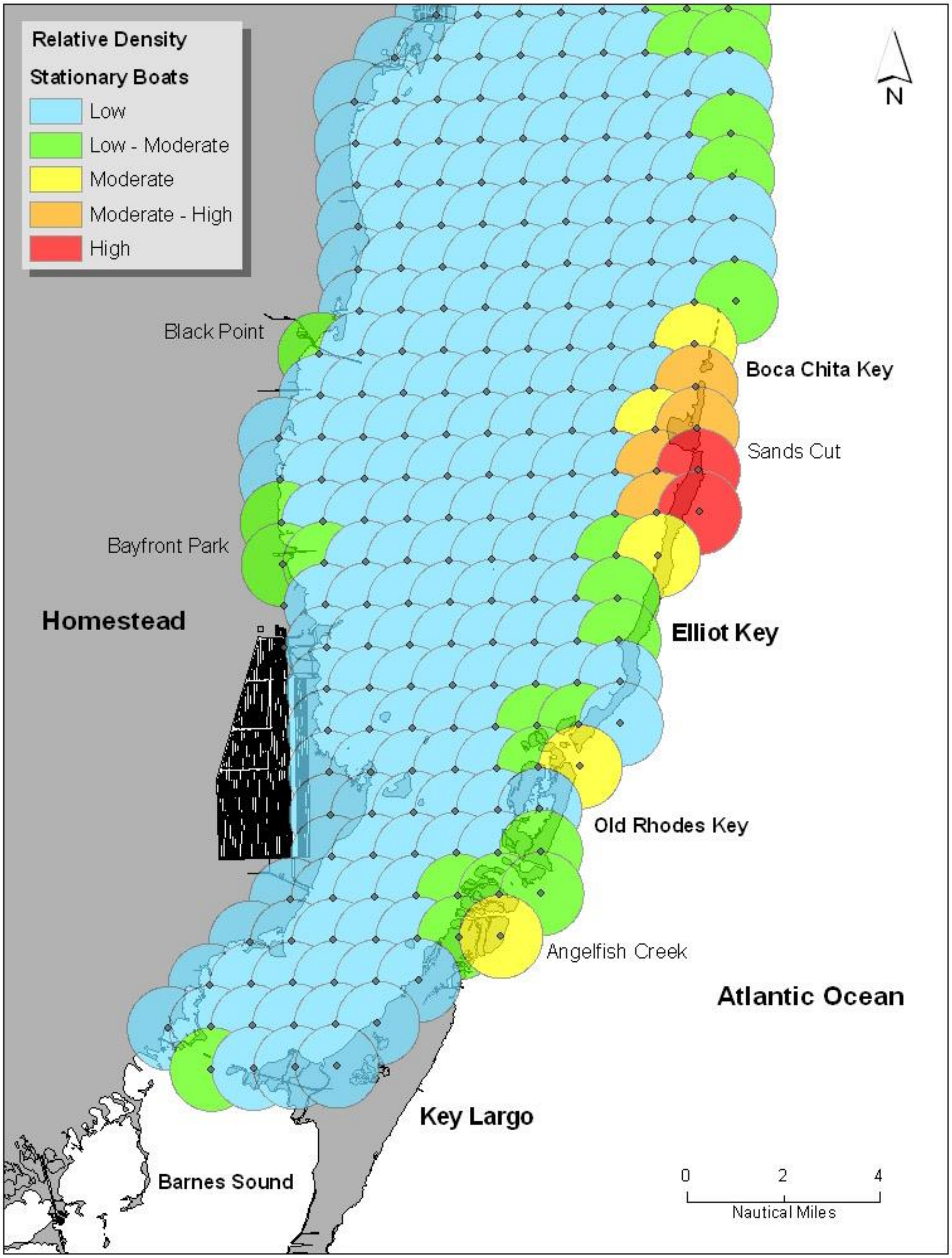


Figure 25. Spatial analysis results, expressed as areas of relative density, for all vessels traveling at idle or slow speed along the northern portion of the aerial survey route. Weekday and weekend surveys are combined.

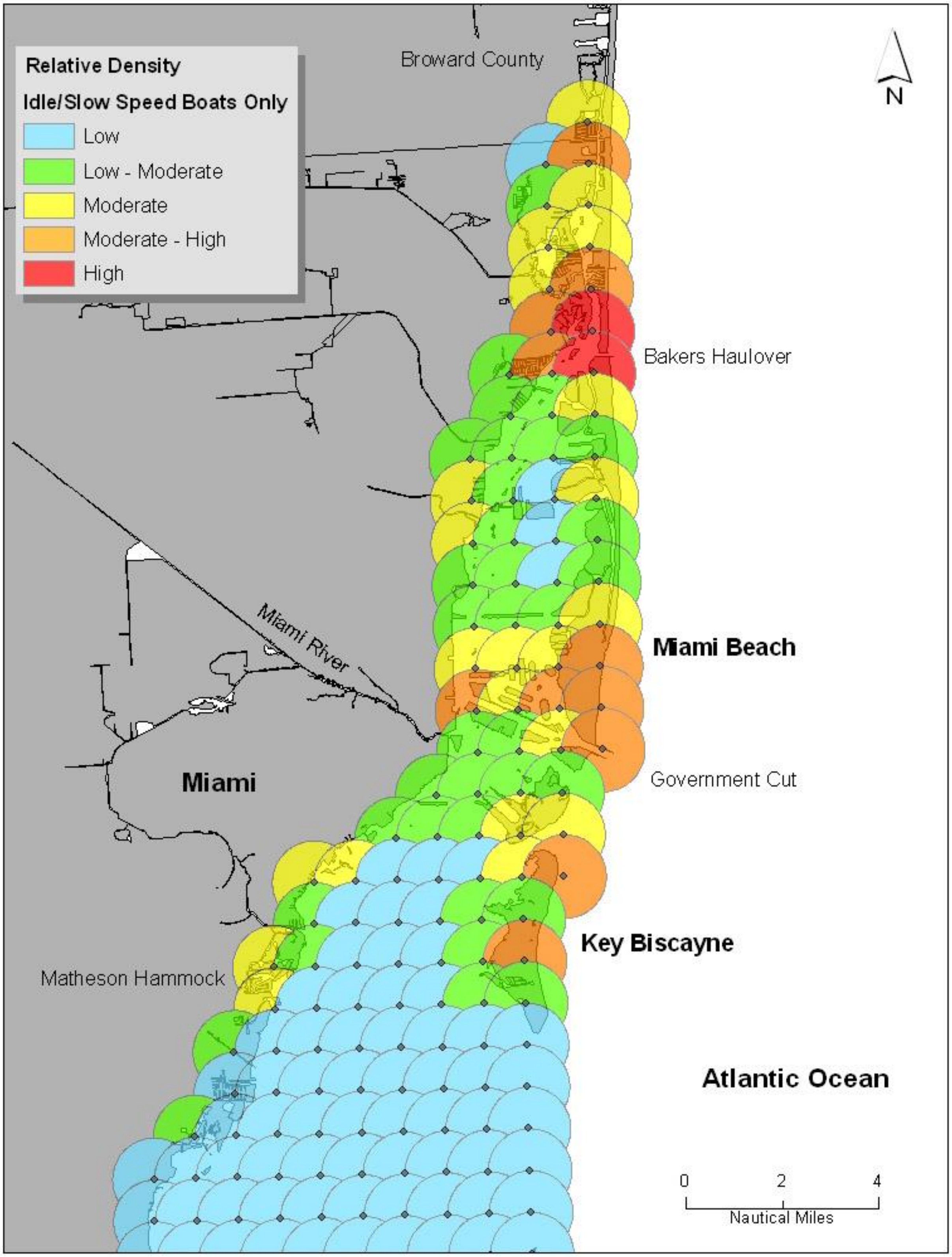


Figure 26. Spatial analysis results, expressed as areas of relative density, for all vessels traveling at idle or slow speed along the southern portion of the aerial survey route. Weekday and weekend surveys are combined.

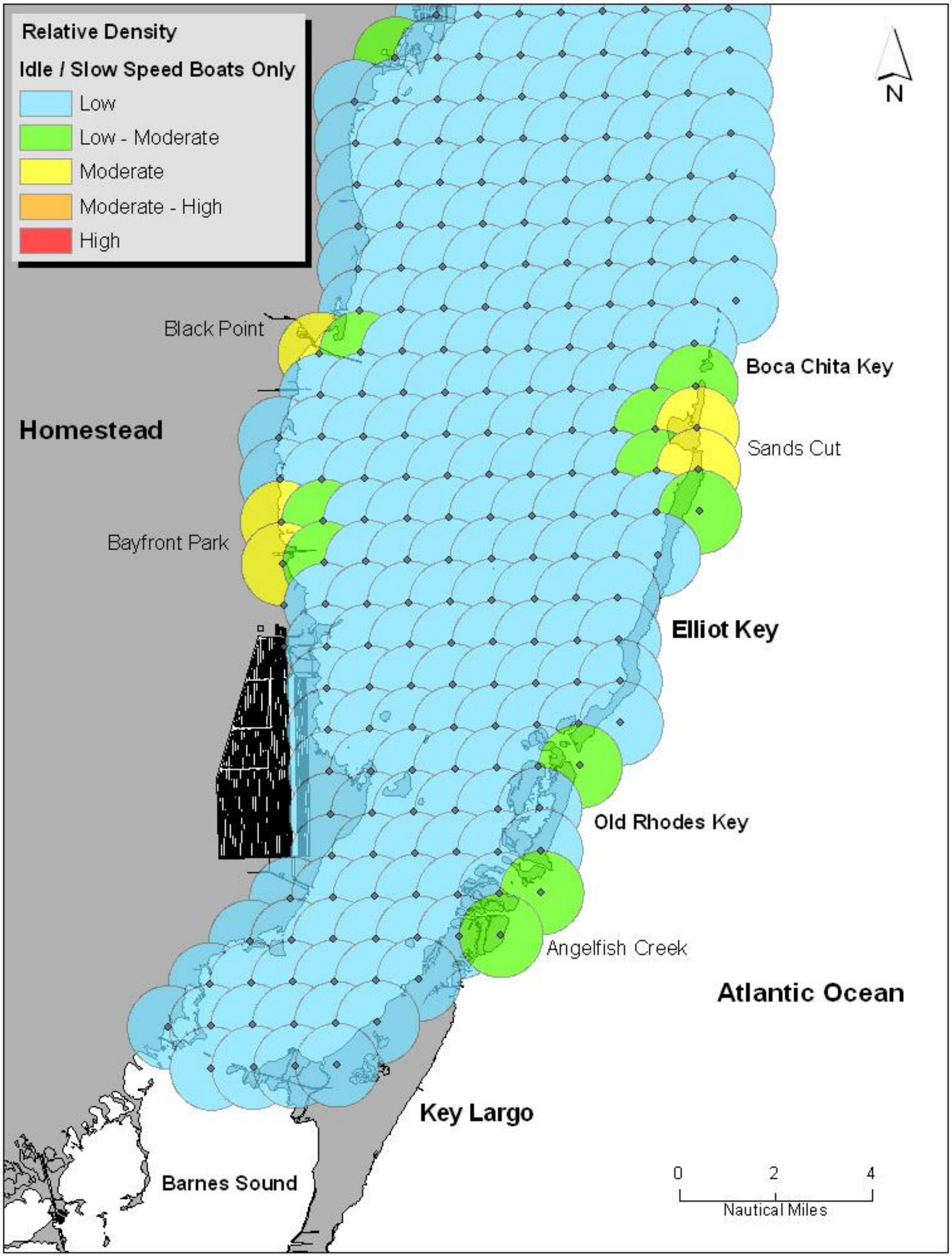


Figure 27. Spatial analysis results, expressed as areas of relative density, for all vessels traveling at plowing, cruising, or planing speed along the northern portion of the aerial survey route. Weekday and weekend surveys are combined.

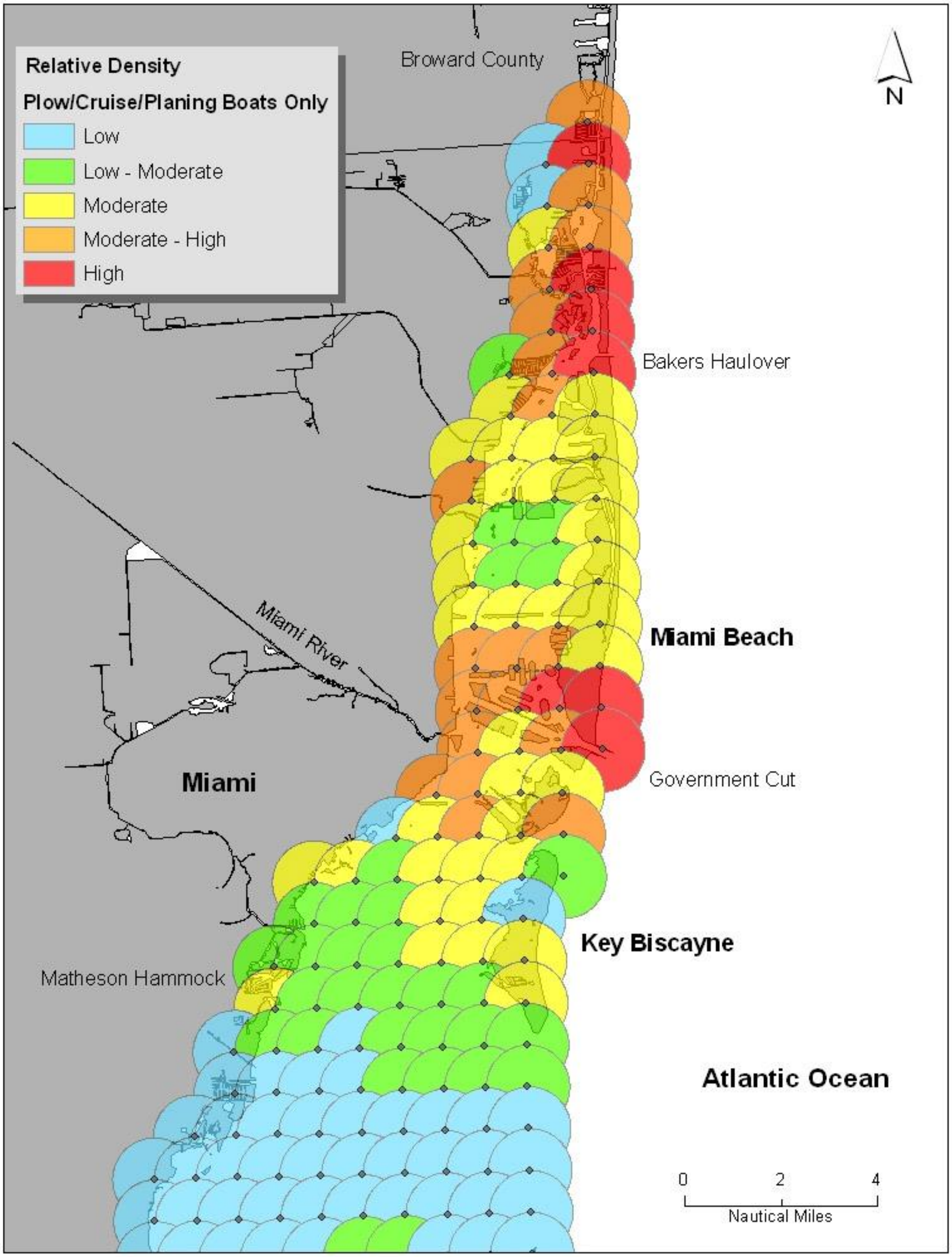


Figure 28. Spatial analysis results, expressed as areas of relative density, for all vessels traveling at plowing, cruising, or planing speed along the southern portion of the aerial survey route. Weekday and weekend surveys are combined.

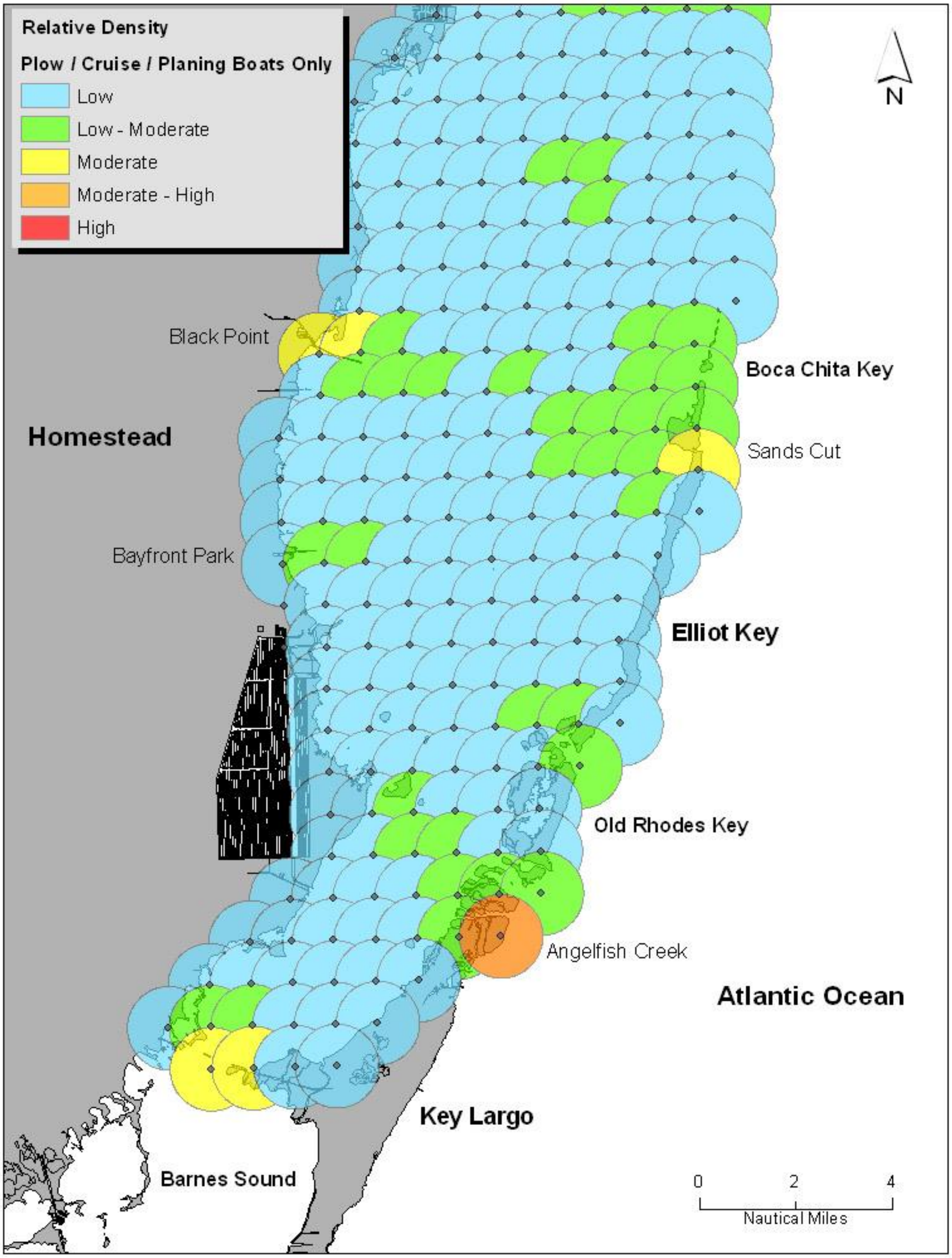


Figure 29. Spatial analysis results, expressed as areas of relative density, for all vessels traveling at planing speed along the northern portion of the aerial survey route. Weekday and weekend surveys are combined.

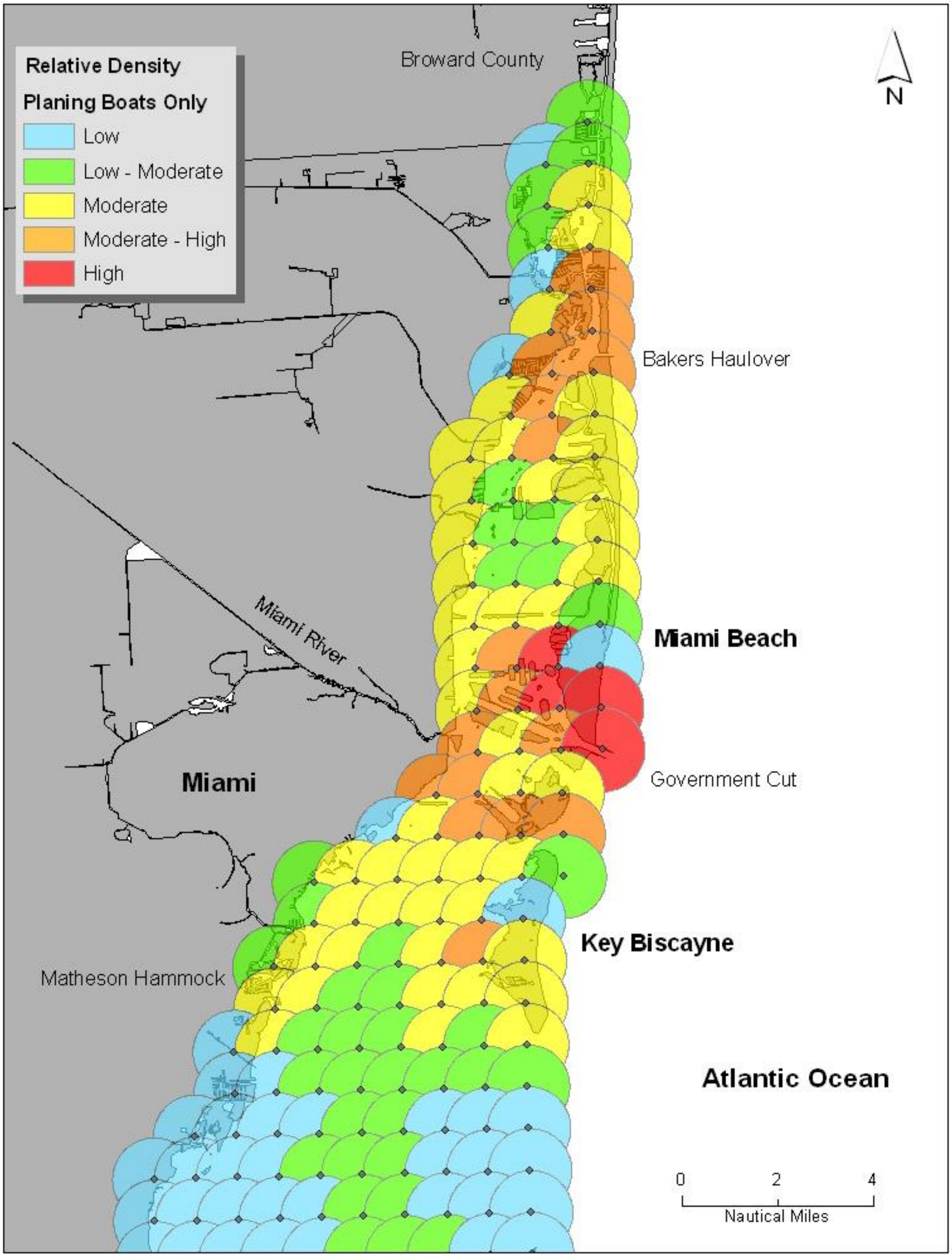


Figure 30. Spatial analysis results, expressed as areas of relative density, for all vessels traveling at planing speed along the southern portion of the aerial survey route. Weekday and weekend surveys are combined.

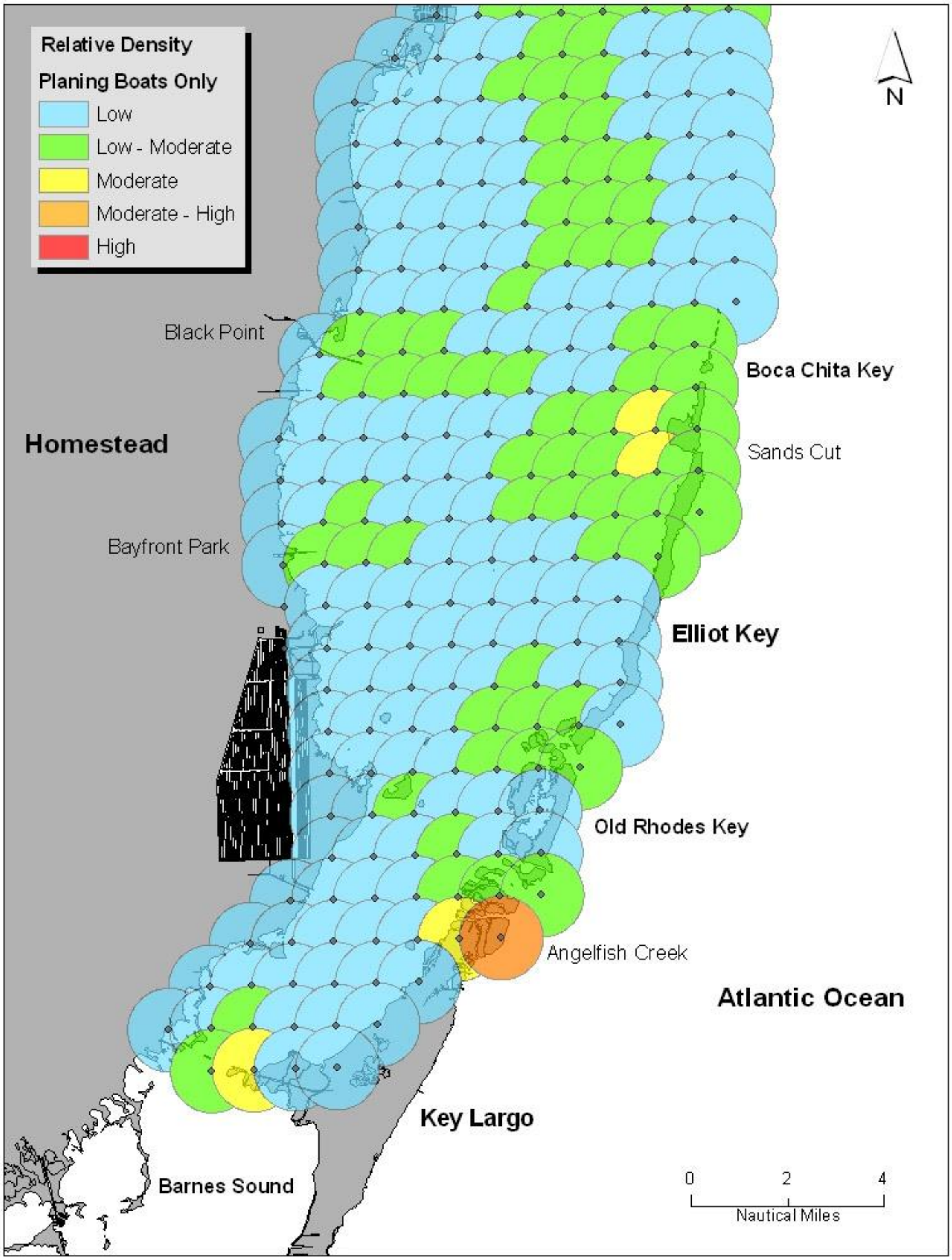


Figure 31. Composite map of all vessels under power observed near Bakers Haulover Inlet, along with their observed speeds.

Figure 32. Composite map of all vessels under power observed near the Port of Miami and entrance to the Miami River, along with their observed speeds.

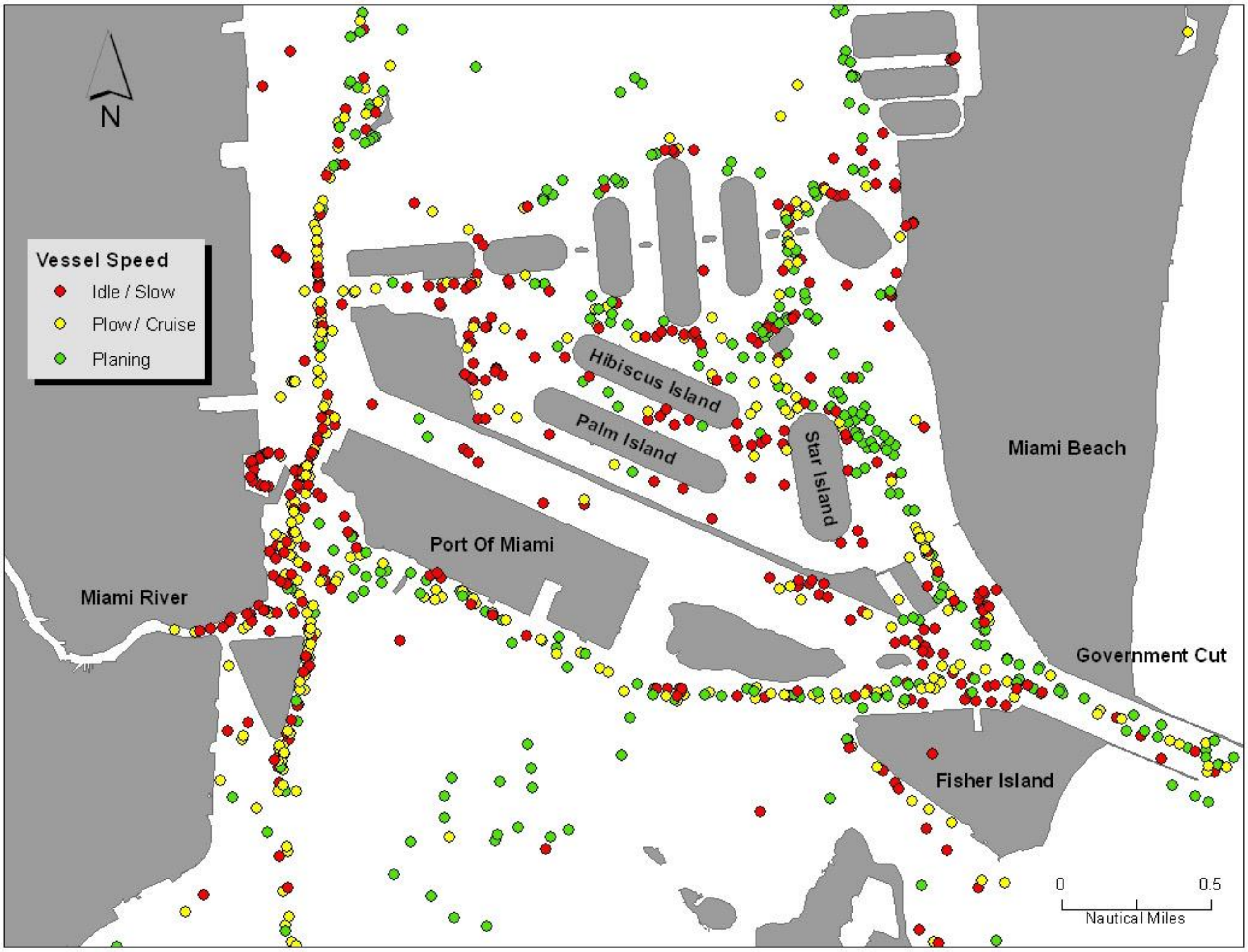


Figure 33. Composite map of all vessels under power observed in upper Biscayne Bay between Dinner Key and Key Biscayne, along with their observed speeds.

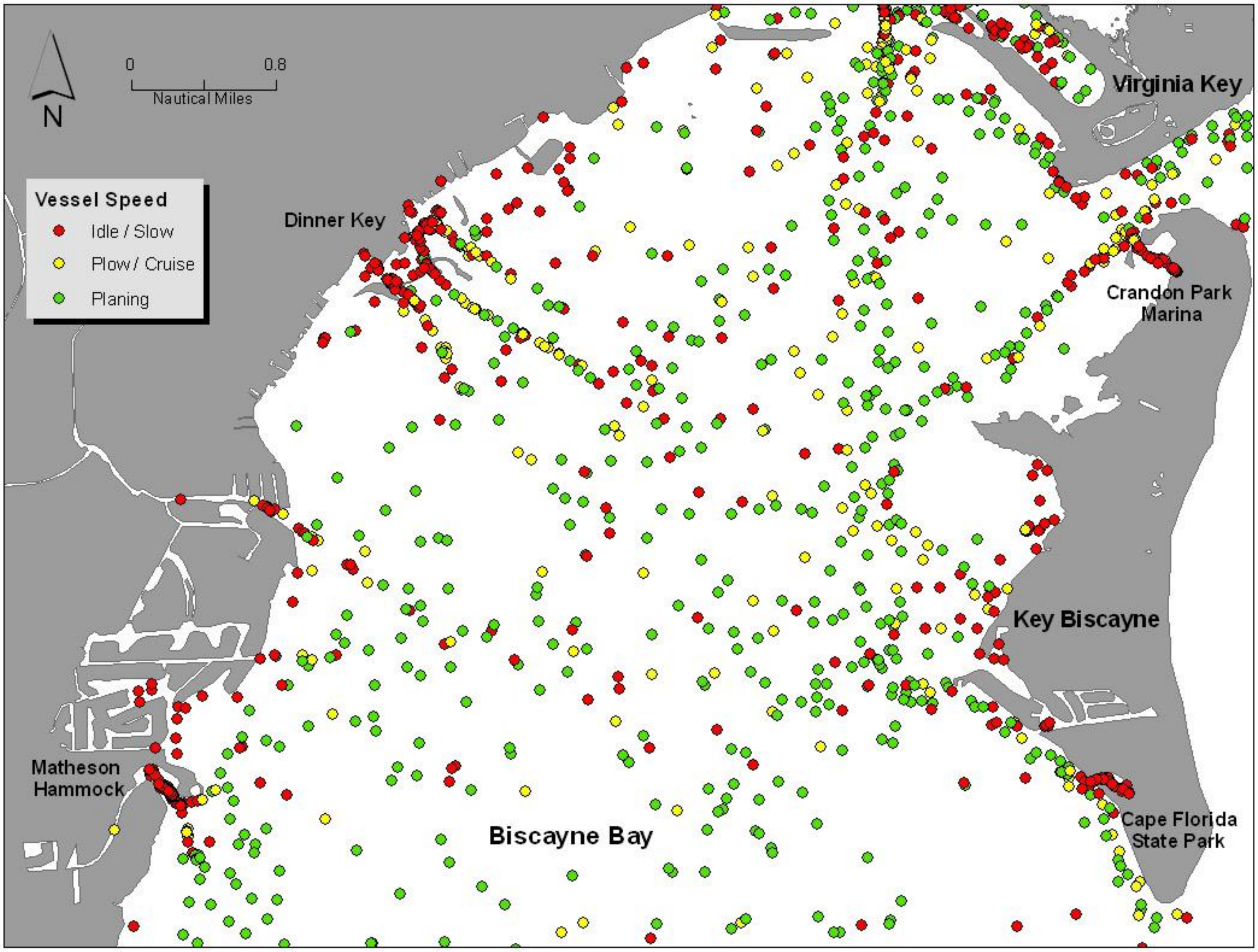


Figure 34. Composite map of all vessels under power observed in lower Biscayne Bay between Black Point and Elliot Key, along with their observed speeds.

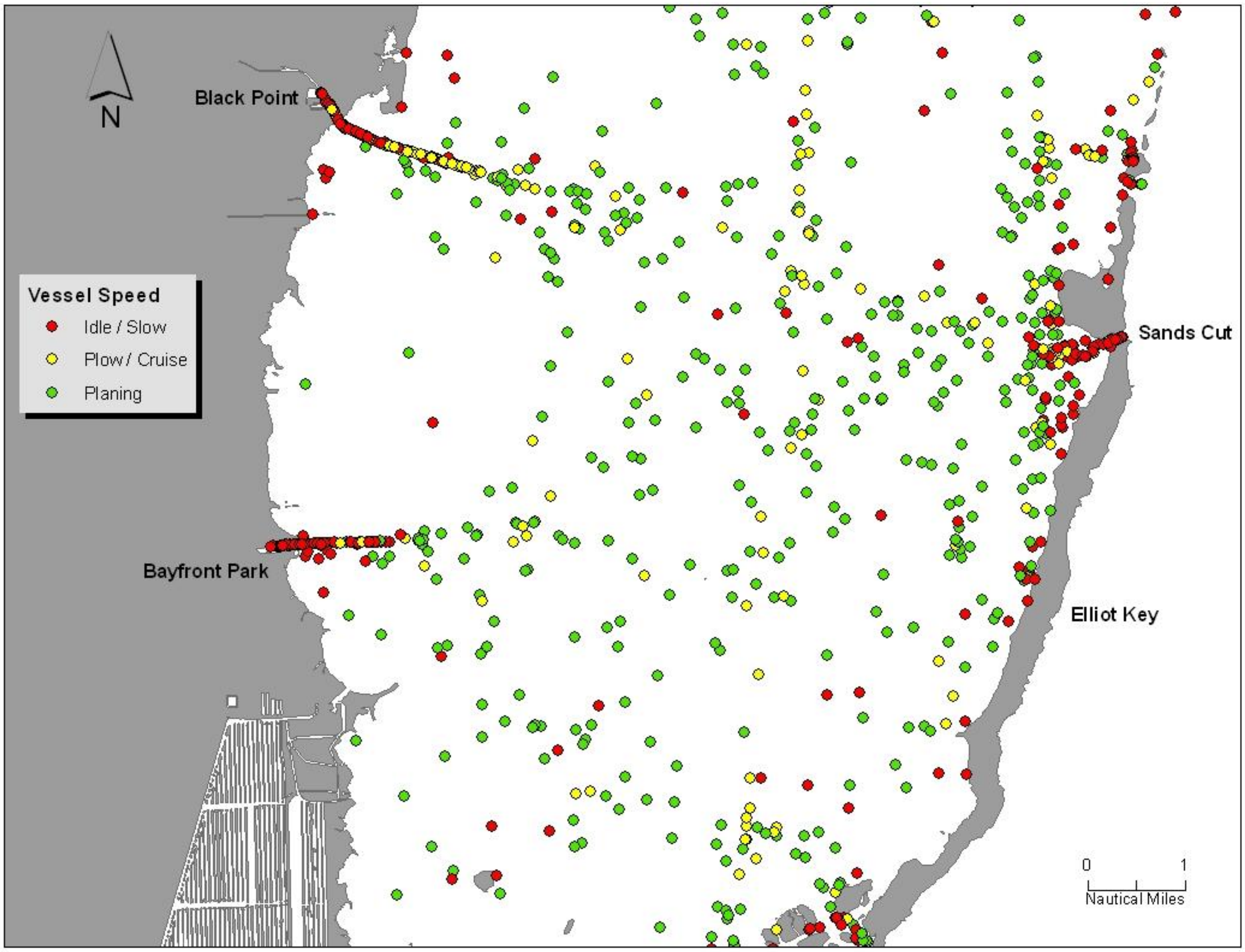


Figure 35. Comparison of vessel size categories from fixed point survey sites.

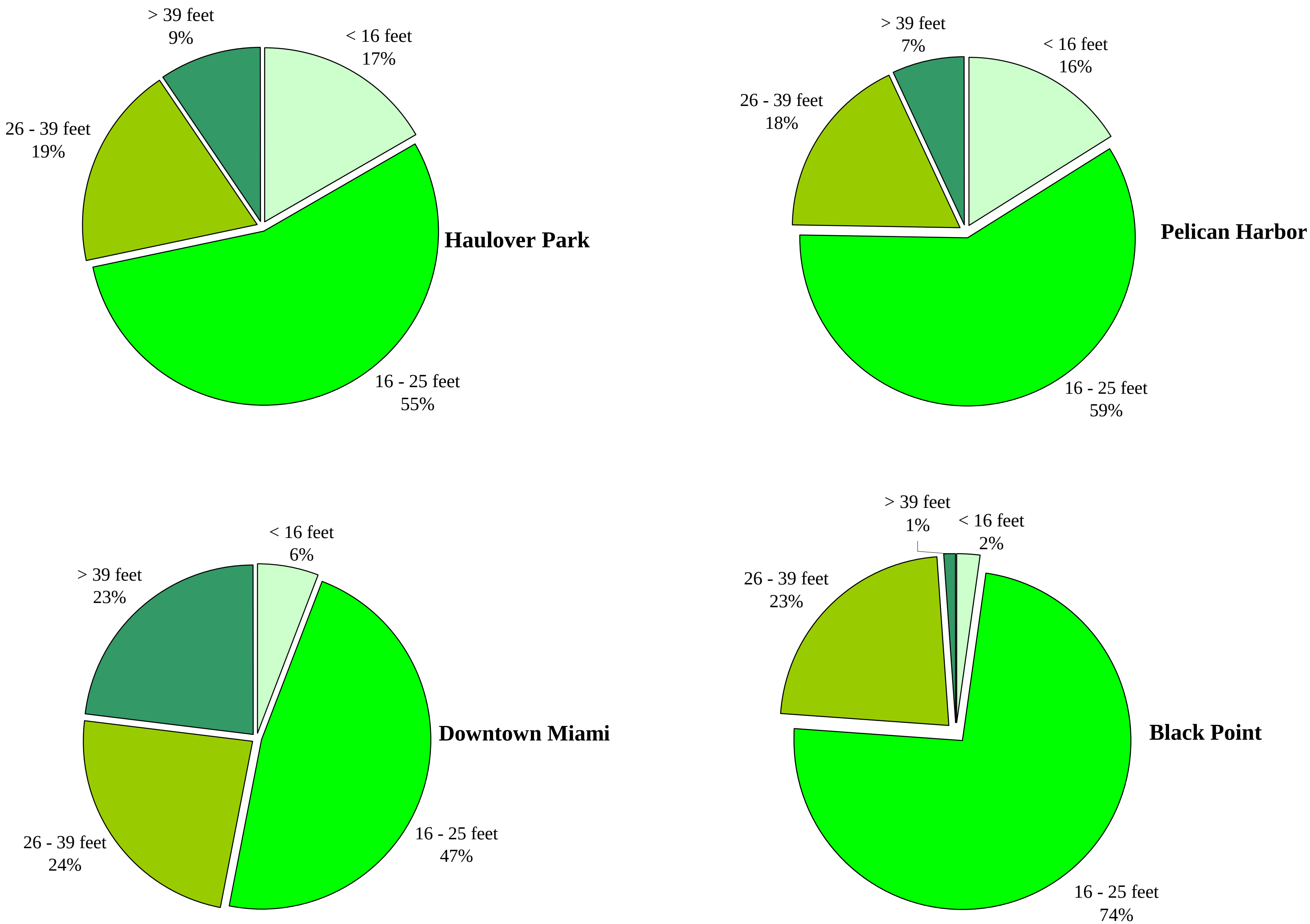


Figure 36. Comparison of vessel type categories from fixed point survey sites.

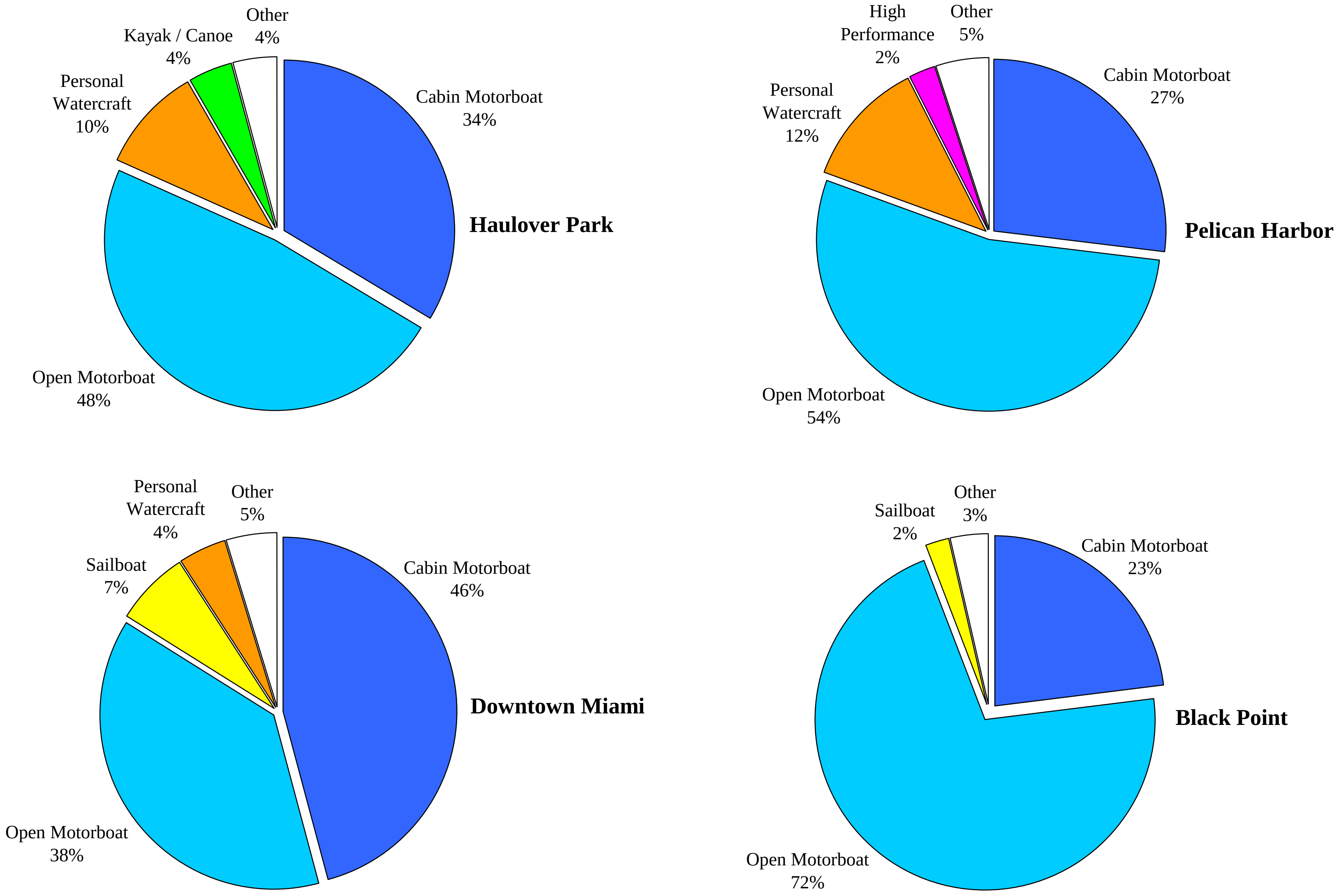


Figure 37. Comparison of vessel type categories from fixed point survey sites.

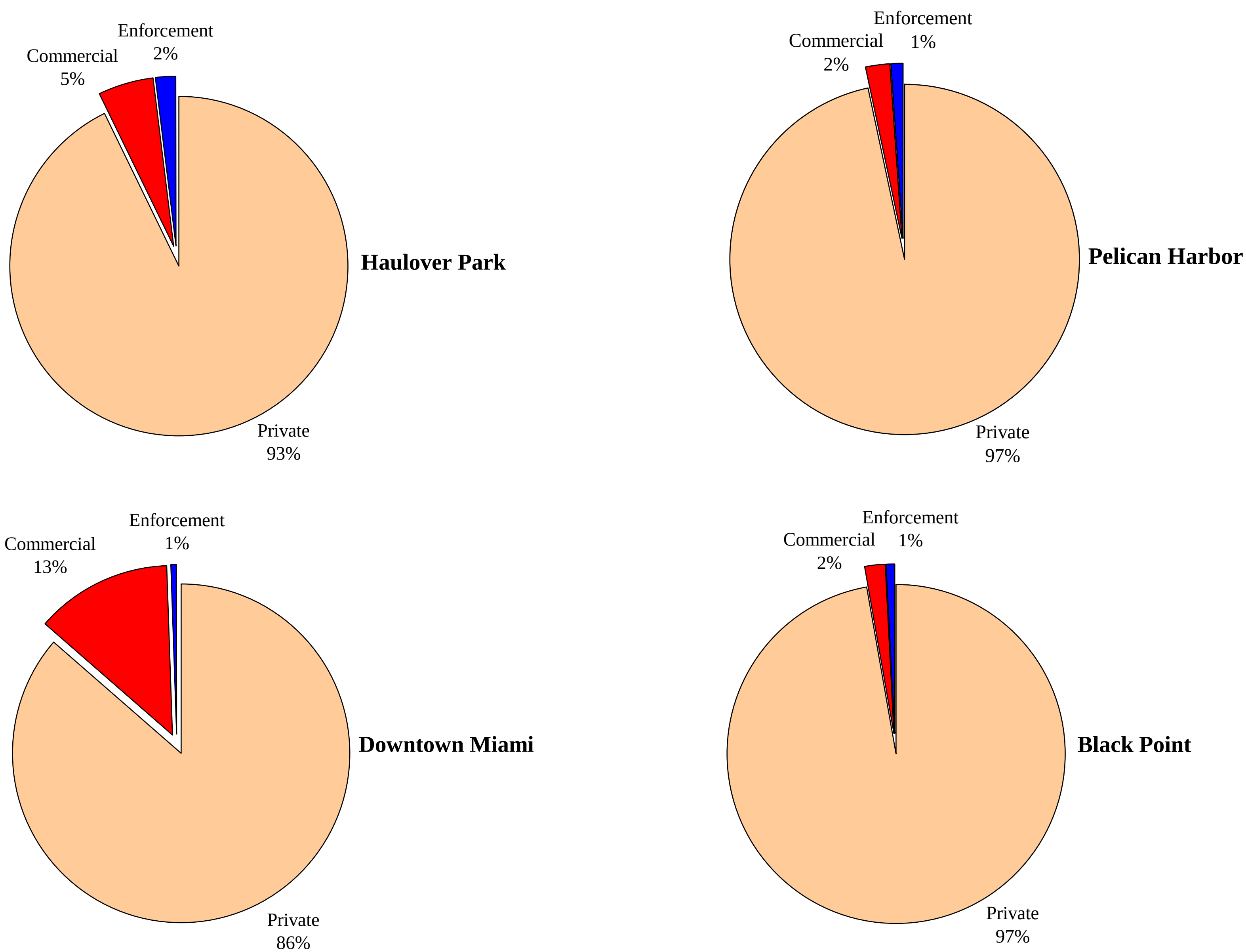


Figure 38. Hourly levels of vessel traffic at the Haulover Park survey site.

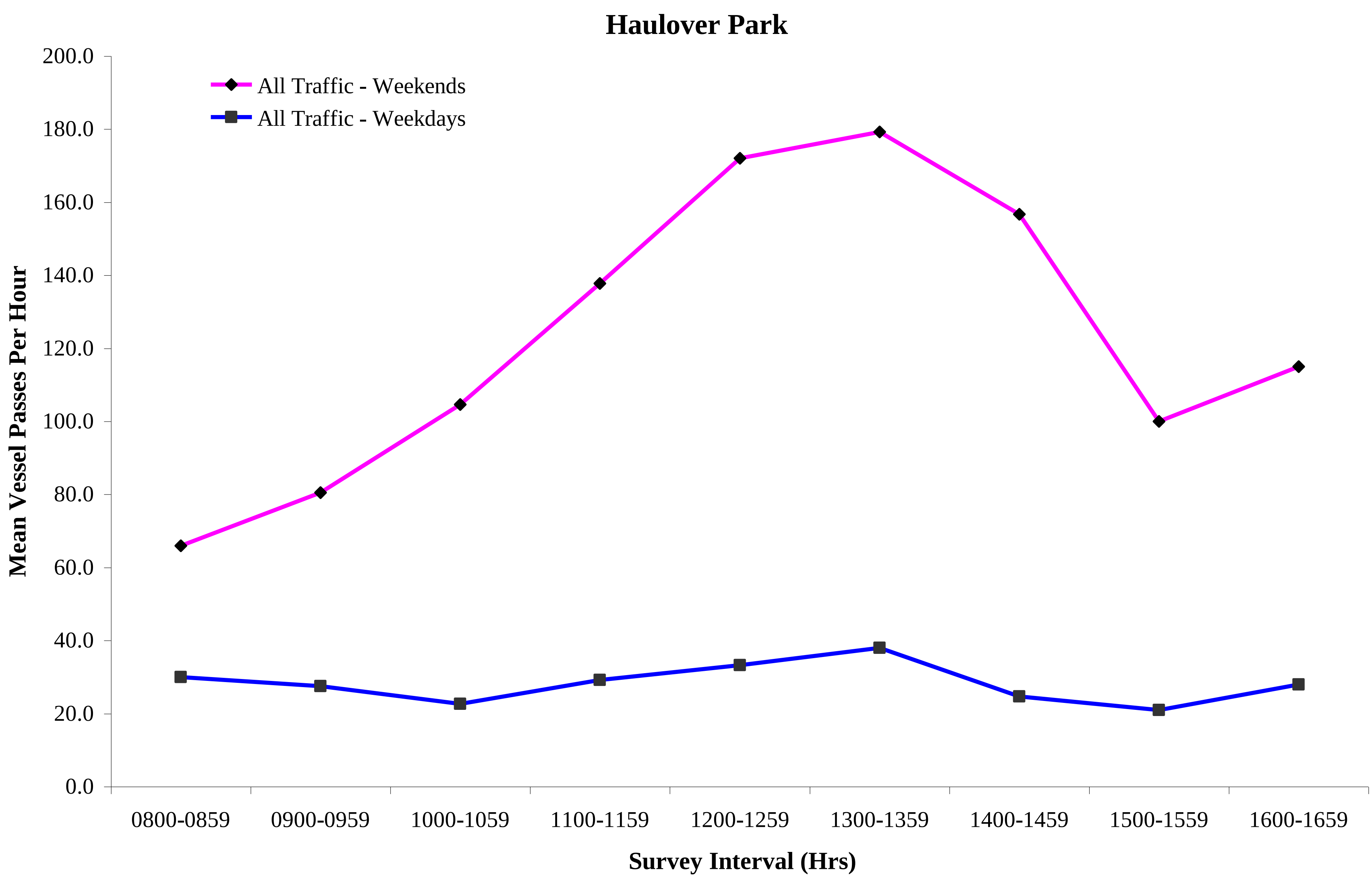


Figure 39. Hourly levels of vessel traffic through Bakers Haulover Inlet.

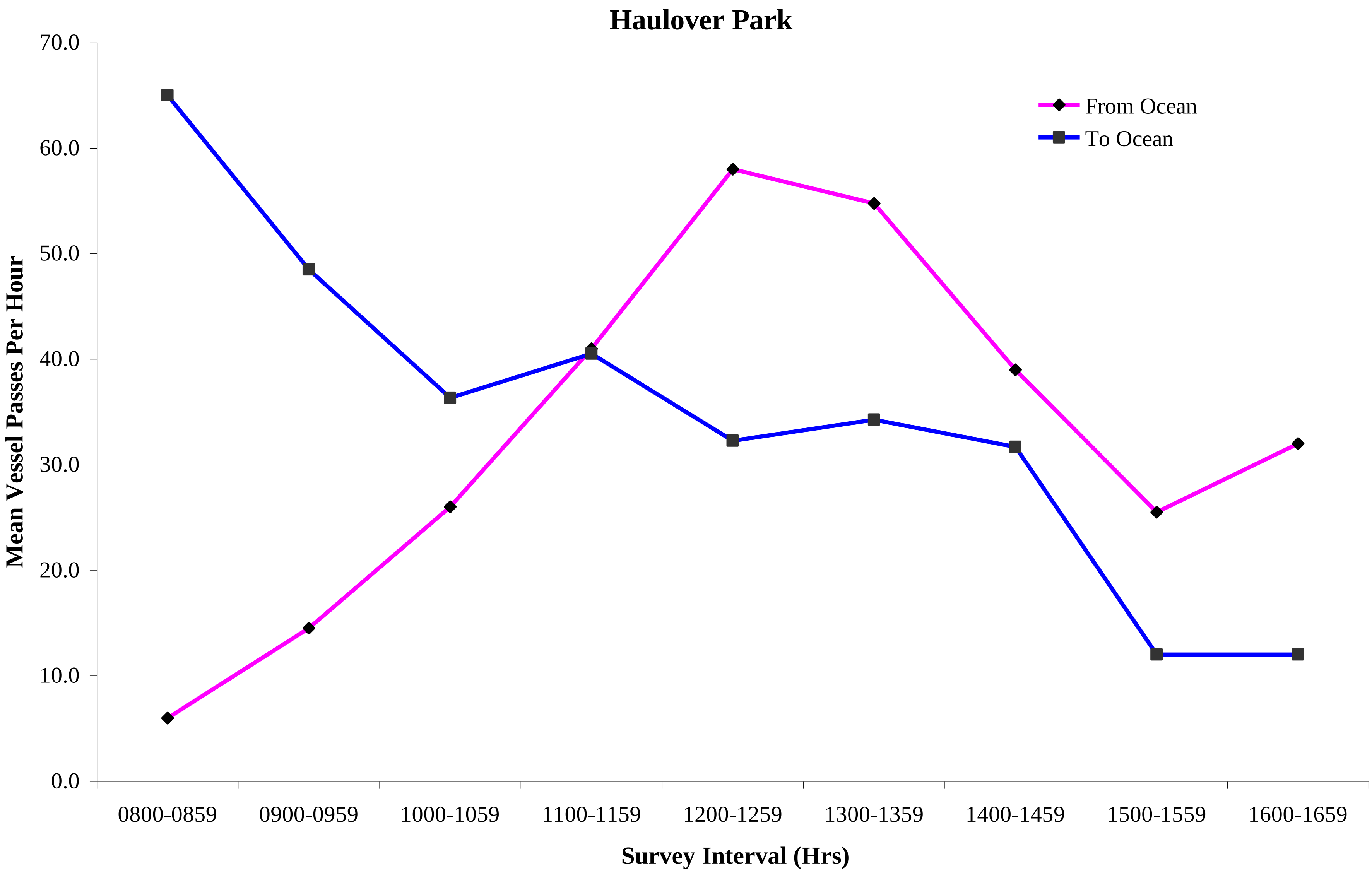


Figure 40. Hourly levels of vessel traffic at the Pelican Harbor Park survey site

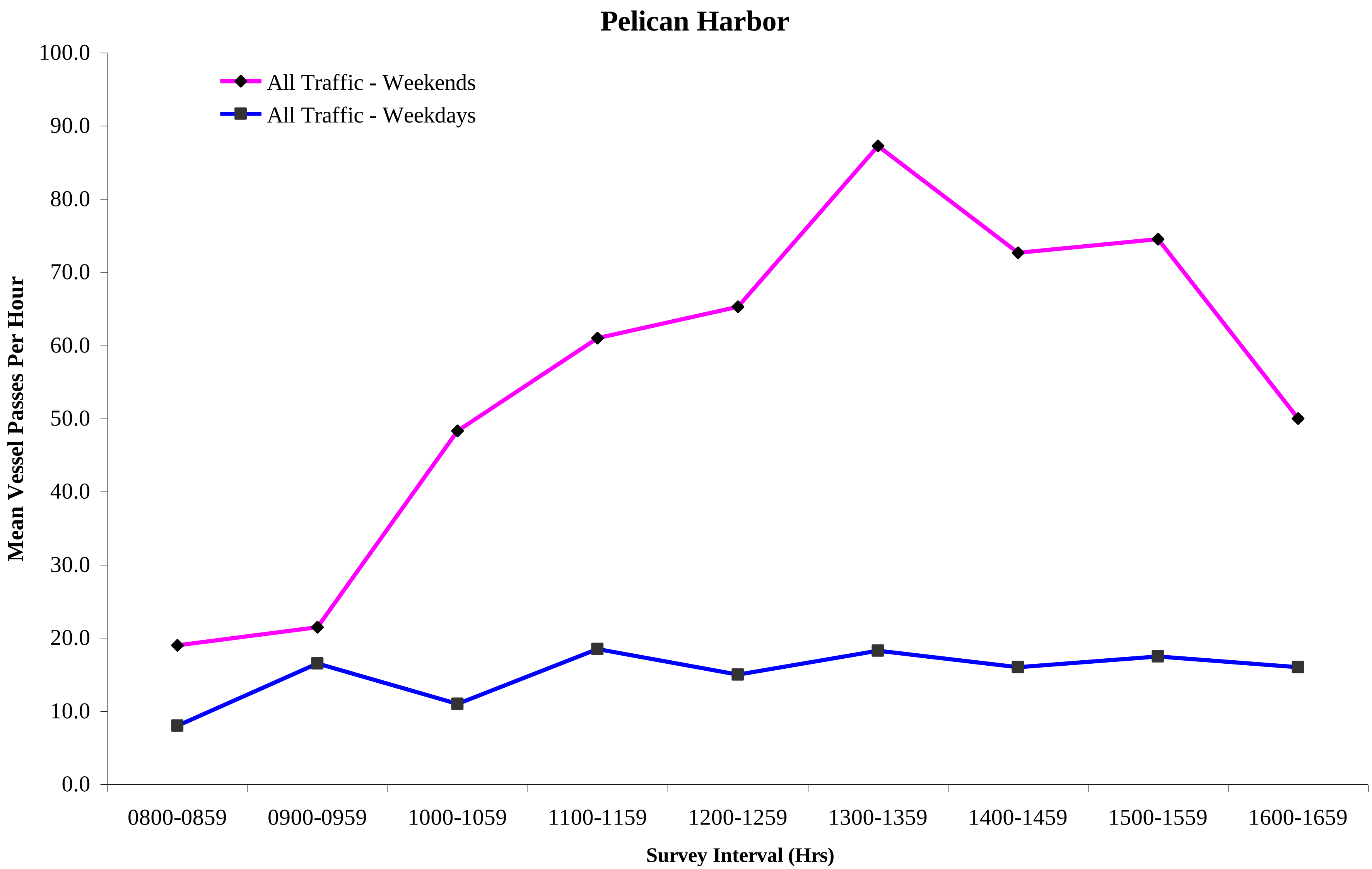


Figure 41. Hourly levels of traffic traveling to/from the Pelican Harbor Park boat ramp.

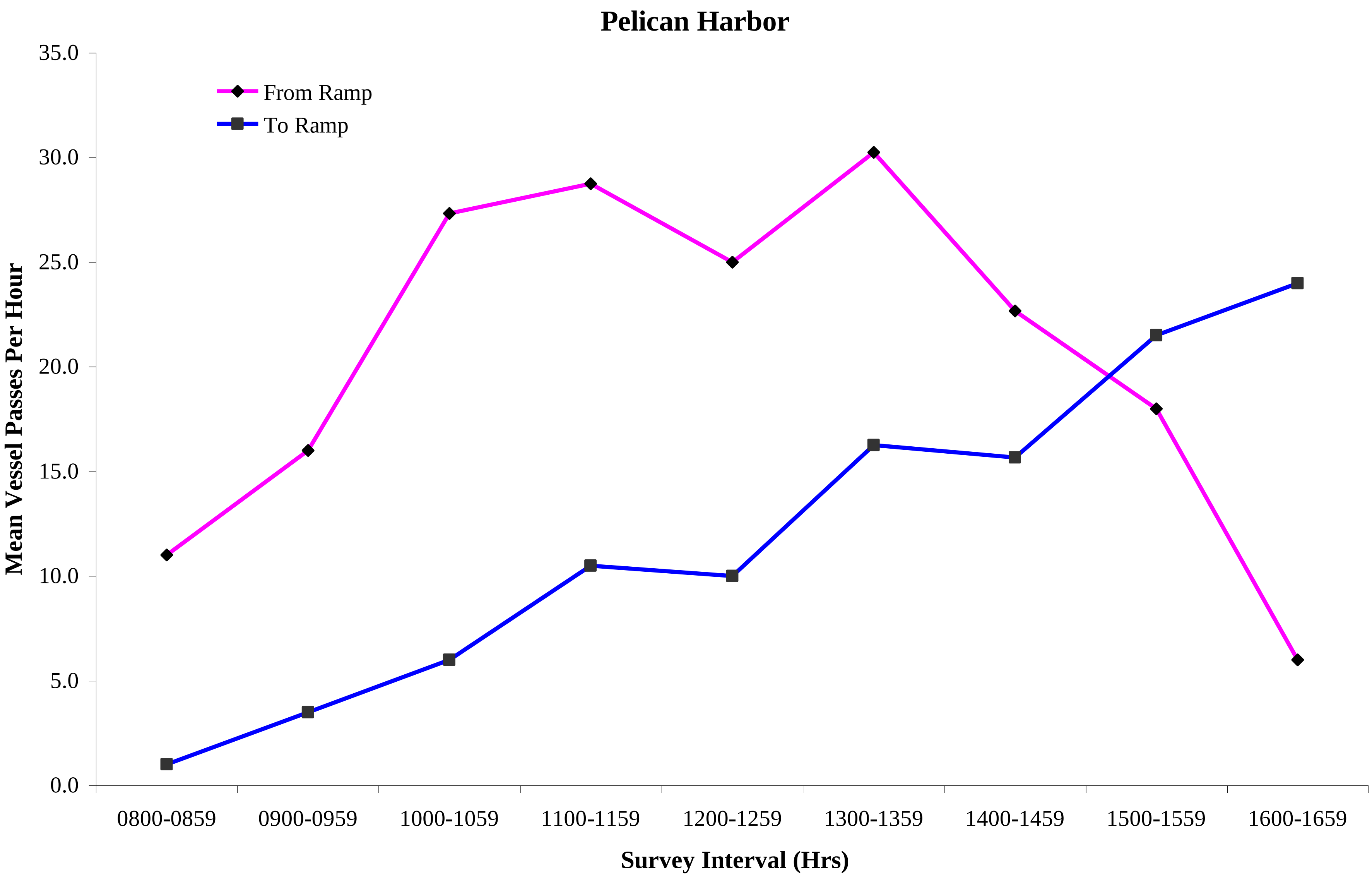


Figure 42. Hourly levels of vessel traffic at the Downtown Miami survey site.

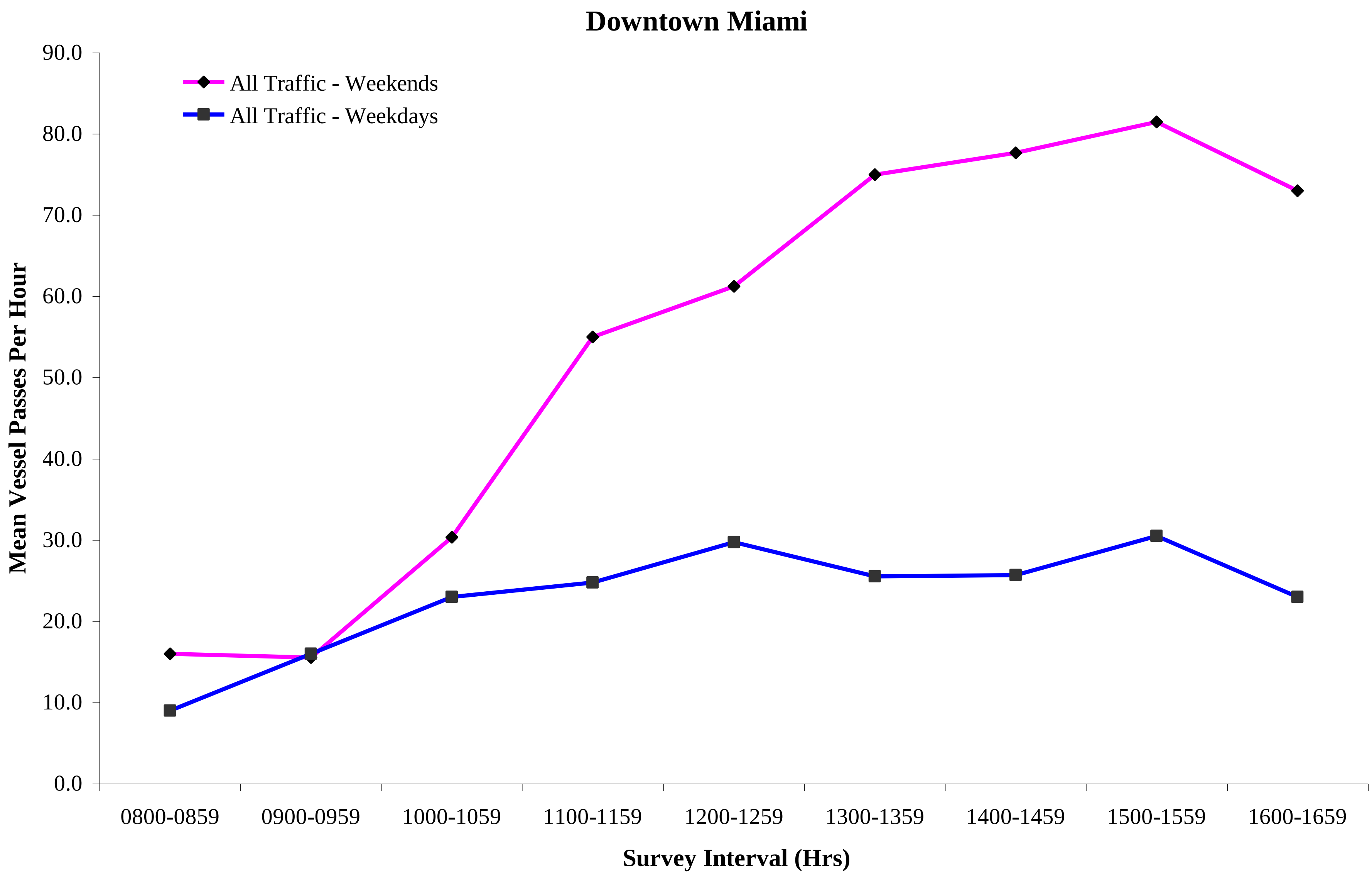


Figure 43. Hourly levels of traffic traveling to/from the Miami River.

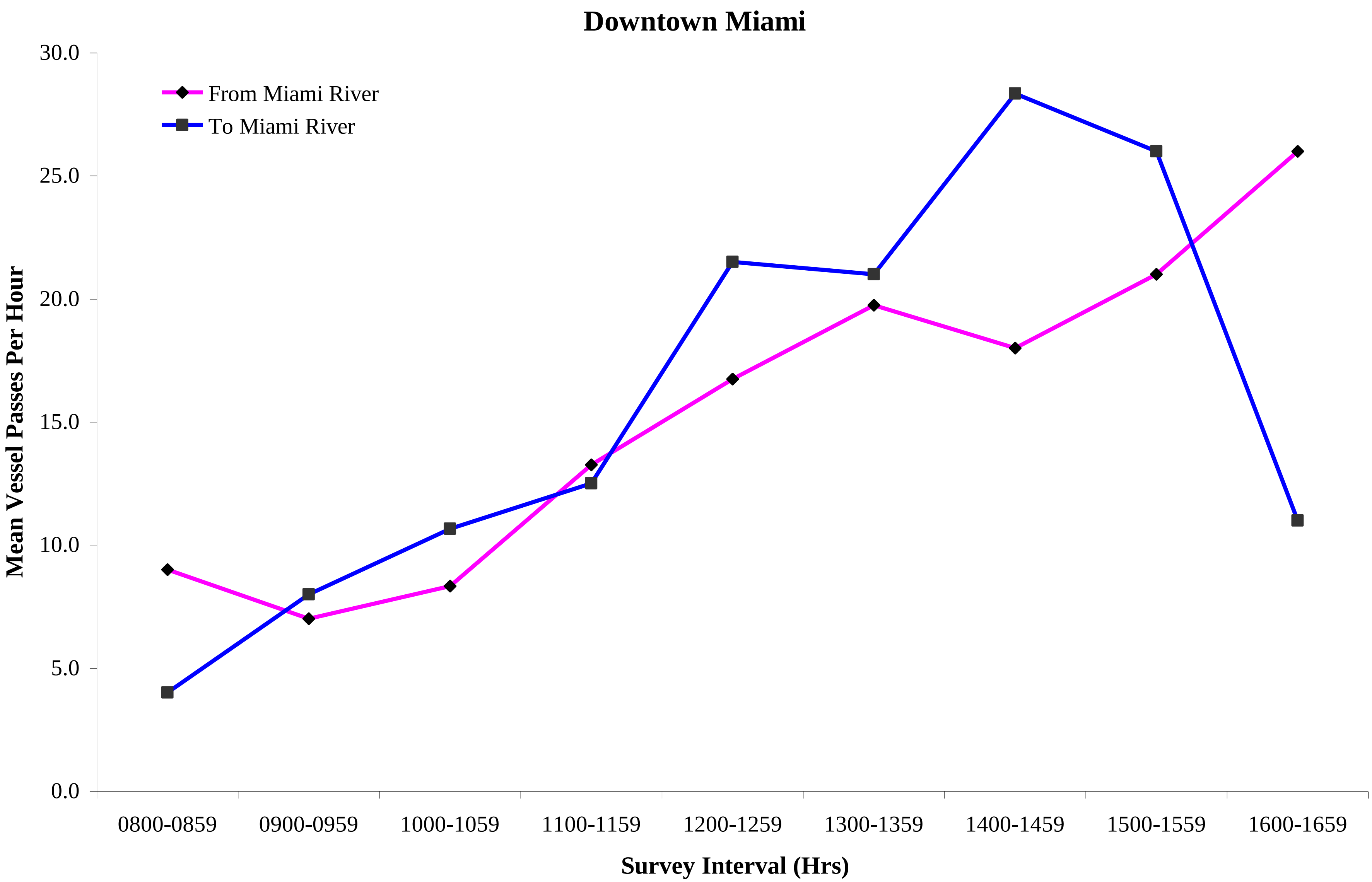


Figure 44. Hourly levels of vessel traffic at the Black Point survey site.

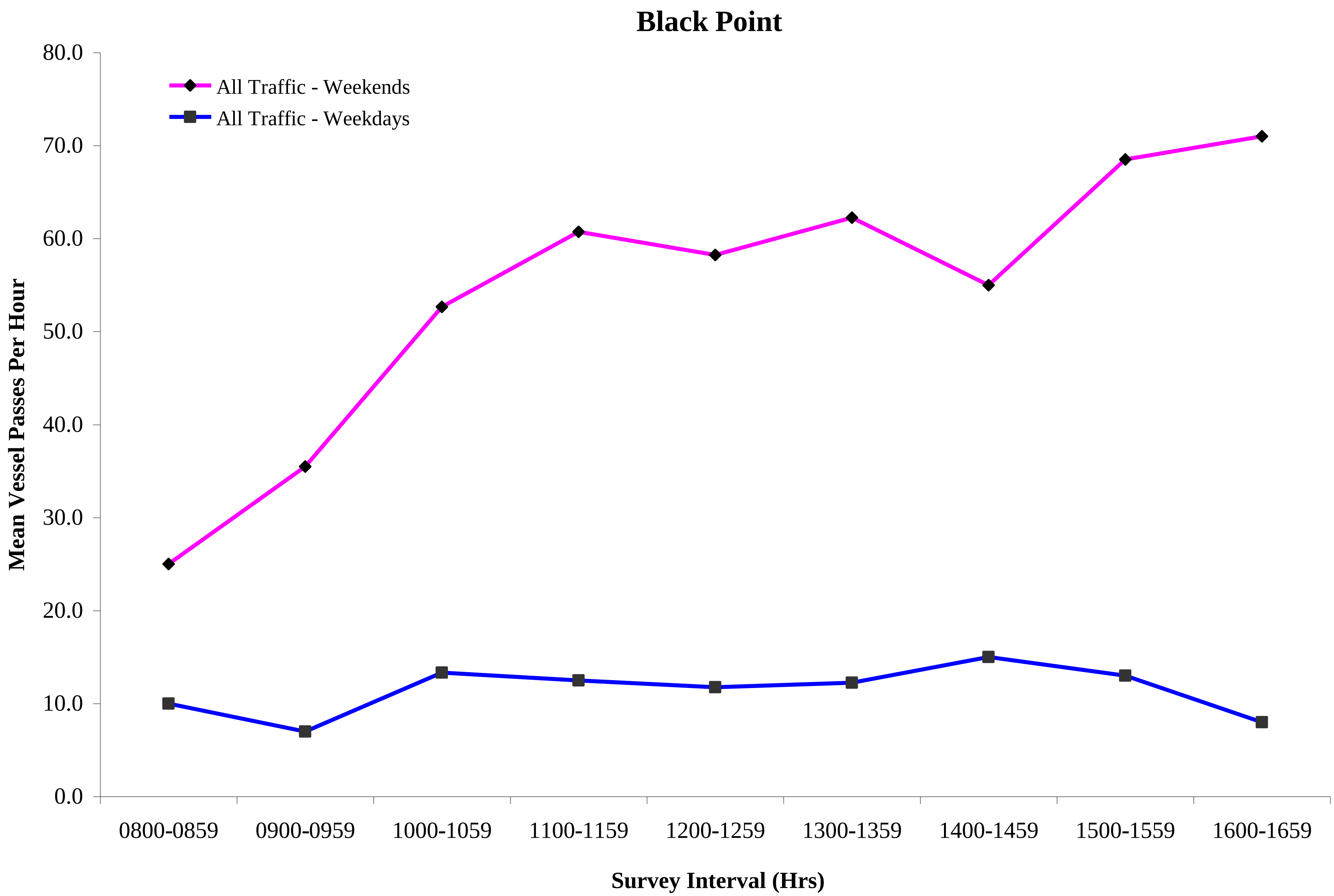


Figure 45. Hourly levels of traffic traveling to/from Black Point Marina.

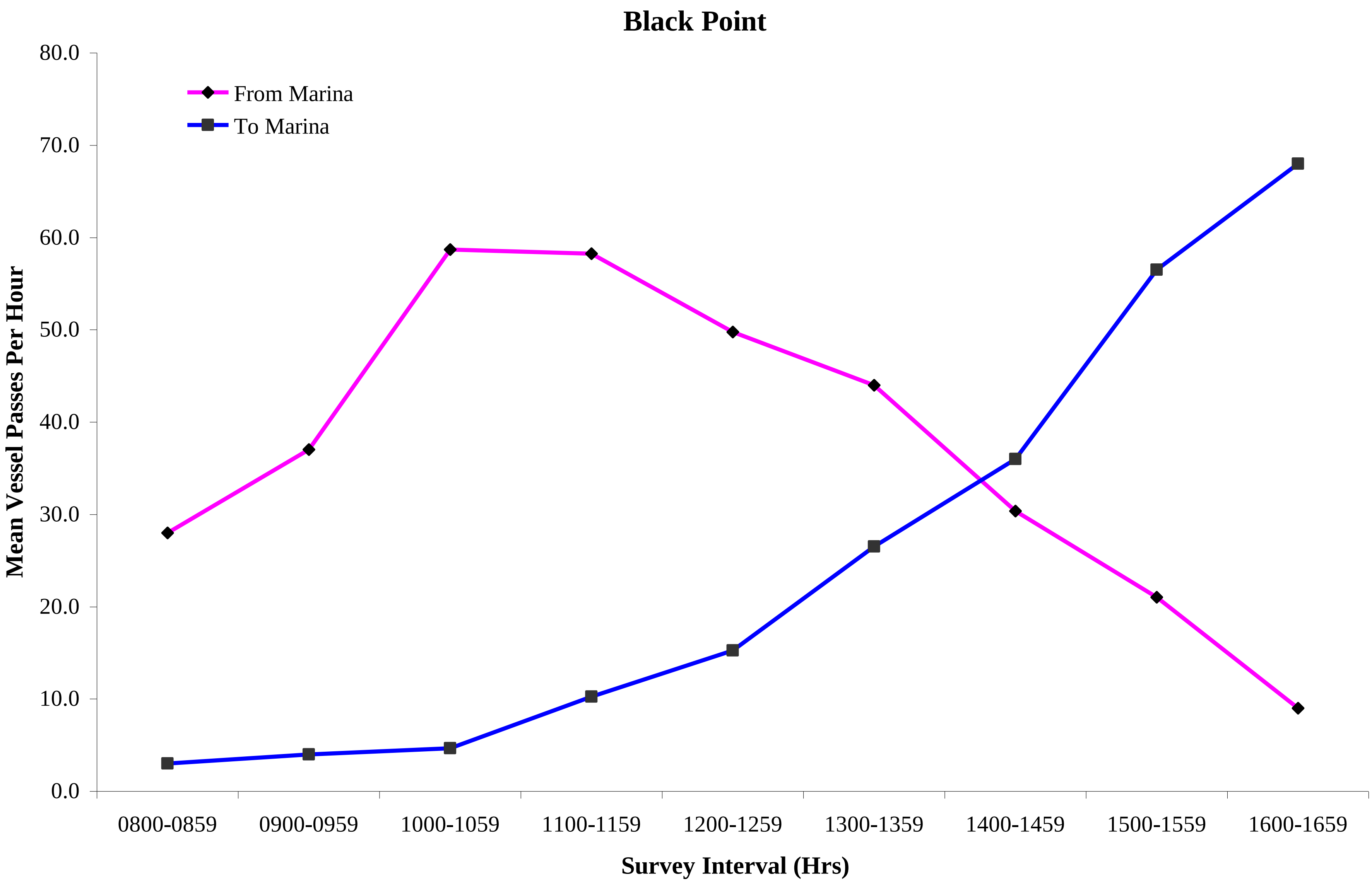


Figure 46. Observed levels of boater compliance, technical non-compliance, and blatant non-compliance at each fixed point survey site and associated regulatory zone.

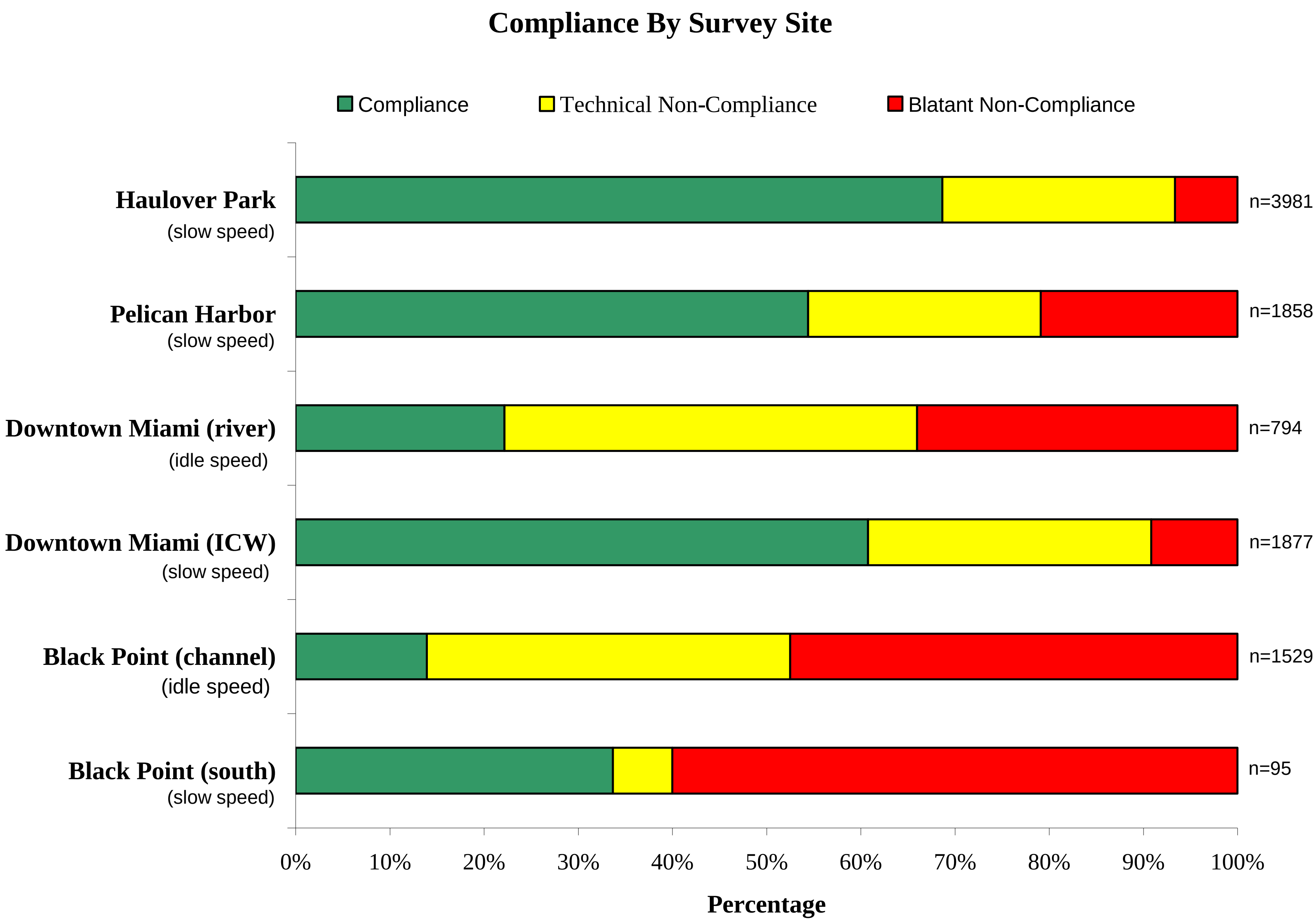


Figure 47. Weekday / weekend comparisons of boater compliance for each survey site and regulatory zone.

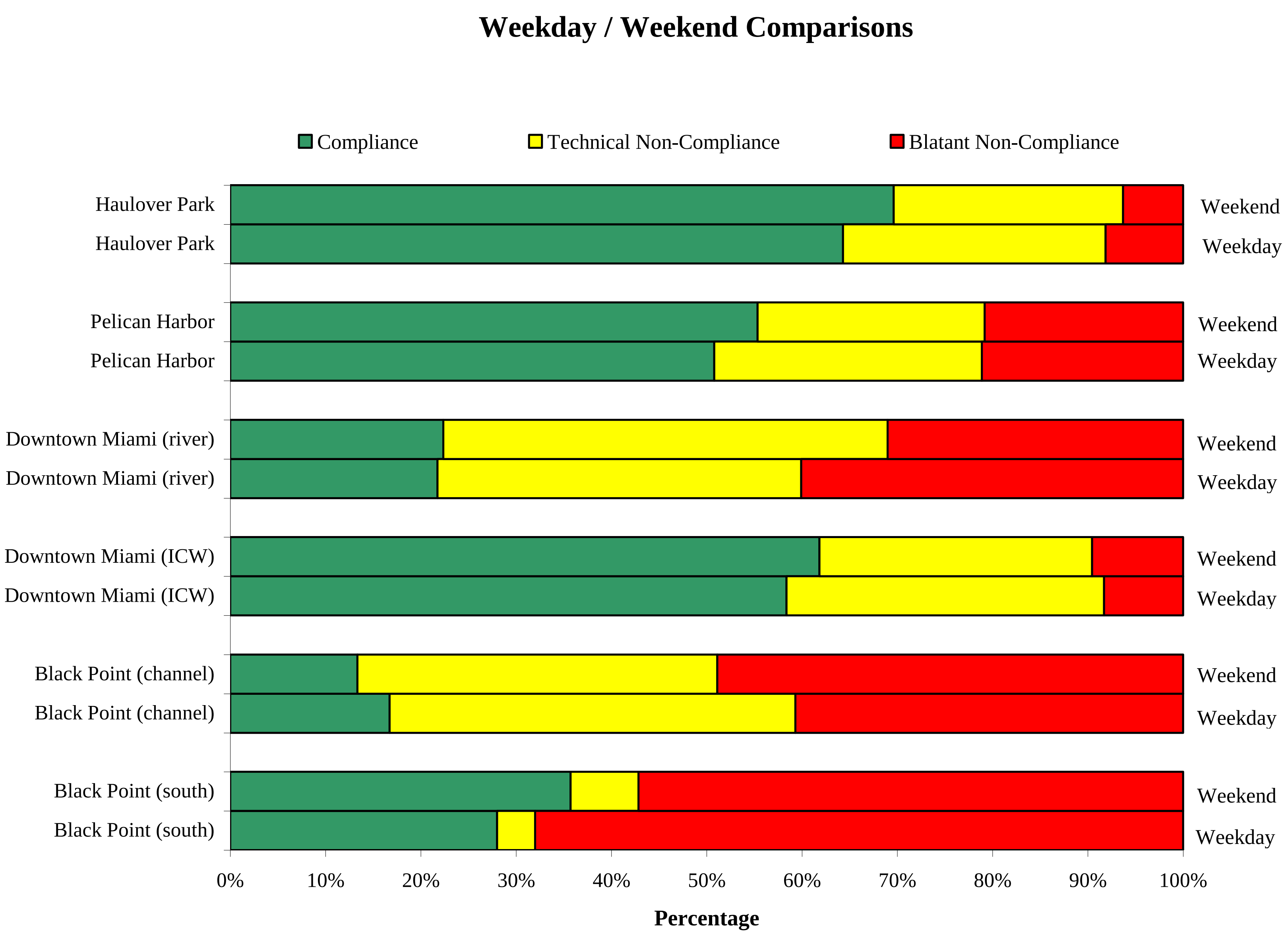


Figure 48. Variations in boater compliance by direction of travel at the Haulover Park survey site.

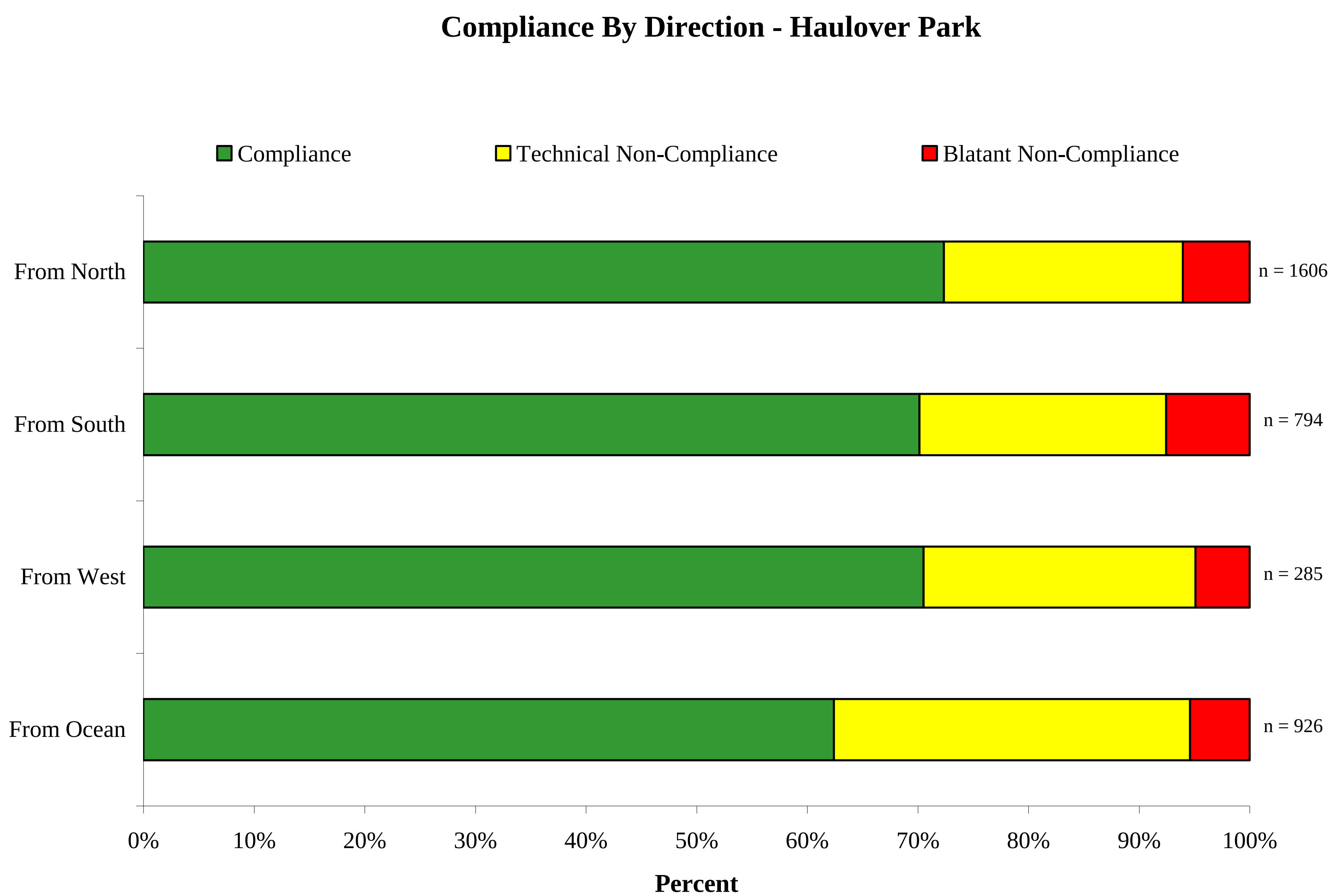


Figure 49. Variations in boater compliance by direction of travel at the Pelican Harbor Park survey site.

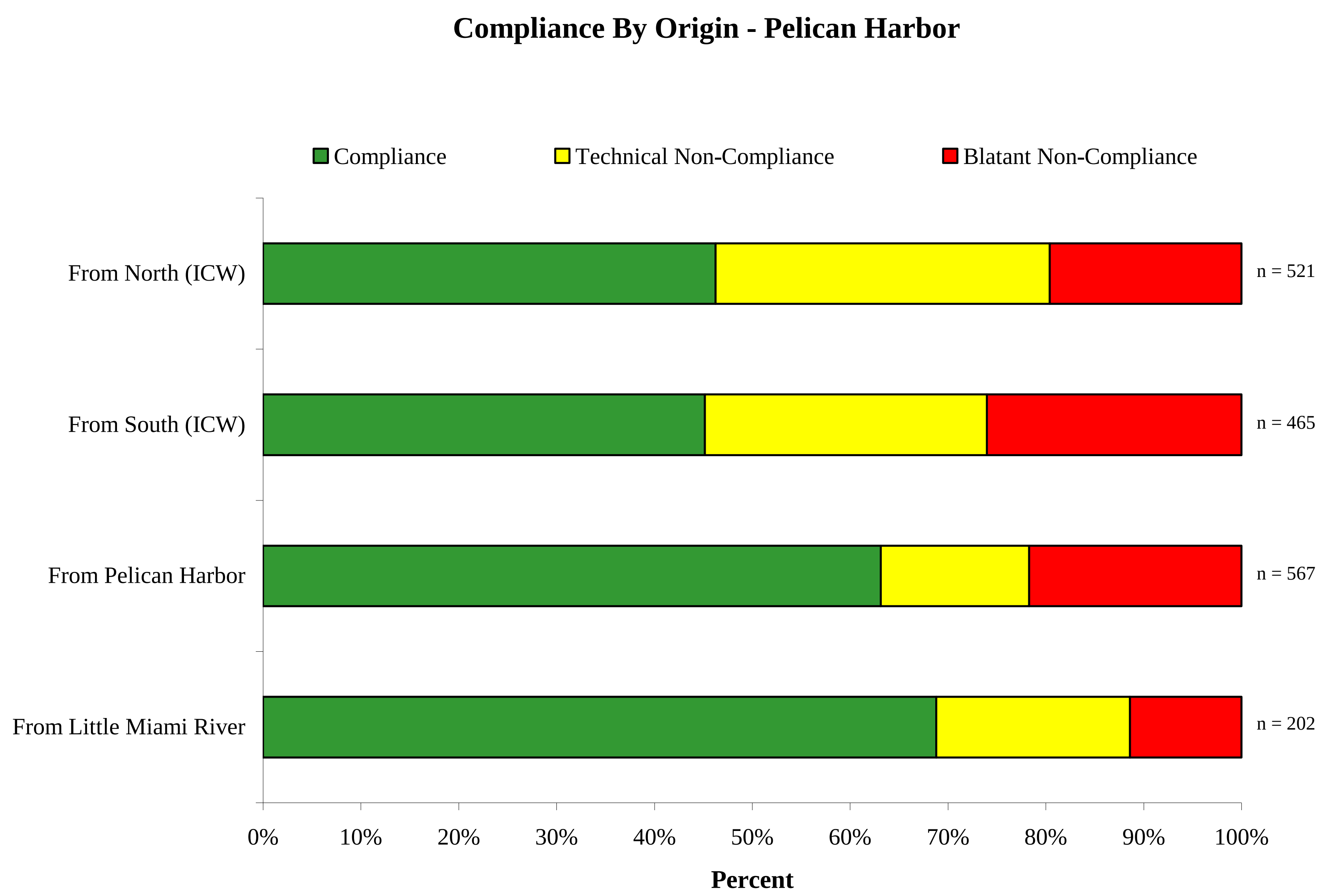


Figure 50. Variations in boater compliance by direction of travel at the Downtown Miami survey site.

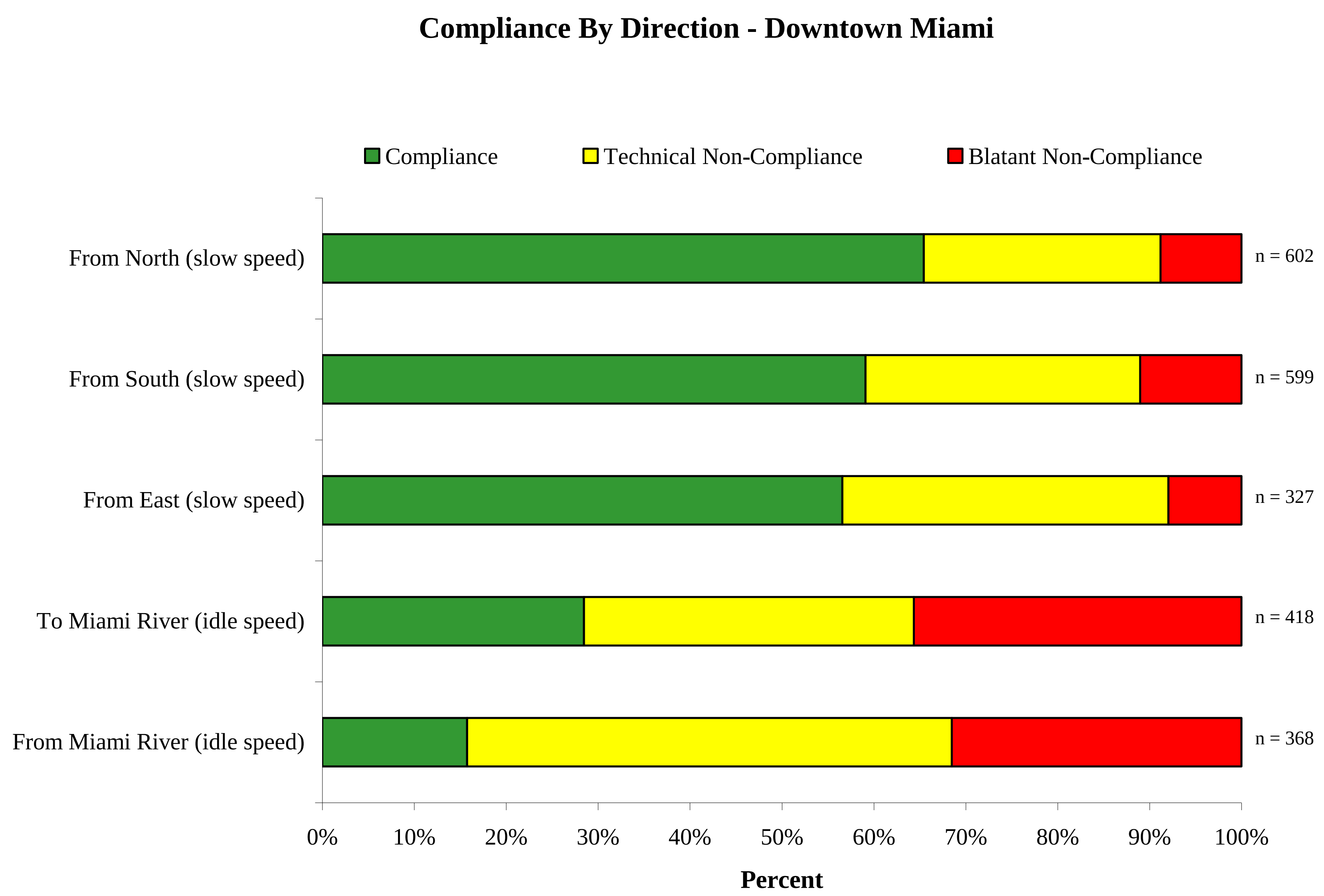


Figure 51. Differences in boater compliance within the same idle speed zone at the Black Point survey site

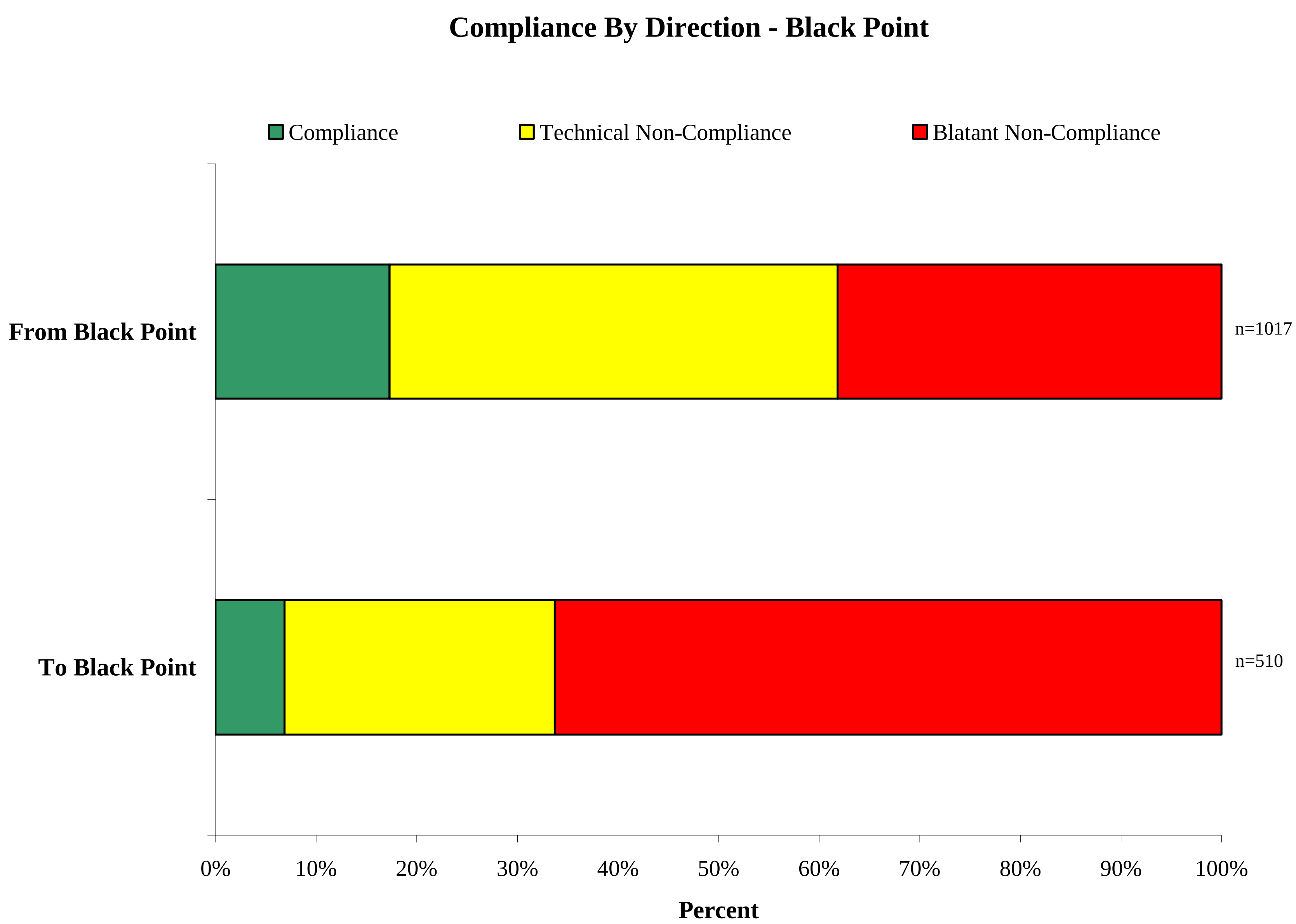


Figure 52. Comparison of boater compliance by vessel size category. All fixed point survey sites are combined.

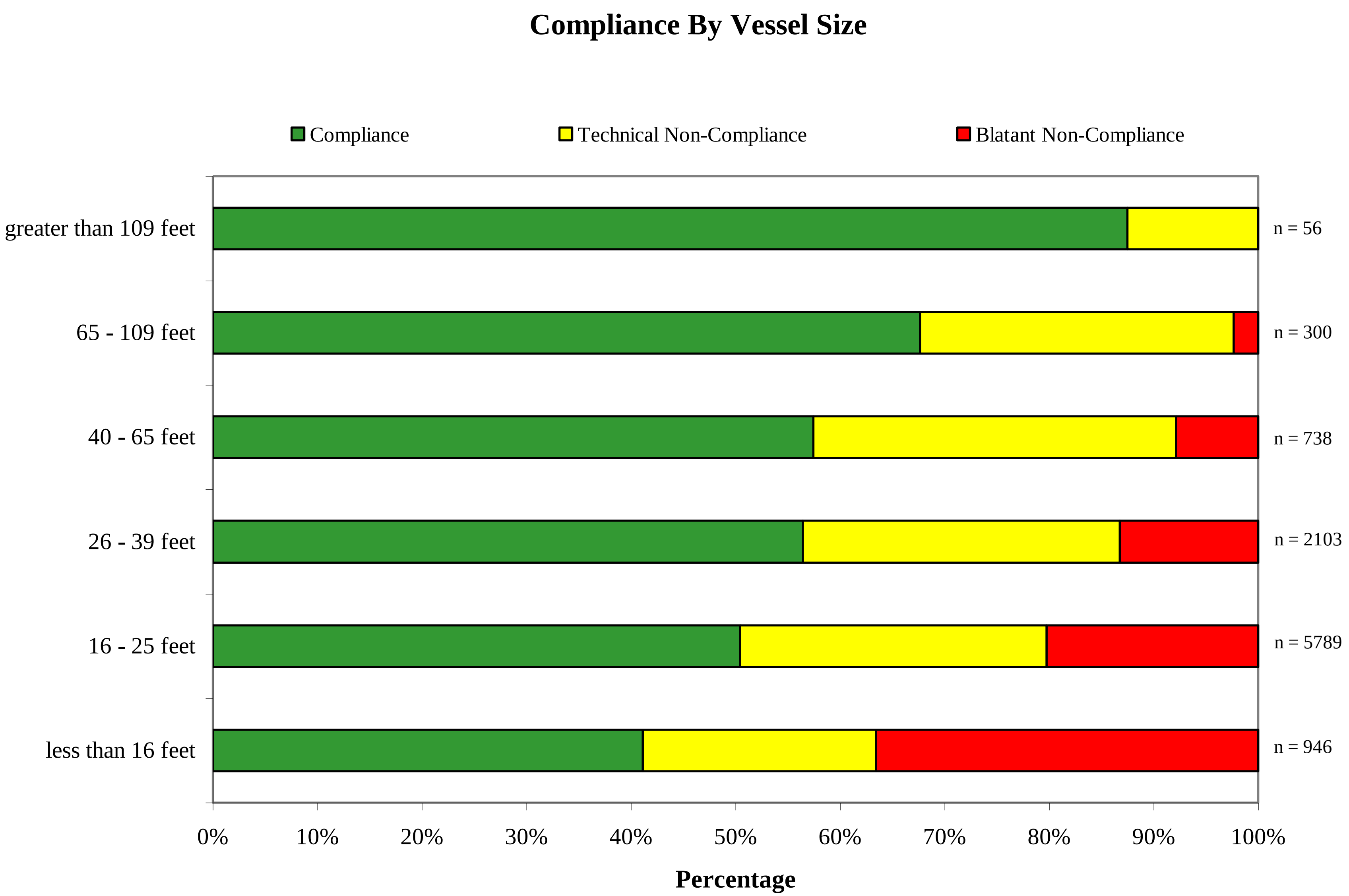
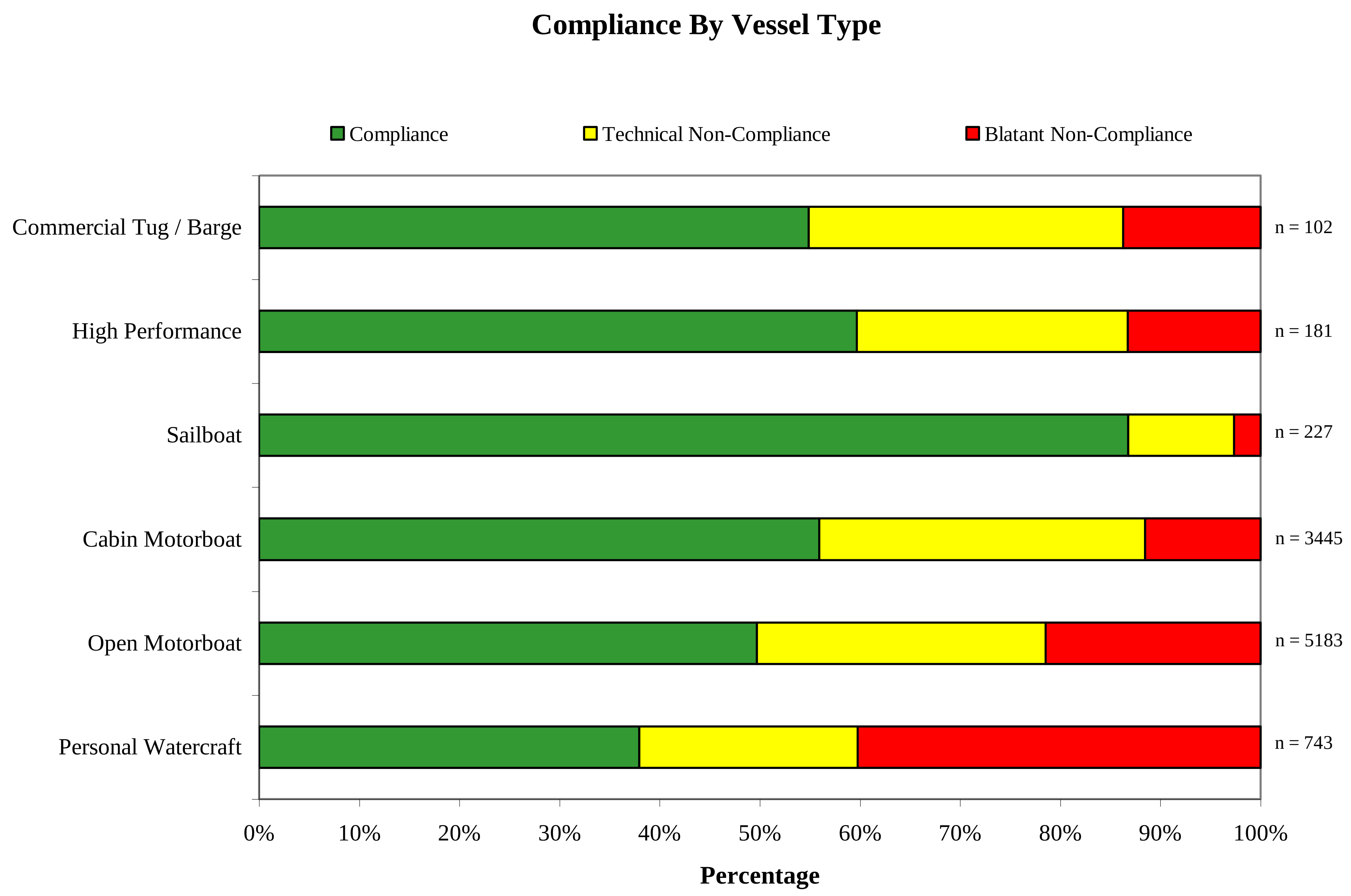


Figure 53. Comparison of boater compliance by vessel size category. All fixed point survey sites are combined.



Appendix A. Manatee protection zones in Miami-Dade County (88C-22.025 F.A.C).
Source: Florida Fish and Wildlife Conservation Commission

MANATEE PROTECTION ZONES
DADE COUNTY
68C–22.025, F.A.C.
October 1991

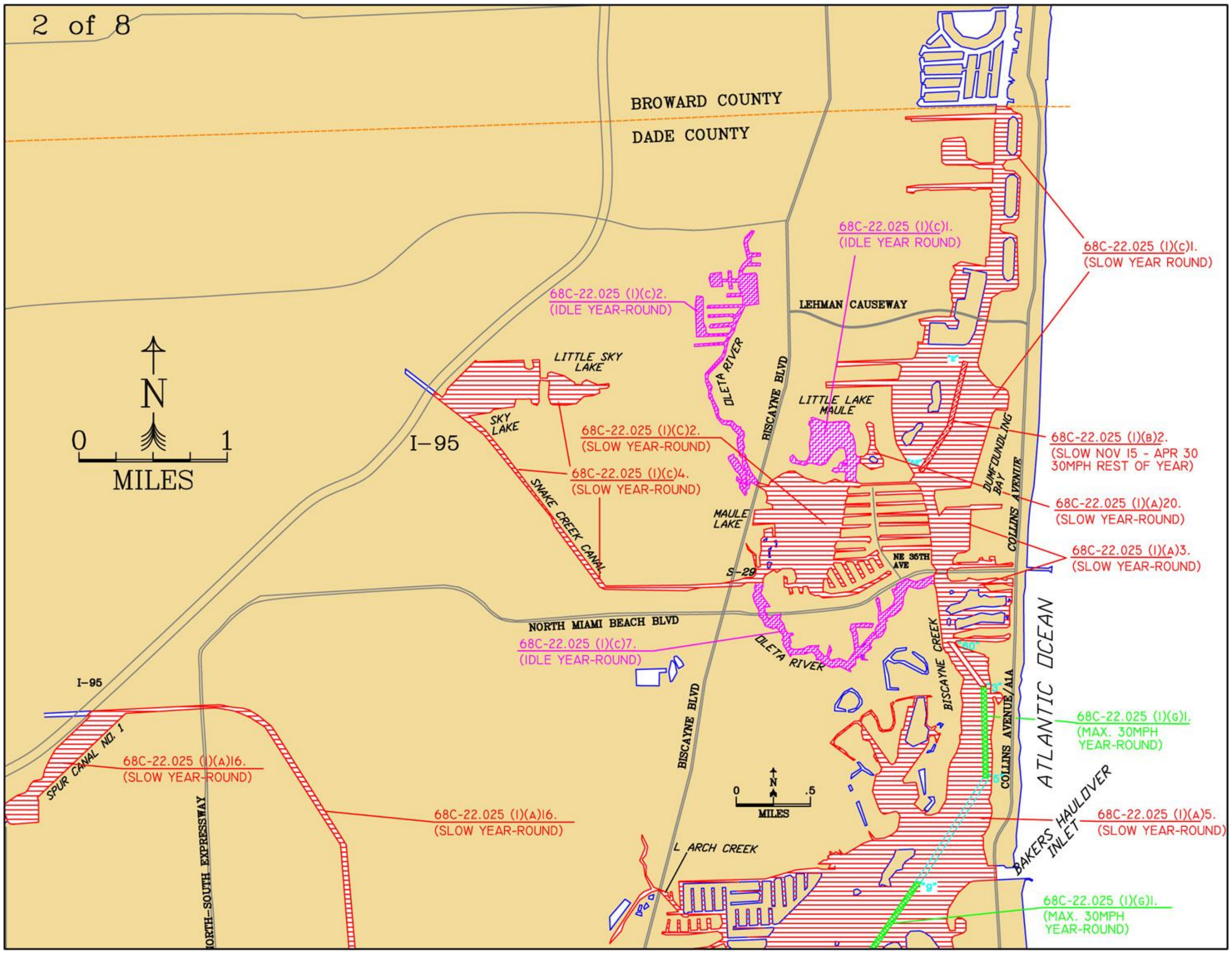
For information please call or write to:
Fish and Wildlife Conservation Commission
Office of Environmental Services
Bureau of Protected Species Management
620 South Meridian Street, OES-BPS
Tallahassee FL 32399-1600
TEL:(850) 922-4330 FAX:(850) 922-4338 SUNCOM: 292-4330

LEGEND

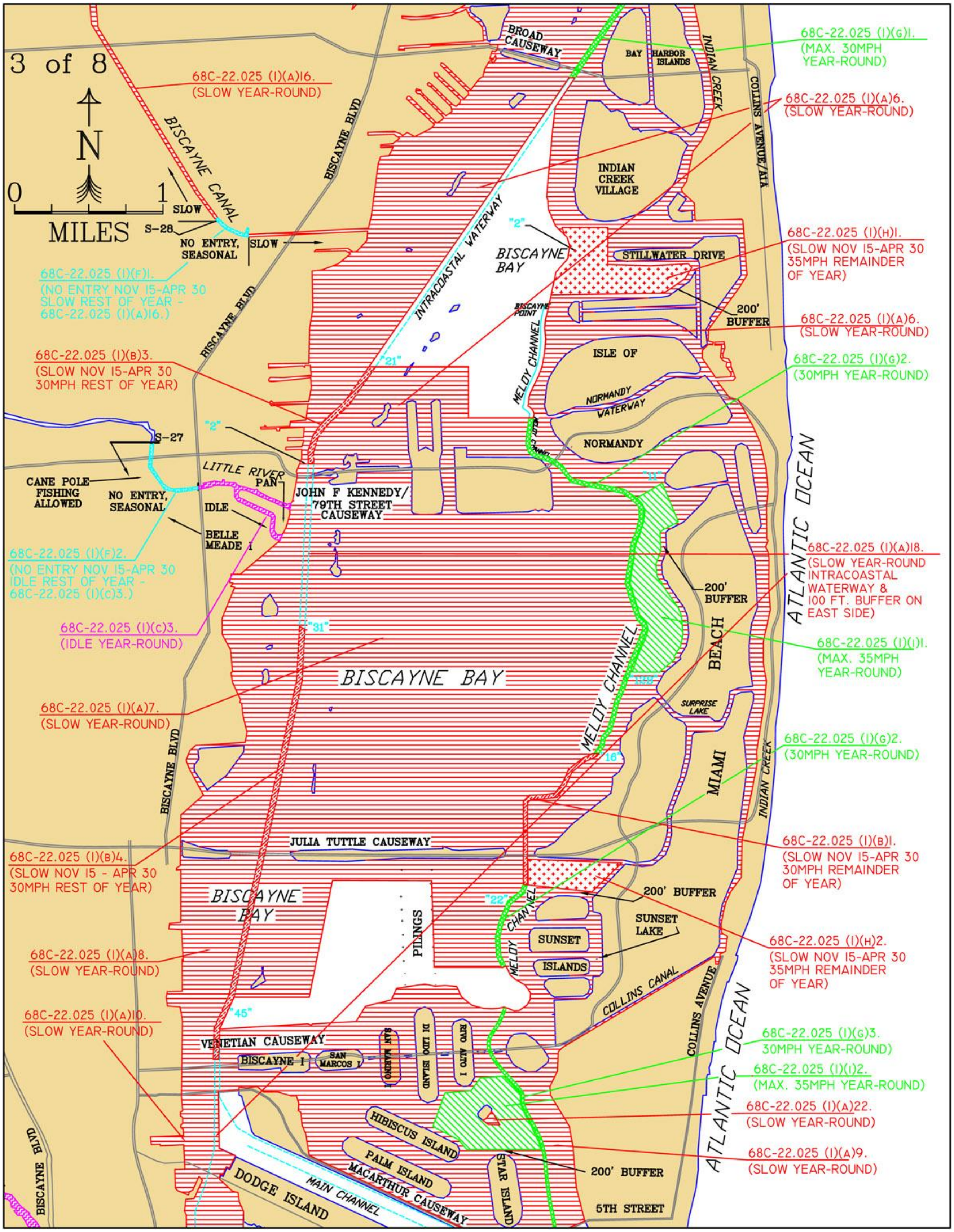
- MOTORBOATS PROHIBITED
- NO ENTRY ALL YEAR
- NO ENTRY NOVEMBER 15 THROUGH APRIL 30, IDLE SPEED REMAINDER OF YEAR
- IDLE SPEED ALL YEAR
- SLOW SPEED ALL YEAR
- SLOW SPEED NOVEMBER 15 – APRIL 30, 30 MPH REMAINDER OF YEAR
- SLOW SPEED NOVEMBER 15 – APRIL 30, 35 MPH REMAINDER OF YEAR
- 35 MPH ALL YEAR
- 30 MPH ALL YEAR

Date Printed: February 11, 2003

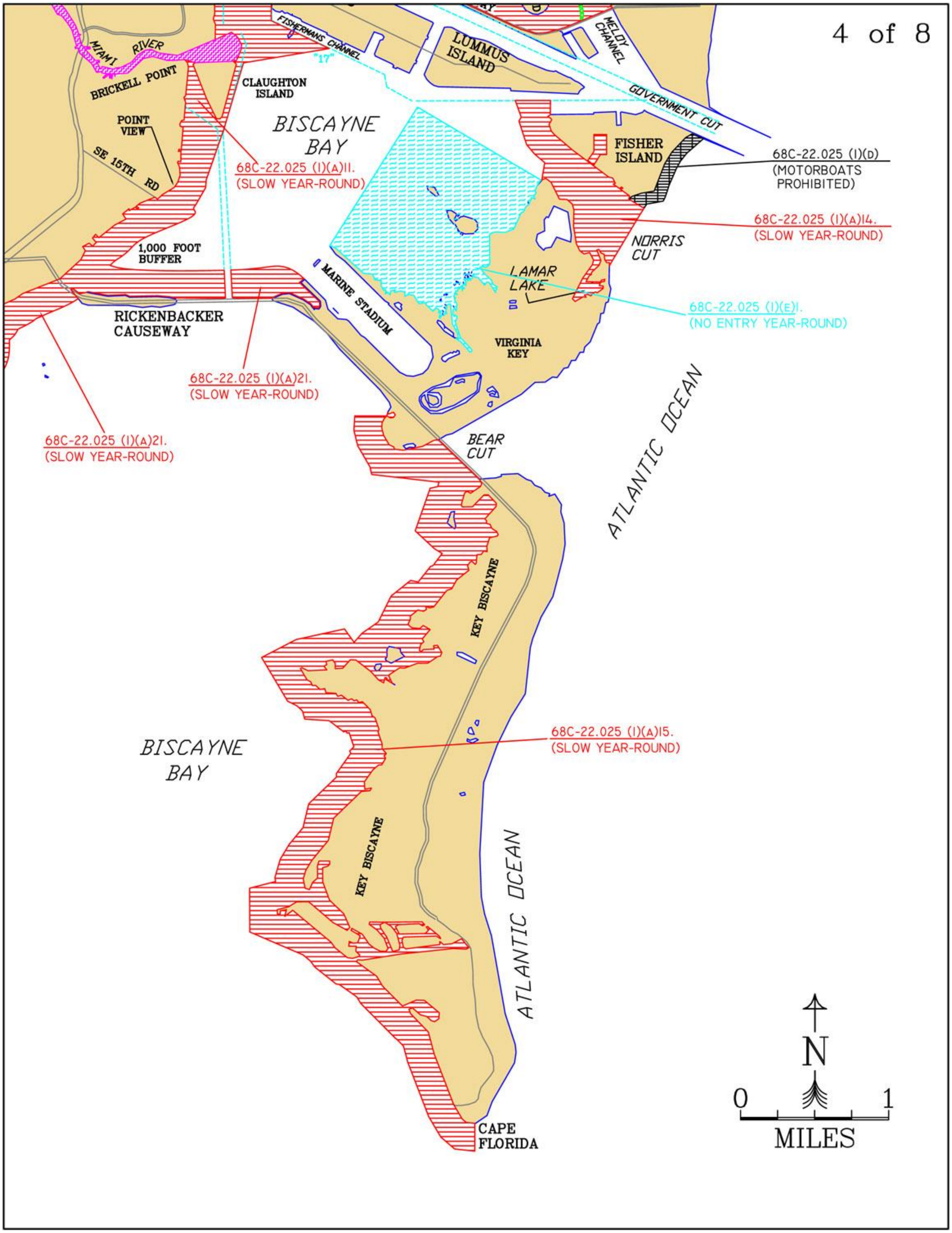
Appendix A. Miami-Dade County Manatee Speed Zones (Continued).



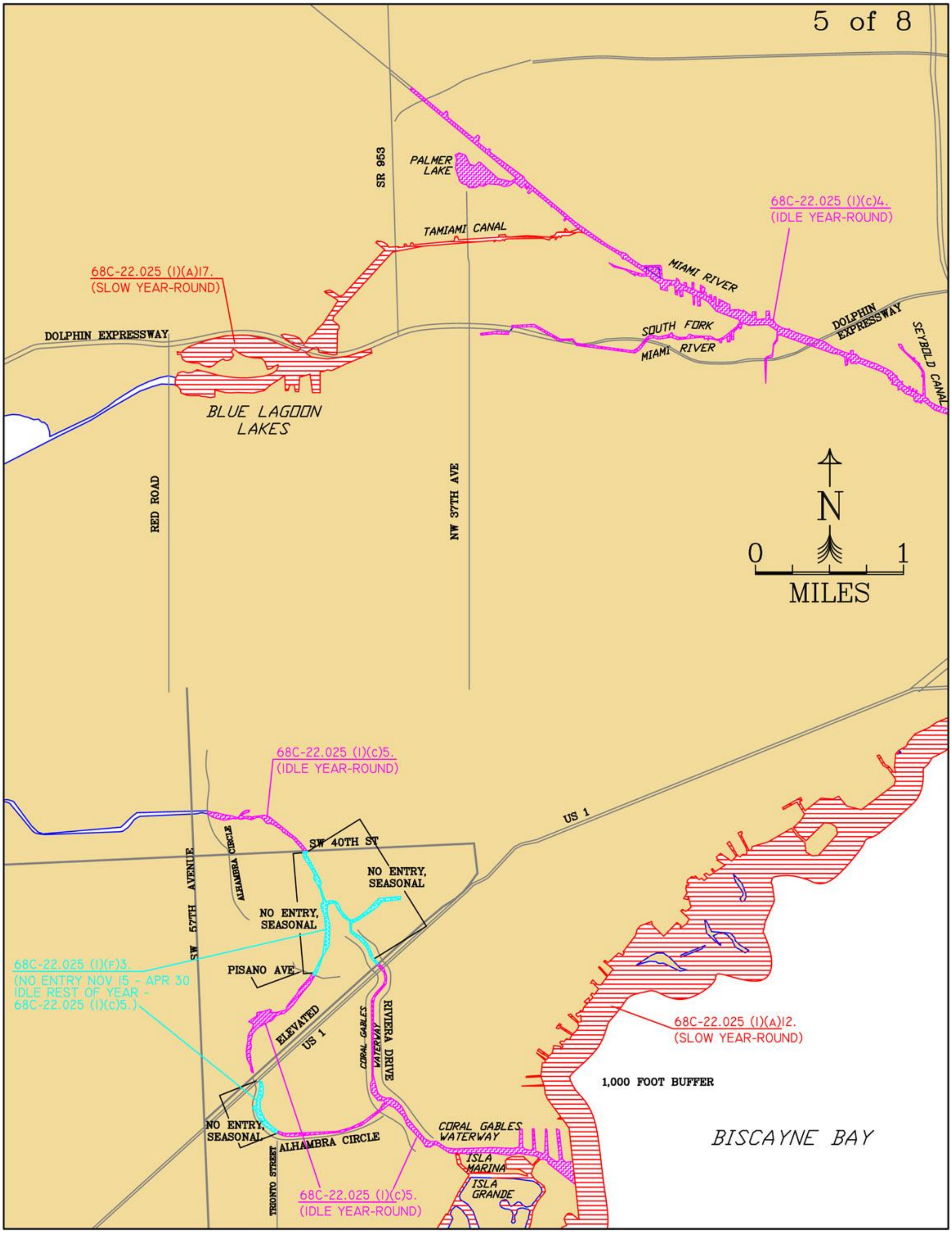
Appendix A. Miami-Dade County Manatee Speed Zones (Continued).



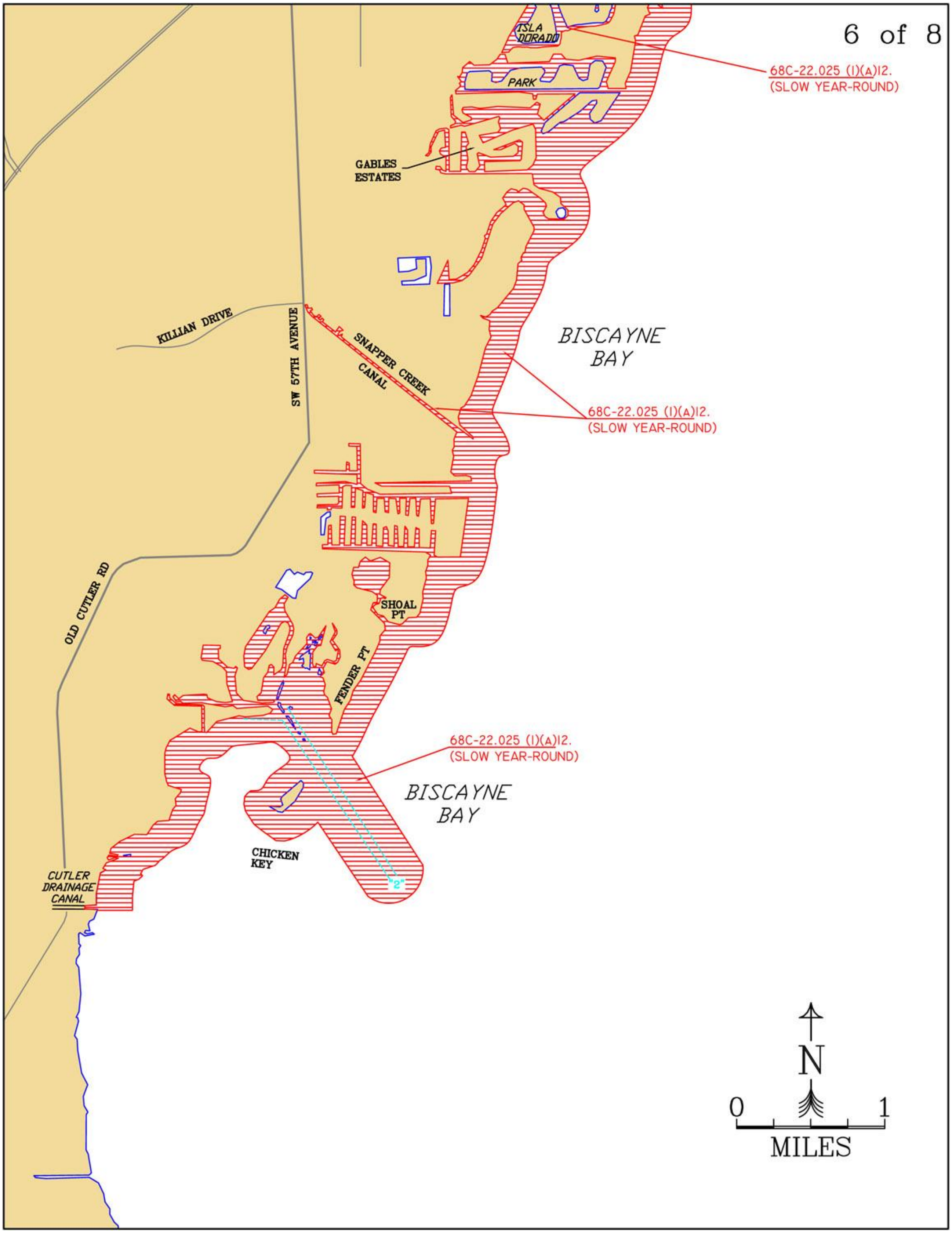
Appendix A. Miami-Dade County Manatee Speed Zones (Continued).



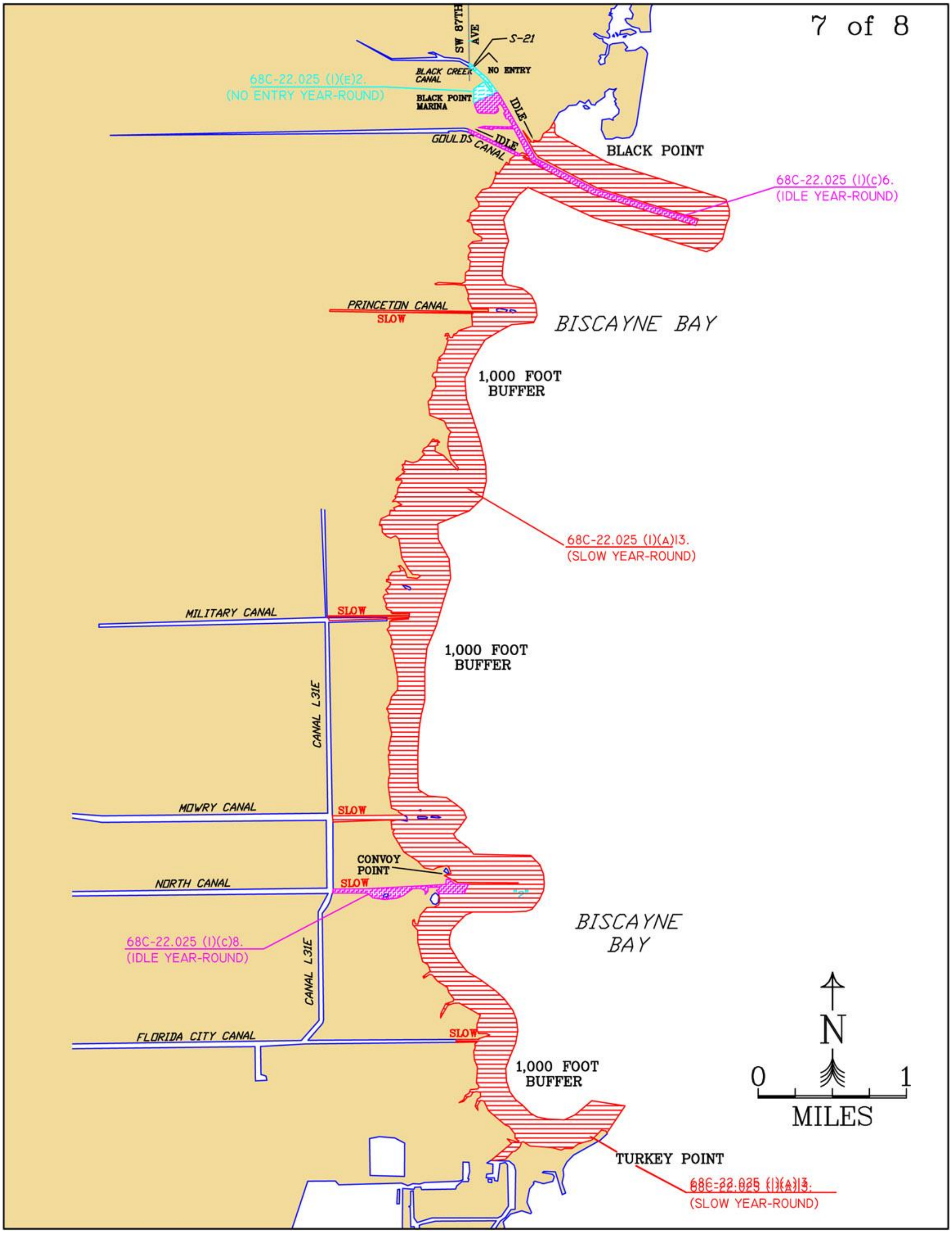
Appendix A. Miami-Dade County Manatee Speed Zones (Continued).



Appendix A. Miami-Dade County Manatee Speed Zones (Continued).



Appendix A. Miami-Dade County Manatee Speed Zones (Continued).



Appendix A. Miami-Dade County Manatee Speed Zones (Continued).