Aerial Surveys Of Recreational Boating Activity In Collier County

Final Report

Submitted To:

Collier County Environmental Services Department
2800 North Horseshoe Drive
Naples, FL 34104

Submitted By:

Jay F. Gorzelany, M.S.

Mote Marine Laboratory
1600 Ken Thompson Parkway
Sarasota, FL 34236

April 4, 2008

Mote Technical Report No. 1259

Executive Summary

A one-year study was undertaken in order to characterize recreational vessel activity in Collier County, Florida. Field data collection consisted of a series of 16 countywide low-level aerial surveys of all navigable inshore waters throughout the county between December 2006 and November 2007. Survey dates and times were alternated in order to represent morning/ afternoon, weekday/weekend, and seasonal traffic patterns. A total of 5,757 vessels were observed and recorded during the study. Collier County boat traffic is largely comprised of smaller vessels (less than 26 feet in length). Large vessels (40 feet in length and greater) comprised less than 3 percent of all boat traffic observed. The most common vessel types observed were open motorboat (73%), closed cabin (8%), pontoon (6%) and kayak/canoe (4%). The remaining vessel types including sailboats, jon boats, air boats, personal watercraft, and all commercial vessel categories, comprised less than 10% of all vessels observed. The amount of boat traffic was highly variable among survey flights; however vessel counts were consistently higher during afternoon versus morning surveys, and during weekend versus weekday surveys. While traffic counts were variable, highest survey counts overall tended to occur during spring survey flights.

Several high-use boating areas in Collier County were identified. Popular boating destinations, represented by high numbers of anchored or drifting vessels, were identified along Hurricane Pass, Big Carlos Pass, Cape Romano, and throughout the Ten Thousand Islands area. Significant travel corridors were identified along the northern portions of the county through Naples Bay, Gordon Pass, and Big Carlos Pass. A relatively high use, high speed travel corridor was also identified between Naples Bay and Big Marco Pass. Highest overall vessel counts (total vessels in-use observed and numbers of vessels in-use per km^2) were observed near Hurricane Pass.

The spatial distribution of boat traffic was examined from several perspectives, including all flights, weekdays-only, weekends only, fast-moving boats-only, and stationary boats-only. It was concluded that the primary focus areas for waterways management-related issues would have: 1) High overall numbers of powerboats in-use, 2) High densities of powerboats in-use relative to the available water area, and 3) a significant number of boats traveling at higher speeds. Within Collier County, areas which met these criteria included the inshore waters

through Naples Bay and Gordon Pass, the waters in proximity to Hurricane Pass, Capri Pass, and Big Carlos Pass, and the inshore waters along Wiggins Pass. While the spatial analysis technique used in this study was useful as a guide in identifying areas of potential concern, a closer examination of individual areas is needed in order to specifically address either wildlife management or human safety issues.

The examination of boater compliance indicated a reduction in levels of high speed boat traffic within most idle and slow speed-restricted areas in Collier County. These areas included regulatory speed zones near Wiggins Pass, Big Marco Pass, Naples Bay, The Narrows, and the waters near Marco Island and Goodland. A reduction in high speed traffic was less noticeable along the Faka Union Canal, and a significant number of boats traveling at high speed, non-compliant boats were observed.

The analyses in this report serve as an effective management tool for understanding countywide recreational boating patterns. The associated GIS data also can provide researchers 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 Collier County. Although aerial survey data is useful for identifying areas of potential management concern, additional ground-level surveys, including land- and boat based surveys compliance surveys, are recommended in order to further document recreational boating use patterns, particularly in speed-regulated areas.

Aerial Surveys Of Recreational Boating Activity In Collier County

Final Report

Submitted To:

Collier County Environmental Services Department
2800 North Horseshoe Drive
Naples, FL 34104

Submitted By:

Jay F. Gorzelany, M.S.

Mote Marine Laboratory
1600 Ken Thompson Parkway
Sarasota, FL 34236

April 4, 2008

Table of Contents

Background and Rationale

Recreational boating activity in Florida has changed considerably over the past 50 years, primarily resulting from increased development, recreational use, and waterway access along the coast of Florida. In 2006, registered in southwest Florida (Manatee, Sarasota, Charlotte, Lee, and Collier counties) totaled 144,394; a 627 percent increase since 1970. Assessments of recreational boating activity and boater compliance have been identified as important tools for both waterway management and protection of the endangered Florida manatee (USFWS, 2001). As a result, the evaluation of levels of human activity on Florida waterways is becoming increasingly important. While there has been a great deal of debate surrounding the establishment of new speed zones and sanctuary areas for Florida manatees, there appears to be somewhat broad-reaching support for studies designed to better understand and characterize recreational boating activity. In spite of this, information on boating activity has been lacking during the development process of many county-wide manatee protection plans, and studies have been somewhat limited (Tyson, 1999, Gorzelany, 1996, 1998, 2005, 2006, Shapiro, 2001). Counties typically rely upon the numbers of registered vessels, and the quantity and distribution of boat facilities (marinas, boat ramps, etc) in order to characterize boat use. Spatial and temporal patterns of recreational boating use, however, are frequently unavailable.

In Collier County, data collected from a recreational boat traffic study is directly relevant to many local issues and programs. The characterization of recreational boat traffic can assist in identifying the areas of greatest demand and where future facilities could potentially be placed to meet this demand. This is particularly relevant to answer the communities' concerns regarding service levels for waterway access. The spatial distribution of boats along a waterway can assist in guiding waterway maintenance issues. Overlaying recreational boating data with other GIS layers can also provide guidance in resolving potential resource conflicts. Understanding on-water boating behavior can also assist programs that utilize limited on-water resources, such as the marine law enforcement, in optimizing how resources are allocated. Temporal and activity-derived spatial profiles may also serve to estimate boating pressure on small scale environments. Finally, data collected can enhance current management efforts and future management plans, including protection and conservation of the Florida manatee. As a result, a comprehensive

study examining recreational boating patterns in Collier County was undertaken in 2006. This report details results of the first phase of this study; the characterization of countywide boating patterns through the use of aerial surveys.

Methods

Low-level aerial surveys of recreational boat traffic were performed utilizing a Cessna 172 or Cessna 182 fixed-wing aircraft at an altitude of 750-1000 feet and a speed of approximately 90 knots. The single observer/videographer method, used successfully during similar surveys in Lee County (Gorzelany, 1998) and Broward County (Gorzelany, 2005) was employed. For this method, a single observer / videographer was seated in the front passenger seat of the survey aircraft. An electronic image-stabilizing Digital 8mm Sony camcorder with date and time imprint was used to record all vessels in-use while flying a standard flight path. A vessel "in-use" is defined as either 1) a vessel underway, or 2) a stationary vessel in the process of being used. This includes fishing, picnicking, 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, beaches, spoil islands, or sand bars. "In-use" diid 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 are also not considered in-use. The aerial observer also can provide voice-over audio recording of both spatial information and vessel information through a remote microphone attached to an aircraft headset. Time of day for individual surveys was varied in order to characterize daily boat use patterns.

A total of 16 aerial surveys (four surveys per quarter) were conducted between December 2006 and December 2007. Survey quarters were identified as follows:

Winter Quarter:	December 2006 – February 2007
Spring Quarter:	March 2007 – May 2007
Summer Quarter:	June 2007 – August 2007
Fall Quarter:	September 2007 – November 2007

Two weekday (one morning and one afternoon) and two weekend surveys (one morning and one afternoon) were conducted per quarter.

All coastal waters in Collier County from Bonita Shores to Cape Romano, and west though Ten Thousand Islands, were included in the survey flights. Areas surveyed included the Intracoastal Waterway and all tidal inlets (Wiggins Pass, Doctors Pass, Gordon Pass, Hurricane Pass, Capri Pass, Big Marco Pass, and Caxambas Pass). Surveys also included Little Hickory Bay, Dollar Bay, Henderson Creek, Naples Bay, Rookery Bay, and all navigable waters of Marco Island. The Ten Thousand Islands portion of the survey included the Blackwater River, Barron River, Pumpkin Bay, Goodland Bay, Chokoloskee Bay, Faka Union Bay, and the Faka Union Canal (including Port Of The Islands). Surveys extended to, but did not include, the Gulf of Mexico. Starting and ending locations within Collier County were varied between surveys. A typical flight track is provided in **Figures 1 and 2**. The linear survey track length was approximately 225 nautical miles.

Once completed, original aerial survey footage was transferred to DVD-R format for analysis. Vessels in use observed on the video footage were then hand-plotted directly onto a series of digital orthophotos (Albers 1999, NAD 83) using ArcMap® 8.3 GIS software. Attributes for each identified vessel in use included date and time of sighting, vessel type, size, activity, mapped GIS location, relative speed, and direction of travel (if any).

Vessel type categories were identified as:

- Air Boat
- Open Motorboat
- Cabin Motorboat
- Sail Boat
- Jon boat
- Inflatable
- Houseboat
- Pontoon Boat
- High Performance / Racer
- Kayak / Canoe
- Personal Watercraft
- Commercial Tug / Tender
- Commercial Barge
- Commercial Transport
- Commercial Other
- Enforcement

Vessel size categories were identified 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
- Commercial

Vessel speeds were identified as:

- Anchor, Drift , or Human-Powered
- Sailing
- Idle / Slow
- Plowing
- Cruising
- Planing

Physical data were also recorded, including the pre-flight National Weather Service marine forecast, boating and weather conditions, wind speed and direction, and sea surface conditions. For quality assurance, a minimum of 10% of all mapped GIS data was rechecked against the original video footage for accuracy. Archival copies of all original video footage were maintained and are available upon request.

Results

A total of 5,757 vessels in-use were observed during 16 survey flights of Collier County. Boating conditions were evaluated as either "Good" or "Excellent" during all 16 flights. Highest boat counts occurred during an afternoon survey on April 4, 2007 (n = 717) and during an afternoon survey on January 27, 2007 (n = 645). Lowest counts occurred during a morning survey on December 11, 2006 and during a morning survey on November 13, 2007 (n = 167). A summary of survey dates, start times, and vessel counts per survey is provided in **Table 1**.

Vessel Composition

A summary of vessel composition in Collier County by size category is shown in **Table 2**. Smaller vessels (less than 26 feet in length) were observed most frequently, comprising 88.8% of all vessels observed (all 16 surveys combined). Large vessels (greater than 40 feet in length) comprised only 2.8% of all vessels in-use observed. Very small vessels (less than 16 feet in length) were somewhat more abundant during weekday surveys. The relative abundance of other vessel size classes was similar between weekdays and weekends.

Vessel composition by type category is provided in **Table 3**. The single most common vessel type observed was open motorboat (70.4% of all vessels observed). Other relatively common vessel types included closed cabin vessels (7.6% of all vessels observed), pontoon boats (6.6% of all vessels observed), and kayaks/canoes (5.3% of all vessels observed). As mentioned above, smaller vessels were observed more frequently during weekday surveys. These smaller vessels were largely comprised of kayaks and canoes (7.4% of all vessels observed on weekdays compared with 3.9% of all vessels observed on weekends). Other vessel types and sizes were similar among weekdays and weekends.

Enforcement and commercial vessel traffic, including barges, tenders, transport, and fishermen, comprised less than 1% of all vessels in-use observed.

Temporal Variation

While there was a great deal of variation among individual survey flights, the number of vessels observed was consistently higher during afternoon surveys, and also during weekend surveys.

Ratios of morning / afternoon and weekday / weekend boat traffic were nearly identical. An average of 440 vessels per survey (+/- 187) was observed during afternoon flights, compared with an average of 280 vessels per survey (+/- 119) during morning flights (a ratio of 1.57 to 1). Average weekend surveys yielded 442 vessels per survey (+/- 124), compared with 278 vessels per survey (+/- 196) during weekday flights (A ratio of 1.59 to 1). The one exception was an extraordinarily high weekday vessel count during an afternoon survey on April 4, 2007 (n=717). Daily changes in traffic volume were also examined based upon the fact that numerous aerial surveys were flown as independent morning and afternoon flights on the same day. Once again, while there was a great deal of variability among survey dates, boat traffic was consistently higher during afternoon flights on the same day, increasing from 13 to 126 percent, with an average increase of 58 percent. Overall, highest vessel counts were observed during surveys conducted in the spring. Along with the highest weekday morning and afternoon survey counts, the spring interval also provided the highest weekend morning survey count and the second highest weekend afternoon count. Lowest weekday vessel counts occurred during the winter interval. Lowest weekend vessel counts occurred during the summer. A summary of survey data comparing daily, weekly, and seasonal boat traffic is provided in **Figure 3**.

Spatial Distribution

The spatial distribution of the most common vessel type (open motorboat), was fairly widespread throughout the county (**Figure 4**.). A similar distribution was also observed for other types of small powerboats including jonboats, pontoon boats, and smaller (less than 26 feet) closed cabin motorboats. The countywide distribution was more limited, however, for several other vessel types. Airboats, for example, were only observed along the Barron River. Non- motorized vessels (kayaks and canoes) were more commonly observed within protected inshore areas such as the upper Cocohatchee River, Blackwater River, Rookery Bay, Henderson Creek, and within the Ten Thousand Islands (**Figure 5**). Larger, deeper draft vessels, including larger closed cabin motorboats and sailboats, were more commonly seen along deeper channels, major waterways, and tidal inlets, particularly Gordon Pass, Hurricane Pass, and Big Marco Pass (**Figure 6**.).

Selected areas within Collier County are displayed in **Figures 7-9** in order to show moving versus stationary boat use patterns. In the Naples Bay / Gordon Pass area (**Figure 7**), some

small aggregations of vessels were commonly observed along the inner and outer portions of Gordon Pass; otherwise the majority of vessels in this area were traveling either to/from the Gulf of Mexico through Naples Bay and Gordon Pass, or north/south along the Intracoastal Waterway. For the Marco Island area, a significant travel corridor to/from the Gulf of Mexico was observed inside Big Carlos Pass, along with large aggregations of anchored/drifting vessels at Hurricane Pass and along the south shore of Big Marco Pass (**Figure 8**). Along the southern and eastern portions of the county, anchored vessels were widely distributed throughout the Ten Thousand Islands area, along with aggregations of stationary vessels near Cape Romano. Relatively large numbers of moving vessels, indicating traffic corridors to/from the Gulf of Mexico, were observed between Goodland and Coon Key Pass, between Port Of The Islands and Fakahatchee Pass, and between the Barron River and Indian Key Pass (**Figure 9**). Boating patterns did not vary noticeably between weekdays and weekends, or at different times of the year.

Spatial Analysis

The spatial distribution of vessels throughout Collier County was also examined quantitatively by overlaying a series of 215 equal-sized 1 mile radius polygons over the entire survey area (**Figure 10**). Within each sequentially-numbered polygon, the total area of water was calculated, the number of vessels observed was 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 3, boat density within each polygon was identified as Low, Moderate, or High.

Countywide results are shown in **Figures 11-13**. For all survey flights combined (**Figure 11**), highest densities of boat traffic were observed in proximity to the major tidal inlets along the north and central portions of Collier County (Wiggins Pass, Gordon Pass, Hurricane Pass, Capri Pass, and Big Marco Pass). High boat densities were also observed throughout Naples Bay,

along the Faka Union Canal, and along the upper portion of the Blackwater River. Moderate levels of boat traffic were observed near Caxambas Pass, Goodland, Port of The Islands, the Barron River, the Faka Union River, the lower portions of the Blackwater River, and along the Intracoastal Waterway between Little Hickory Bay and Hurricane Pass. Relatively low densities of boat traffic were observed throughout much of the central and southern portions of the county, including Rookery Bay, Johnson Bay, Tarpon Bay, Cape Romano, the waterways east of Marco Island, and throughout the Ten Thousand Islands. Areas with the highest overall boat counts and highest overall boat densities were observed near Hurricane Pass and Capri Pass (Areas #33, #34, and #39). In some cases, high calculated boat densities were not the result of high boat counts; but instead the result of relatively small areas of water. For example, the upper Blackwater River had a relatively high calculated boat density, but the total number of vessels observed (n=27) and total water area (0.13 km^2) were relatively low. A similar trend (low vessel counts, low water area, and high calculated density) was observed along the Faka Union Canal. Similar countywide spatial trends were observed when examining weekday boat traffic-only (**Figure 12**) and weekend boat traffic-only (**Figure 13**).

A similar spatial analysis was performed for higher speed traffic-only (vessels traveling at plowing, cruising, or planing speed). Results were again similar (**Figure 14**), however a more contiguous high density, high speed corridor was observed from Naples Bay to Big Marco Pass. The inner portions of Wiggins Pass and the upper portion of the Blackwater River were reduced from high density to moderate density, primarily because these areas contained a significant number of kayaks and canoes. A few areas, including portions of the Marco River and lower Barron River, increased from low to moderate density. Finally, a spatial comparison of stationary (anchored / drifting) boats-only was performed (**Figure 15**). Highest densities of stationary boats were identified in Areas #33, 34, and 39 (Hurricane Pass, Capri Pass, and Big Marco Pass). Moderate boat densities were once again observed in proximity to other tidal inlets (Wiggins Pass, Gordon Pass, and Caxambas Pass) and also along the Gulf coast from Caxambas Pass to Cape Romano. Moderate densities were also observed along the Faka Union Canal, Barron River, and upper Blackwater River, however as stated above, these locations also contain relatively limited water area. Expanded views of vessel densities for all survey flights, weekdays-only, weekends-only, fast boats-only, and stationary boats-only are also provided in

Figures 16-30. Calculated values for all parameters are also summarized in **Appendix A**.

Vessel Speed

All vessels traveling at the highest speeds (cruising / planing) and lowest speeds (idle / slow) were also evaluated for compliance with existing state regulatory zones. Results, along with corresponding state speed zone maps, are shown in **Figures 31-44**. Along the northern portion of the Collier County (**Figure 31**) the majority of moving vessels from Wiggins Pass south to Vanderbilt Shores were observed at idle / slow speed, which corresponded with the existing slow speed zone in this area (**Figure 32**). Higher speed traffic was observed north of Wiggins Pass within the posted 30 mph channel. Boat speeds in the Naples Bay area (**Figure 33**) were also consistent with existing regulatory zones. The majority of slower-moving traffic was observed within existing Idle Speed All Year zones (**Figure 34**). The majority of higher-speed boat traffic was observed within the designated 30 mph channel, or along the outer unregulated portion of Gordon Pass. Between Gordon Pass and Hurricane Pass, the only significant speed-restricted zone (Slow Speed All Year) is located north of Rookery Bay along The Narrows (**Figures 35 and 36**). Once again the majority of boat traffic within this area was observed at idle / slow speed. South of The Narrows, boat traffic was predominantly high speed within posted 30 mph channels or in unregulated areas along Little Marco Island and Hurricane Pass. Distinct aggregations of slower-moving vessels were once again observed in areas with existing idle and slow speed zones along Marco Island and near Goodland (**Figures 37 and 38**), with higher-speed boat traffic primarily observed along high speed channels or in unregulated areas. Throughout the southern portion of Collier County, including Ten Thousand Islands, the only significant speed restricted areas are located along the Faka Union Canal / Port Of The Islands (Idle / Slow Speed All Year), and along the Barron River / Everglades City (Idle / Slow Speed All Year). The remaining coastal waters are either unregulated or regulated at 30 mph in channel and 20 mph outside of channel (**Figures 39 – 44**). The majority of vessels observed along the Barron River (**Figures 43 and 44**) were traveling at speeds which were consistent with the posted regulatory zones. A significant proportion of high speed, non-compliant vessels were observed, however, within the slow speed channel along the Faka Union Canal (**Figures 41 and 42**).

Discussion

While aerial survey data is useful in identifying seasonal trends in countywide boat traffic patterns, these data are based upon a relative small survey sample size (n=16) with a great deal of variation among individual survey flights. The numbers of vessels in-use observed during individual flights can be greatly influenced by physical conditions such as wind speed and direction, weather conditions, air temperature, and water temperature. Other local activities (regattas, boat shows, or other public events) may also influence the amount of boating activity on any given day. While these surveys can provide some insight into seasonal trends, a larger sample size (i.e., additional survey flights) is needed to more accurately determine seasonal variation. Although seasonal boating use in Collier County was limited by sample size, the results obtained during this study, particularly higher boat use in the spring, were consistent with findings on seasonal trends from other recent studies in Southwest Florida (Gorzelany, 1998, 2006, Sidman et al., 2004, 2006). Increases in vessel traffic on weekends were also consistent with findings from previous studies; however weekend / weekday differences were more subtle. In Collier County, a weekend-weekday traffic ratio of 1.59 - 1 was observed. A higher ratio was observed from recent studies in Lee County (2.08 - 1), Sarasota County (2.13 - 1) and Broward County (2.51 – 1). Whether these differences are significant or simply the result of a high variability in boat counts among survey flights is uncertain.

While commercial and enforcement vessels contributed only a small percentage of the total vessels observed, their relative proportion was likely underestimated because many vessels could not be accurately identified from aerial video footage. This is particularly true of smaller unmarked commercial fishing vessels, such as fishing guides and charters. Similar findings have been reported in recent boating studies conducted in Southwest Florida (Gorzelany, 1998, 2004, 2006). There are also some limitations on the reporting of other vessel types. Airboats, for example, were only observed in the Barron River but this does not suggest that they do not occur in other areas. Because airboats frequently occupy relatively remote areas, including areas which may not be readily seen from an airplane, it seems likely that some observations were missed. While not limited to the Barron River, data suggests that they probably occur more frequently in this area than in other coastal areas of Collier County. The same is true for kayaks and canoes, which were also likely undersampled because they were either not visible in more

remote areas of the county (such as Ten Thousand Islands) or their distribution extended inland beyond the limits of the survey area. The relative proportion of other vessel types surveyed, including the high proportion of smaller open motorboats observed, is consistent with findings from similar studies conducted in Lee County (Gorzelany, 1998, 2004), Charlotte County (Gorzelany and Flamm, 2004), and Sarasota County (Gorzelany, 1996, 2006).

Overall, aerial survey data was successful in identifying several high use boating areas in Collier County. Popular boating destinations, represented by high numbers of anchored or drifting vessels, were identified along Hurricane Pass, Big Carlos Pass, Cape Romano, and widely distributed throughout the Ten Thousand Islands area. Significant travel corridors were identified along the northern portions of the county through Naples Bay, Gordon Pass, and Big Carlos Pass. A relatively high use, high speed travel corridor was also identified between Naples Bay and Big Marco Pass. While the spatial analysis technique used in this study is useful in examining countywide recreational boating trends, it has some limitations and some of the results should be approached with some caution. Along with the determination of high density boating areas, the amount of water within each designated area must also be taken into consideration. For example, Area #46 (upper Blackwater River) was determined to be a "high" density boating area (**Figure 11**). Because the calculation of boat density is dependent upon the area of water within each polygon, survey areas with only small amounts of water, such as those associated with narrow tidal creeks, rivers, and canals, will significantly influence density values. Boat density along the upper portion of the Blackwater River was considered "high" in spite of the fact that relatively few vessels were observed (n=27, or less than 2 vessels per survey flight). This is because Area #46 also contained a relatively small water area (0.1335 km^2). The opposite trend was also true. In survey areas such as Cape Romano (Area #157) and northwest Big Marco Pass (Area #48) there were relatively high vessel counts (n=113 and n=199 respectively), and relatively large areas of water (6.624 km2 and 5.873 km2 respectively). As a result, both of these areas were determined to have relatively "low" boat densities (**Figure 11**). An additional consideration is the composition and behavior of vessels in a given area. Another area identified as "high" density was Area #4 (Cocohatchee River). While a relatively high number of boats were observed in this area (n=160), a significant proportion of boats (greater than 20%) were kayaks and canoes, which are presumably less of a management concern. In

addition, a significant portion of the waterway within this area is regulated at Slow Speed All Year, with only a small proportion of fast-moving boats observed. For this reason, the spatial analysis technique used in this study is useful as a guide in identifying areas of potential concern; 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 are areas which 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. Within Collier County, areas which meet these criteria would include the inshore waters through Naples Bay and Gordon Pass, the waters in proximity to Hurricane Pass, Capri Pass, and Big Carlos Pass, and the inshore waters along Wiggins Pass.

Along with human safety concerns, vessel speed also plays a significant role in risk to manatees (Calleson and Frohlich, 2007). For this reason, an evaluation of observed vessel speeds in speed-regulated areas was also performed. From aerial video footage, however, vessel speed can not be determined with the same level of precision as it can be from boat- or land-based surveys. Differences between idle and slow speed, for instance, can be fairly subtle particularly when viewed from aerial footage. Similarly, the determination of speed for a small boat traveling at plowing speed and a larger boat traveling at slow speed can be difficult to distinguish. Finally, because a large proportion of speed regulated areas in Collier County are 20 mph or 30 mph zones, there is no practical way of evaluating the effectiveness of these zones from aerial surveys. For these reasons, the analysis of boater compliance with existing speed zones in Collier County was essentially focused on the more restrictive idle and slow speed zones, and compared against only the fastest qualitative speed categories (cruising and planing). While focusing on the most blatantly non-compliant boats made the determination of levels compliance more reliable, it also created a potential underestimate of the overall levels of non-compliance because technically non-compliant boats were not considered. (recall that vessels traveling at slow speed within an idle speed zone are technically non-compliant, though idle speed and slow speed are considered a single speed (idle/slow) from aerial survey footage).

Boater compliance analysis indicated a reduction in levels of high speed boat traffic within most idle and slow speed-restricted areas in Collier County. These areas included idle/slow speed

regulatory zones near Wiggins Pass, Big Marco Pass, Naples Bay, The Narrows, and the waters near Marco Island and Goodland. A reduction in high speed traffic was less noticeable along the Faka Union Canal, and a significant number of boats traveling at high speed were observed. While aerial survey data suggest that most speed zones in Collier County may be effective in reducing speed, whether or not vessels are actually traveling at speeds which are consistent with posted regulatory speeds is less clear. For instance, a boater may reduce the speed of his/her vessel from planing speed to plowing speed within a posted slow speed zone, however the vessel is still technically non-compliant. Additional boat- and/or land-based field studies may be helpful in areas such as the Faka Union Canal in order to provide a more accurate assessment of the level and extent of potential non-compliance in the area.

The analyses in this report serve as an effective management tool in understanding countywide recreational boating patterns. The associated GIS data also can provide researchers 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 Collier County. Although aerial survey data is useful for identifying areas of potential management concern, additional land- and boat based surveys are recommended in order to further document recreational boating use patterns, particularly in speed-regulated areas.

Literature Cited

Calleson, S.S., and R.K. Frohlich. 2007
Slower boat speeds reduce risks to manatees.. Endangered Species Research 3: 295-304

Gorzelany, J.F. 2006.
Recreational boat traffic surveys of Sarasota County, Florida. Part 2: Aerial surveys. Final project report submitted to Sarasota County Natural Resources. March 2006.

Gorzelany, J.F. 2006.
Recreational boat traffic surveys of Sarasota County, Florida. Part 1: Fixed point surveys and data review. Final project report submitted to Sarasota County Natural Resources. March 2006.

Gorzelany, J.F. 2005.
Recreational boat traffic surveys of Broward County, Florida. Florida Fish and Wildlife Conservation Commission Contract No. 03193. Mote Marine Laboratory Technical Report No. 1017. 88 pp + app.

Gorzelany, J.F, and R.O. Flamm. 2004.
A characterization of recreational boat traffic patterns prior to the establishment of speed restrictions in Lemon Bay, Florida. Final Report submitted to the U.S. Fish and Wildlife Service, 62 pp. Mote Marine Laboratory Technical Report Number 966.

Gorzelany, J.F, 1998.
Evaluation of boat traffic patterns and boater compliance in Lee County, Florida. Final report submitted to the Florida Dept. of Environmental Protection. 109 pp + app.

Gorzelany, J.F, 1996.
Evaluation of boater compliance with speed regulations in Sarasota County, Florida. Final report submitted to the Florida Dept. of Environmental Protection. 106pp + app.

James, W.L., Cossman, R.E., Cossman, J.S., Campbell, C., and T. Blanchard. 2004.

A brief visual primer for the mapping of mortality trend data. Int. J. Health Geogr. 3:7 Published online 2004 April 8. doi: 10.1186/1476-072X-3-7.
http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=400752

Shapiro, S.L. 2001. Assessing boater compliance with manatee speed zones in Florida. Final Report to the U.S. Fish and Wildlife Service, Jacksonville, FL. Project No. 9322-1602280.

Sidman, C., R. Swett, T. Fik, S. Fann, and B Sargent. 2006.
A recreational boating characterization of Sarasota County. Florida Sea Grant publication TP-152, January 2006.

Sidman, C, Fik, T., and W., Sargent. 2004. A recreational boating characterization for Tampa and Sarasota Bays, Florida. Florida Sea Grant Publication TP-130. August 2004.

TerraSeer space-time intelligence system (STIS). About Jenks' natural breaks.
http://www.terraseer.com/products/stis/help/default.htm#interface/map/classify/About_natural_breaks.htm (accessed March 2008).

Tyson, S, and L.R. Combs, 1999.
Canaveral Barge Canal boater activity and compliance study, Brevard County, Florida. Final report submitted to the Florida Department of Environmental Protection. 87 pp.

U.S. Fish and Wildlife Service. 2001.
Florida Manatee Recovery Plan, (*Trichechus manatus latirostris*), Third Revision. U.S. Fish and Wildlife Service. Atlanta, Georgia. 144pp + app.

Acknowledgements

Thanks to aerial survey pilots Lew Lawrence, Greg Baker, Bob Muir, and Bob Ohlinger for their assistance with the field data collection for this study. Also special thanks to Janet Gannon for her invaluable assistance with the GIS spatial analysis and presentation for this report.

List Of Tables

List Of Figures

Table 1. Summary of 2006-07 Collier County aerial surveys, with vessel counts.

Survey Date	Survey Start	Vessels Observed
11-Dec-06	0916 hrs	119
11-Dec-06	1227 hrs	180
27-Jan-07	0924 hrs	286
27-Jan-07	1206 hrs	645
04-Apr-07	0915 hrs	378
04-Apr-07	1212 hrs	717
19-May-07	0938 hrs	429
19-May-07	1301 hrs	541
07-Jul-07	1152 hrs	443
10-Aug-07	0907 hrs	172
10-Aug-07	1210 hrs	195
19-Aug-07	0859 hrs	277
01-Sep-07	0933 hrs	411
01-Sep-07	1226 hrs	501
13-Nov-07	0941 hrs	167
13-Nov-07	1232 hrs	296
Total Vessels Observed		**5,757**

Table 2. Vessel distribution by size class. All survey dates are combined.

Total Vessels Observed

Vessel Size Category	Weekday	Weekend	Total
less than 16 feet	320	356	676
16 - 25 feet	1,653	2,784	4,437
26 - 39 feet	183	300	483
40 - 64 feet	53	78	131
65 - 109 feet	15	14	29
greater than 109 feet	0	1	1
Total	**2,224**	**3,533**	**5,757**

Percentage

Vessel Size Category	Weekday	Weekend
less than 16 feet	14.39%	10.08%
16 - 25 feet	74.33%	78.80%
26 - 39 feet	8.23%	8.49%
40 - 64 feet	2.38%	2.21%
65 - 109 feet	0.67%	0.40%
greater than 109 feet	0.00%	0.03%

Table 3. Vessel distribution by type class. All survey dates are combined.

Total Vessels Observed				Percentage		
Vessel Type Category	**Weekday**	**Weekend**	**Total**	**Vessel Type Category**	**Weekday**	**Weekend**
Open Motorboat	1,481	2,573	4,054	Open Motorboat	66.59%	72.83%
Closed Cabin	144	291	435	Closed Cabin	6.47%	8.24%
Pontoon Boat	165	214	379	Pontoon Boat	7.42%	6.06%
Sail Boat	81	100	181	Sail Boat	3.64%	2.83%
Personal Watercraft	75	104	179	Personal Watercraft	3.37%	2.94%
Air Boat	35	39	74	Air Boat	1.57%	1.10%
Jon Boat	26	27	53	Jon Boat	1.17%	0.76%
Inflatable	3	6	9	Inflatable	0.13%	0.17%
Houseboat	1	3	4	Houseboat	0.04%	0.08%
High Performance	1	5	6	High Performance	0.04%	0.14%
Kayak / Canoe	164	138	302	Kayak / Canoe	7.37%	3.91%
Commercial Fish	1	4	5	Commercial Fish	0.04%	0.11%
Commercial Transport	14	11	25	Commercial Transport	0.63%	0.31%
Commercial Barge	30	11	41	Commercial Barge	1.35%	0.31%
Commercial Tug / Tender	3	3	6	Commercial Tug / Tender	0.13%	0.08%
Commercial Other	0	2	2	Commercial Other	0.00%	0.06%
Enforcement	0	2	2	Enforcement	0.00%	0.06%
Total	**2,224**	**3,533**	**5,757**			

Figure 1. GIS track of flight path (red) from the 7/7/07 Collier County aerial boat survey. (northern portion).

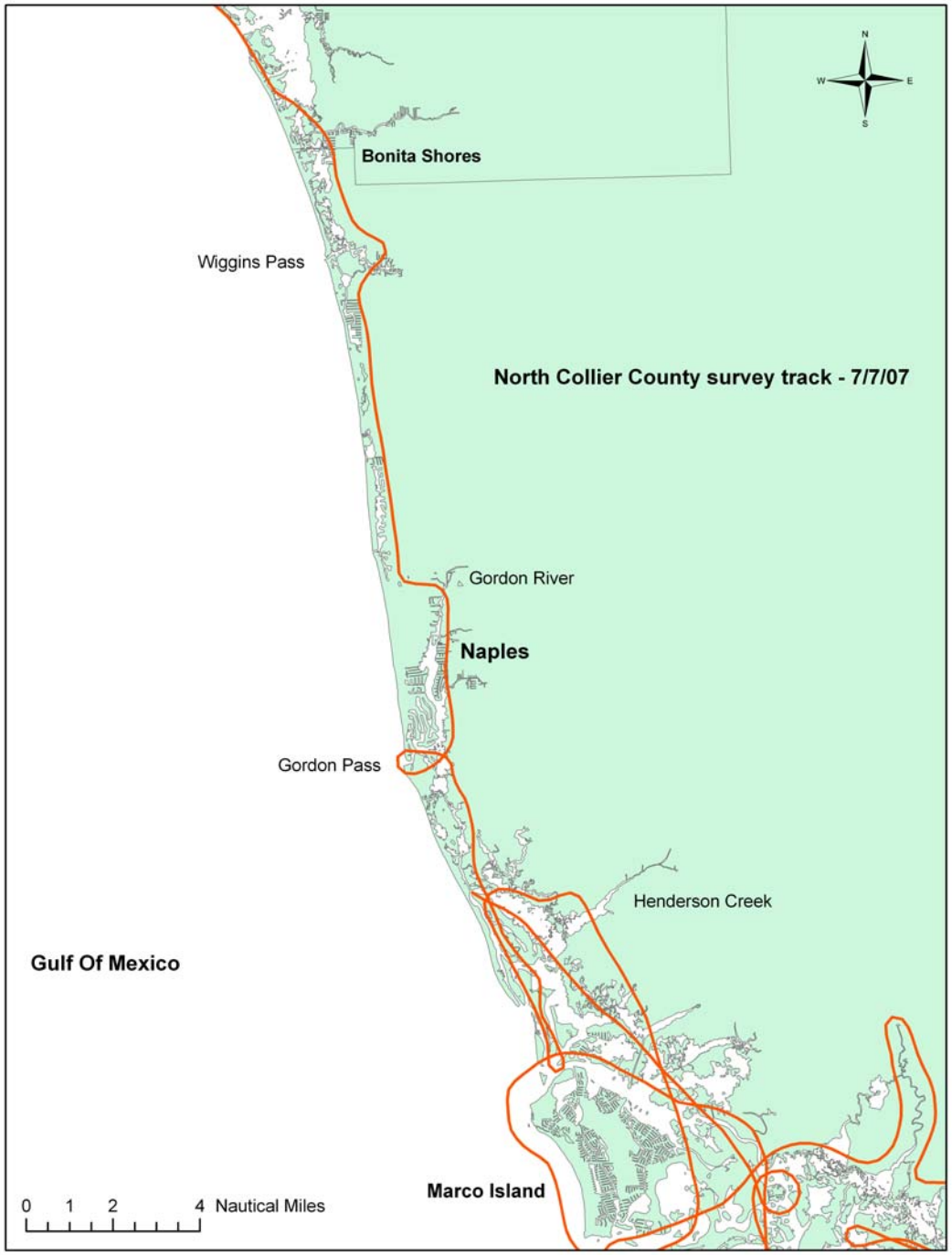


Figure 2. GIS track of flight path (red) from the 7/7/07 Collier County aerial boat survey. (southern portion).

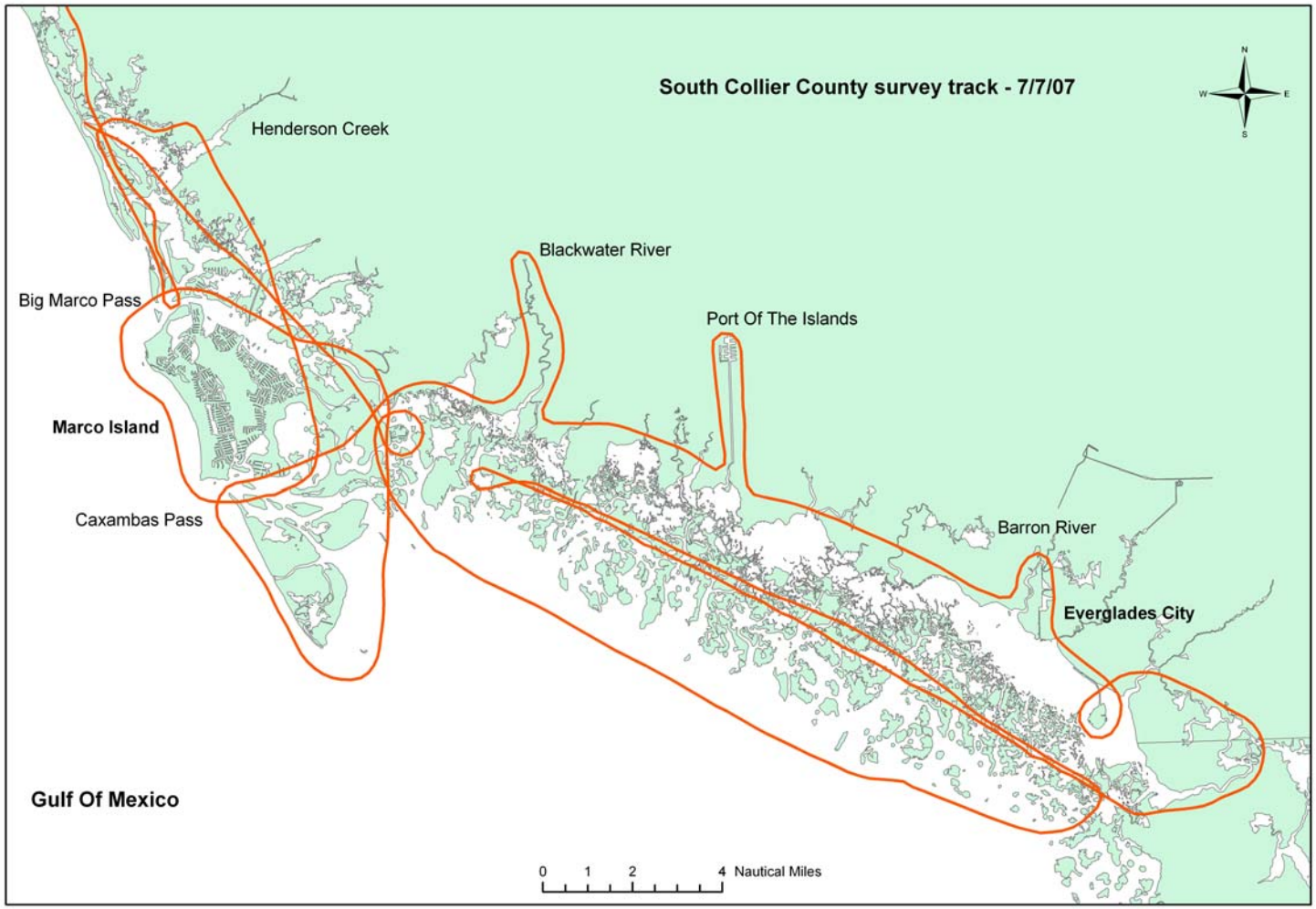


Figure 3. A summary of boat traffic data comparing morning/afternoon, weekday/weekend, and seasonal intervals.

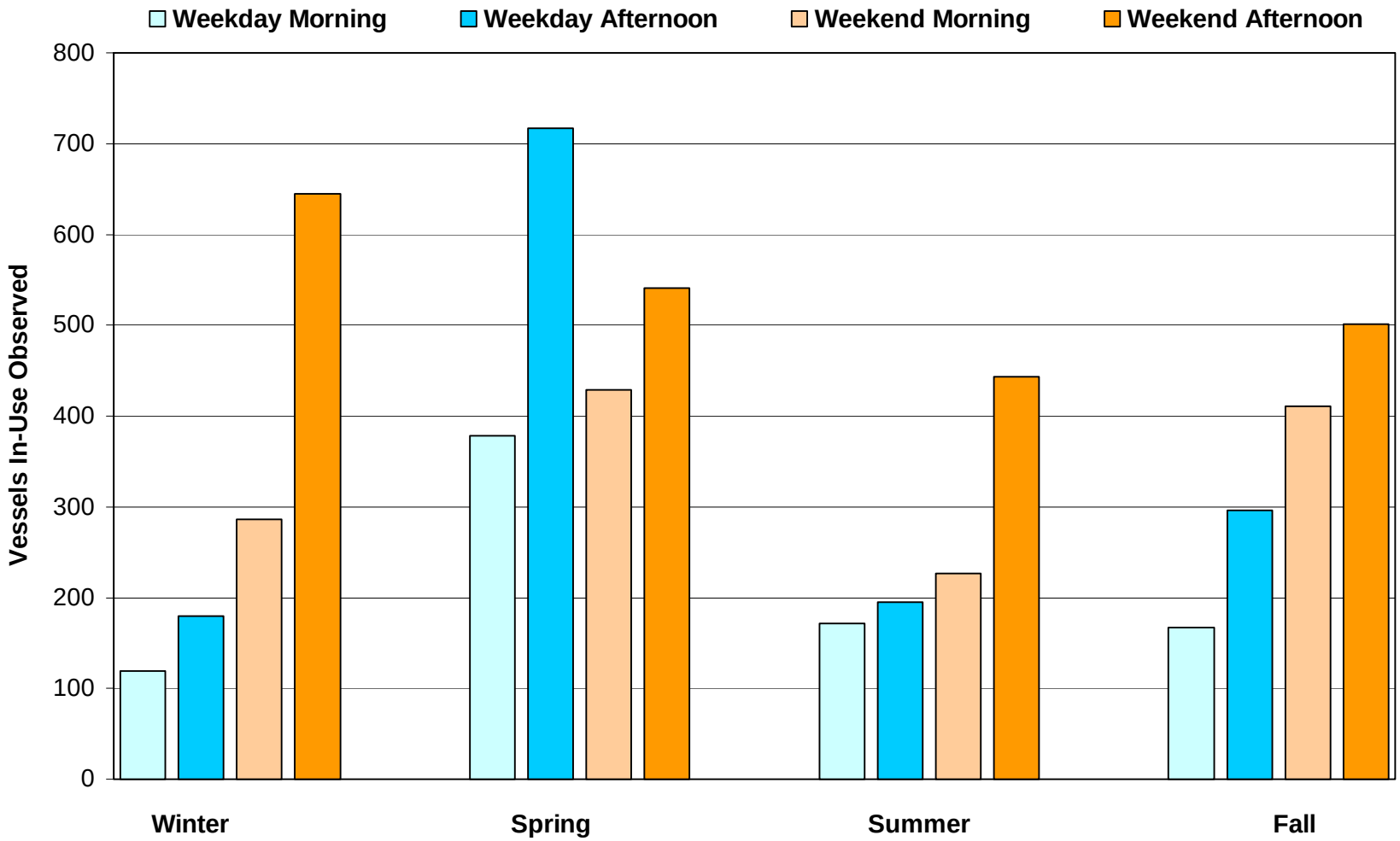


Figure 4. Spatial distribution of vessels identified as open motorboats throughout Collier County. All 16 survey flights are combined.

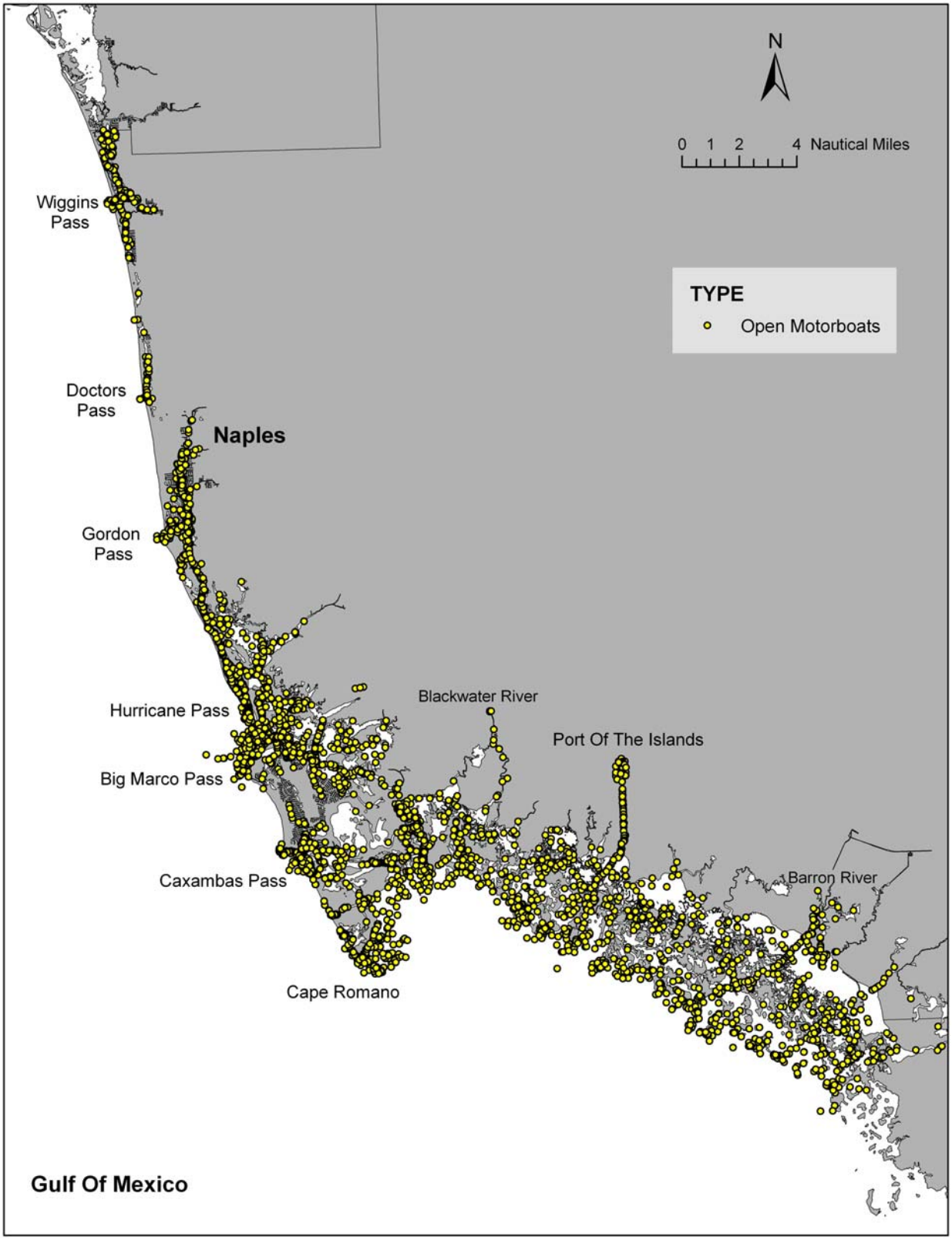


Figure 5. Spatial distribution of vessels identified as either kayak/canoe or airboats throughout Collier County. All 16 survey flights are combined.

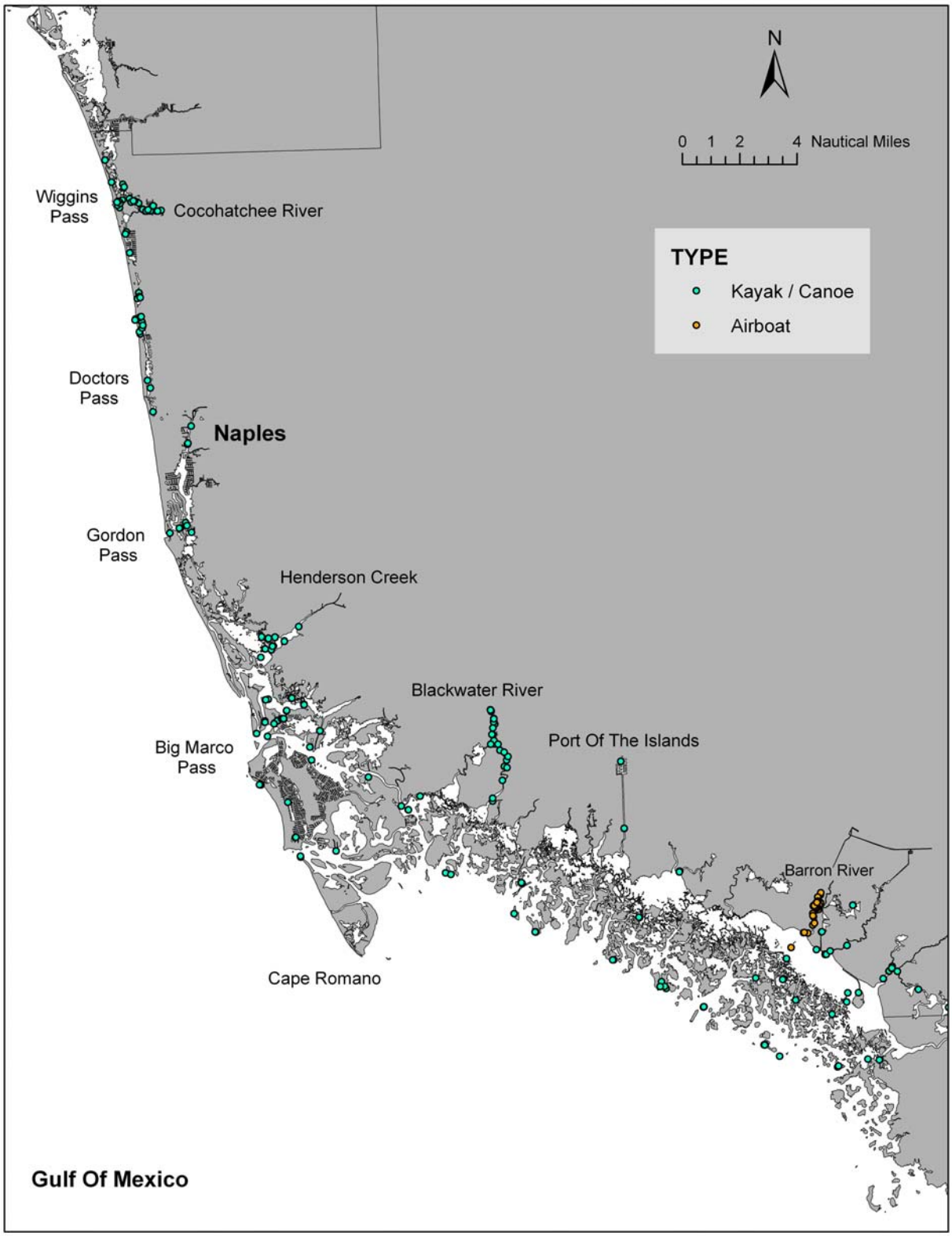


Figure 6. Spatial distribution of vessels identified as either large closed cabin motorboats or sailboats throughout Collier County. All 16 survey flights are combined.

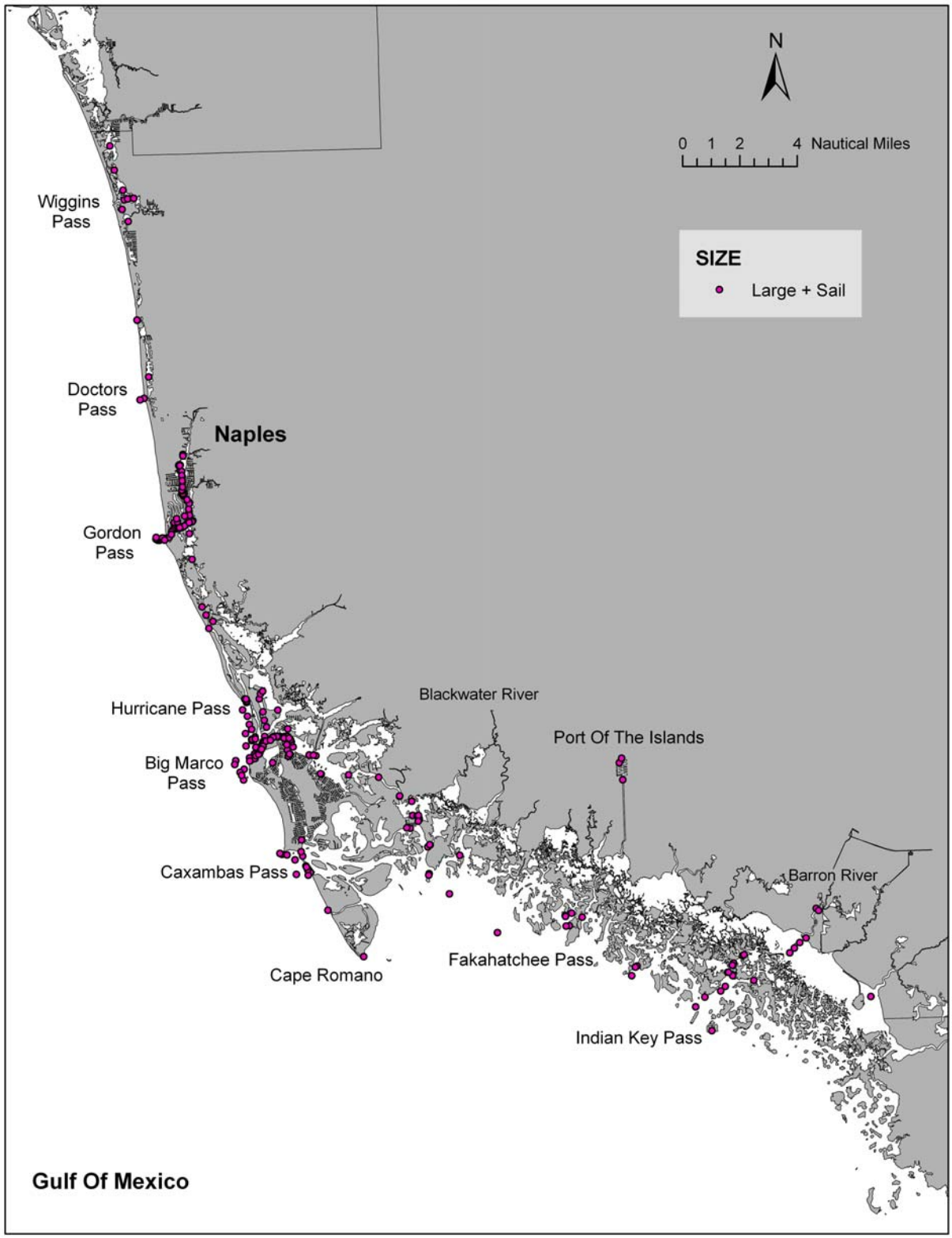


Figure 7. Distribution of moving and stationary vessels near Naples Bay and Gordon Pass. All 16 survey flights are combined.

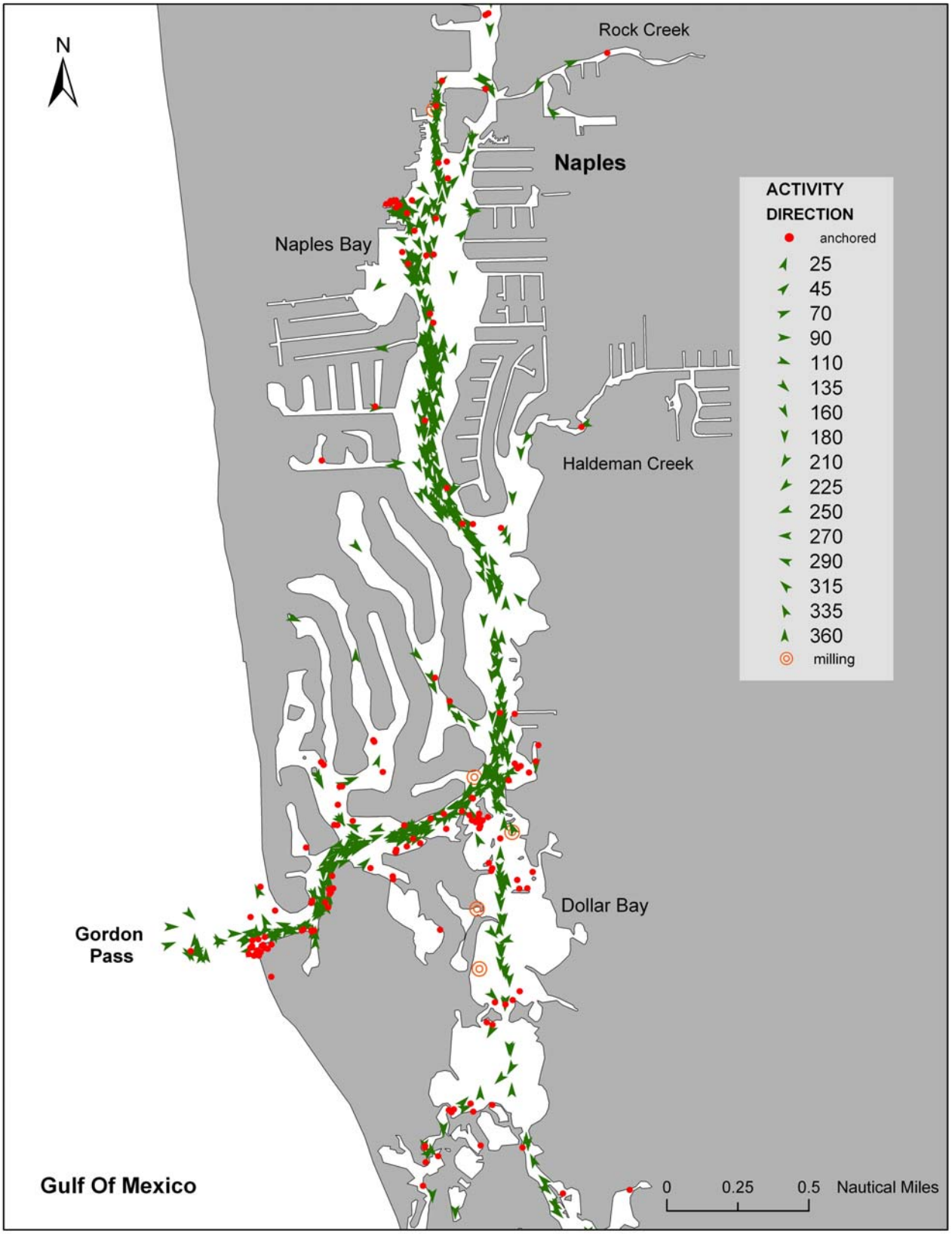


Figure 8. Distribution of moving and stationary vessels near Hurricane Pass and Big Carlos Pass. All 16 survey flights are combined.

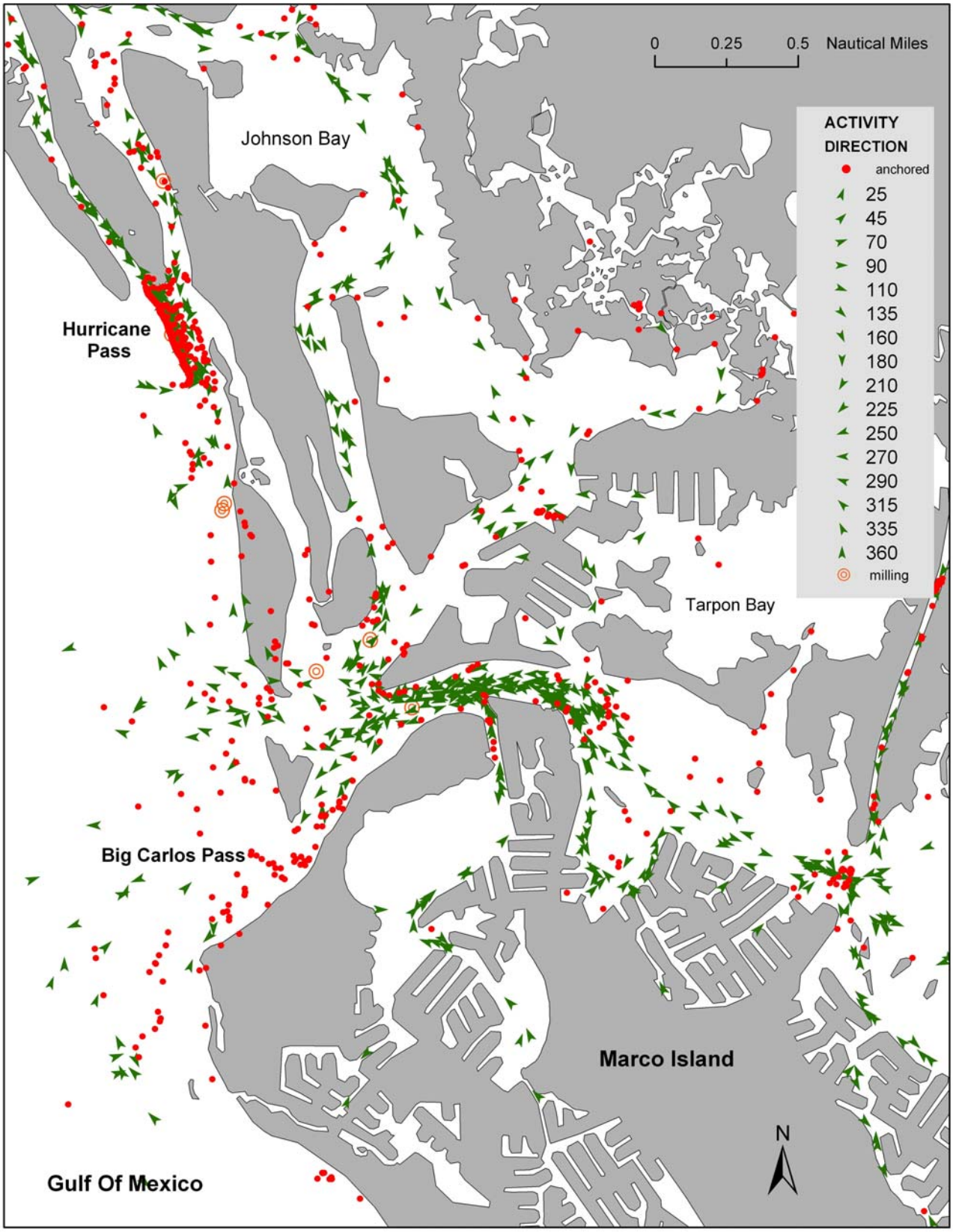


Figure 9. Distribution of moving and stationary vessels through the Ten Thousand Islands area. All 16 survey flights are combined.

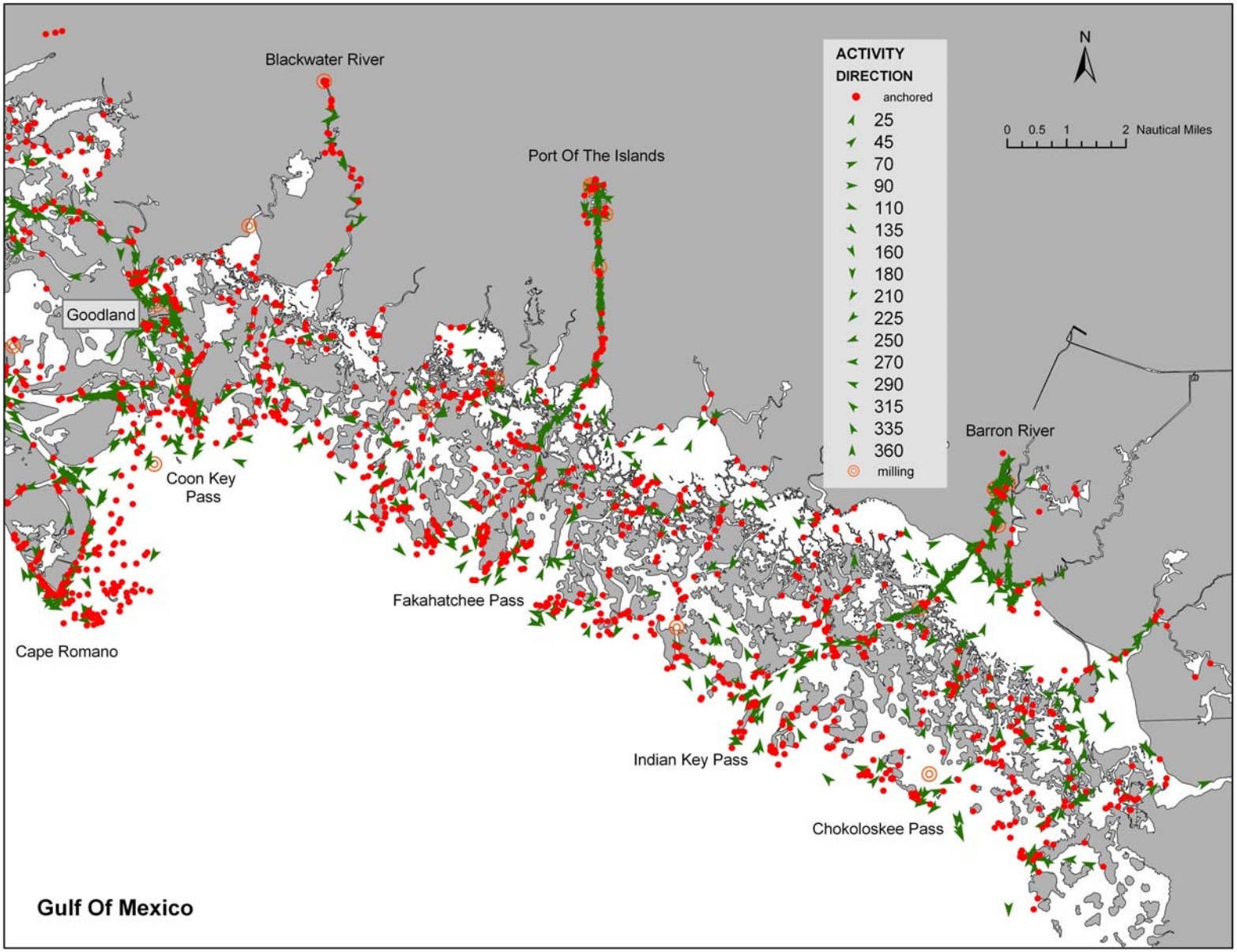


Figure 10. A series of 215 computer-generated polygons used for spatial analysis, covering the entire Collier County study area.

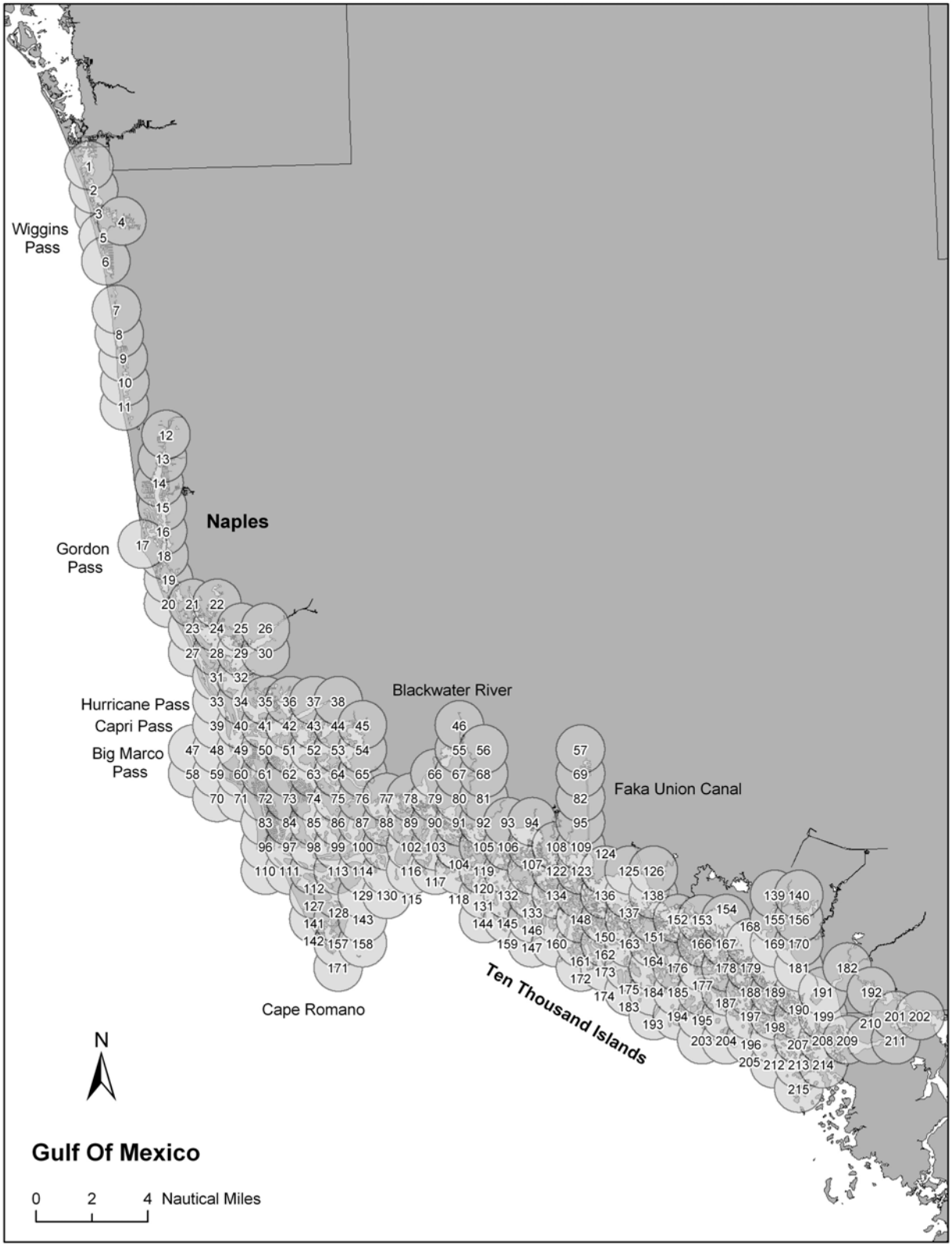


Figure 11. Designated low, moderate, and high density boat traffic areas in Collier County. All survey flights are combined.

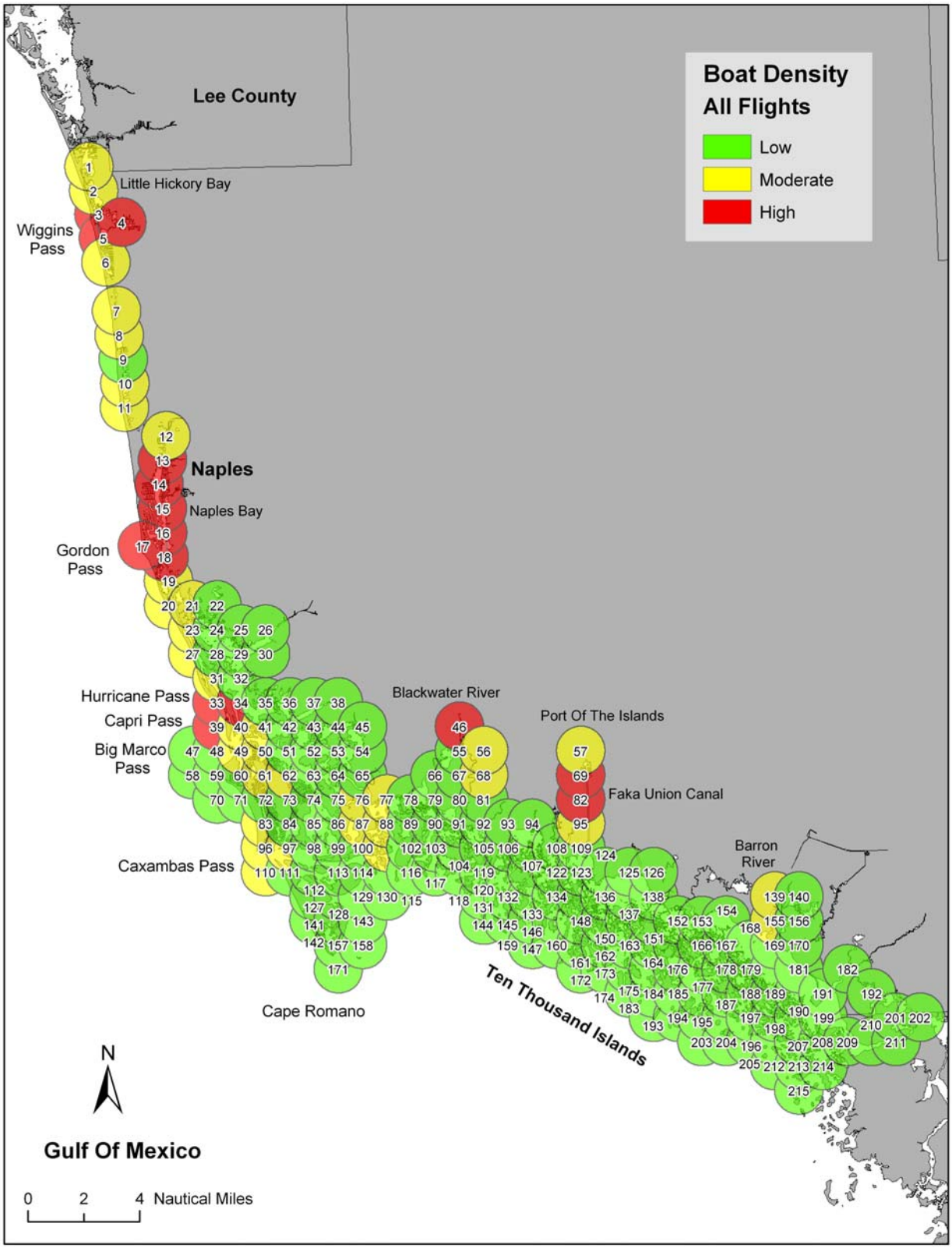


Figure 12. Designated low, moderate, and high density boat traffic areas in Collier County. Weekday survey flights only.

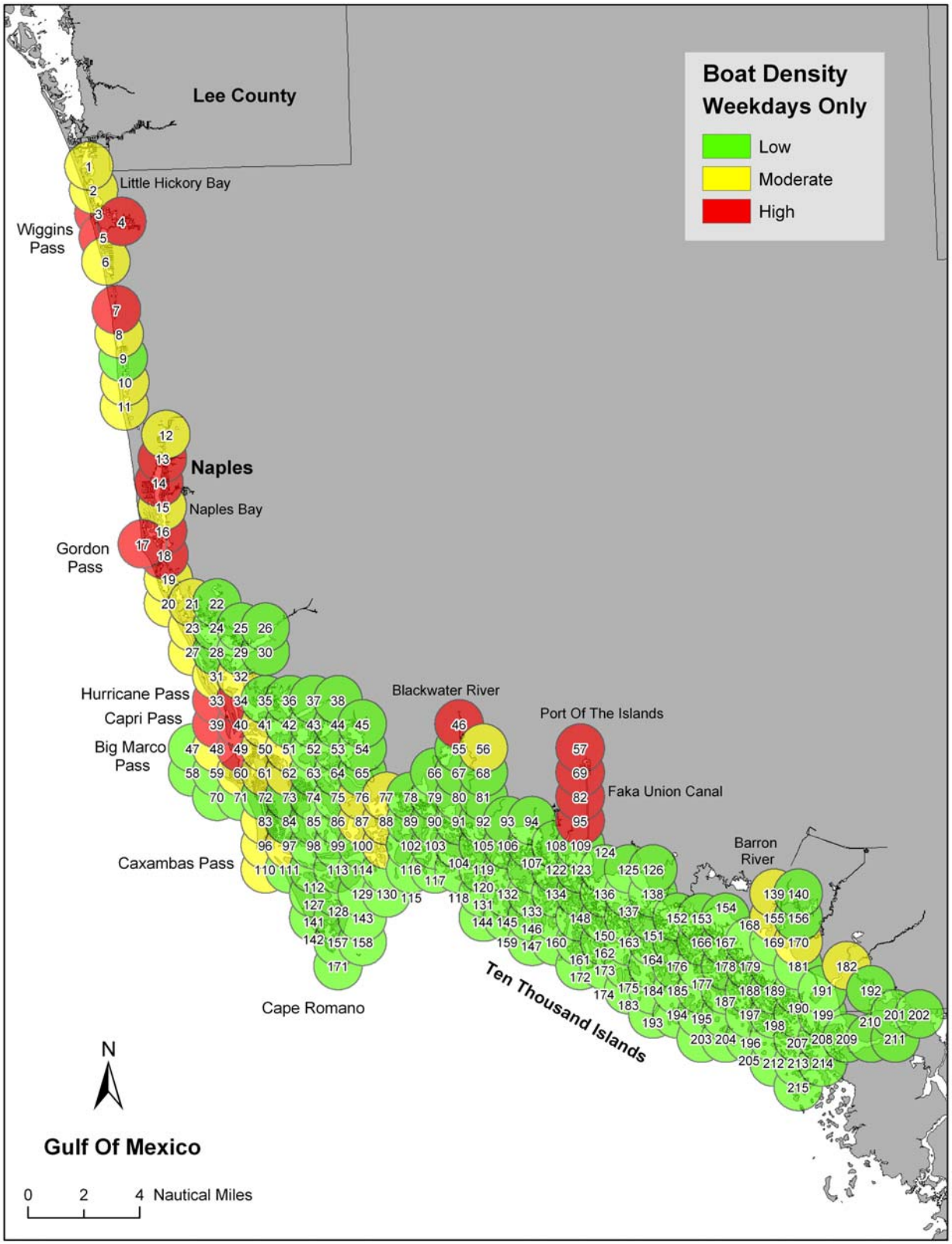


Figure 13. Designated low, moderate, and high density boat traffic areas in Collier County. Weekend survey flights only.

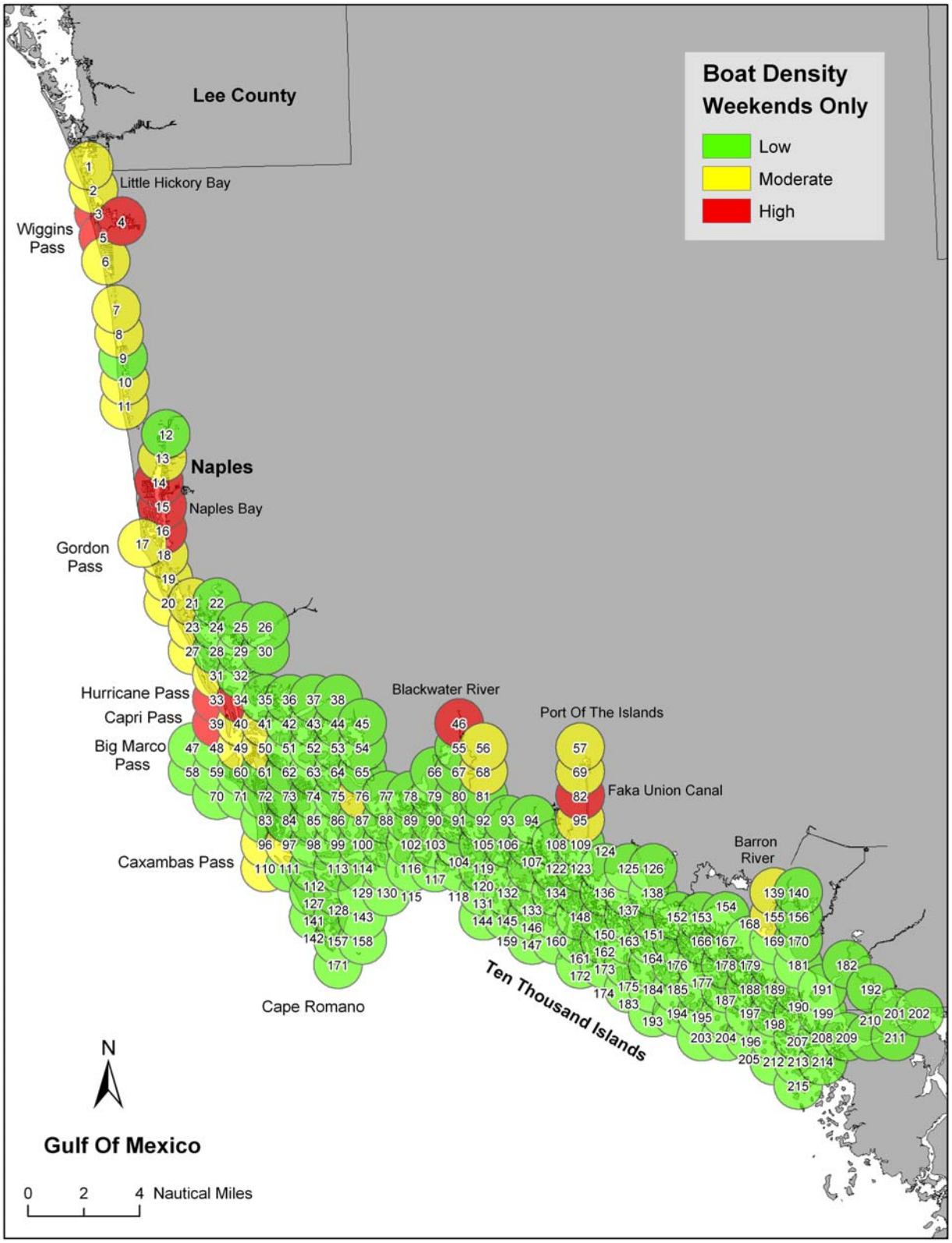


Figure 14. Designated low, moderate, and high density boat traffic areas in Collier County. High speed boat traffic only; all survey flights combined.

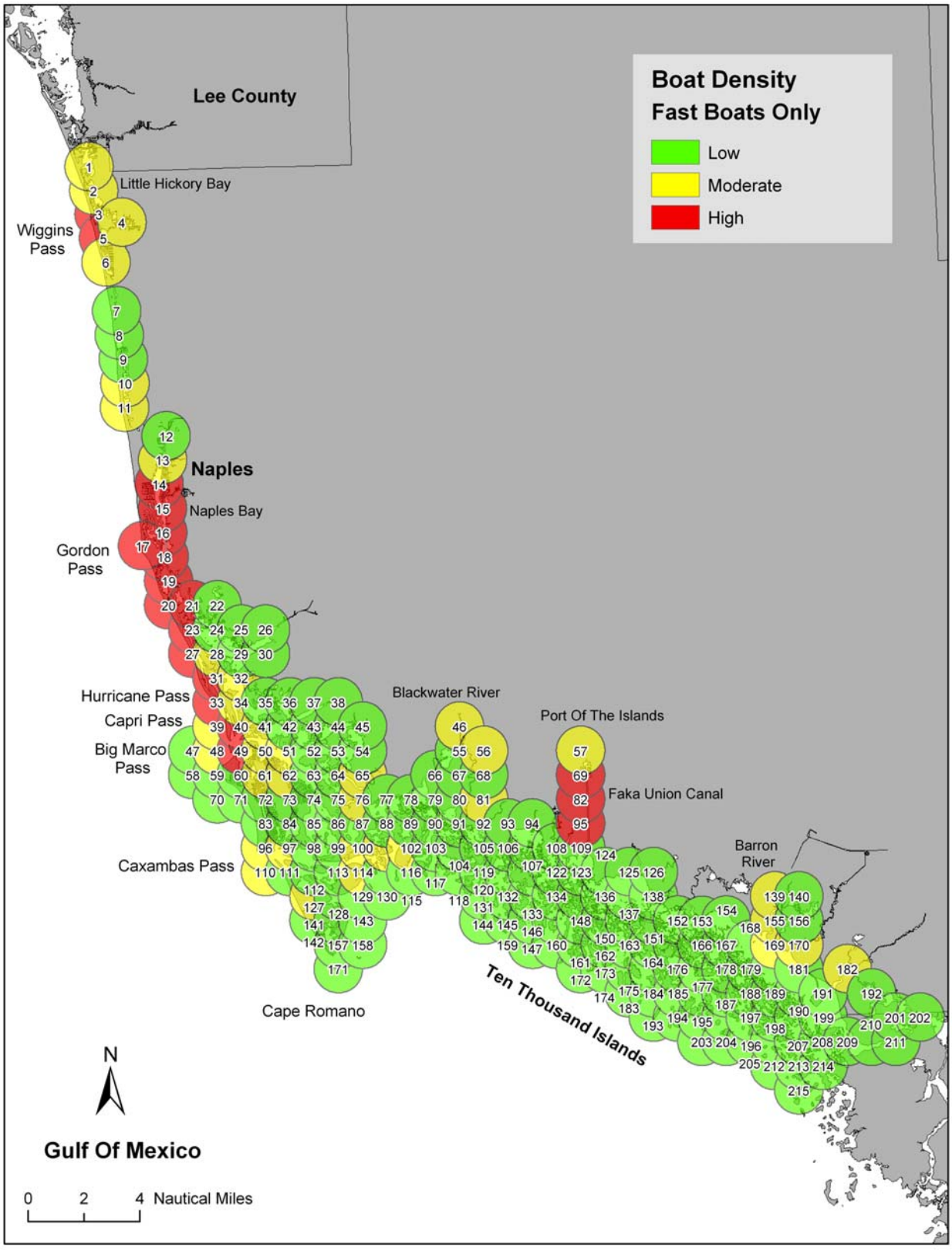


Figure 15. Designated low, moderate, and high density boat traffic areas in Collier County. Anchored / drifting vessels only; all survey flights combined.

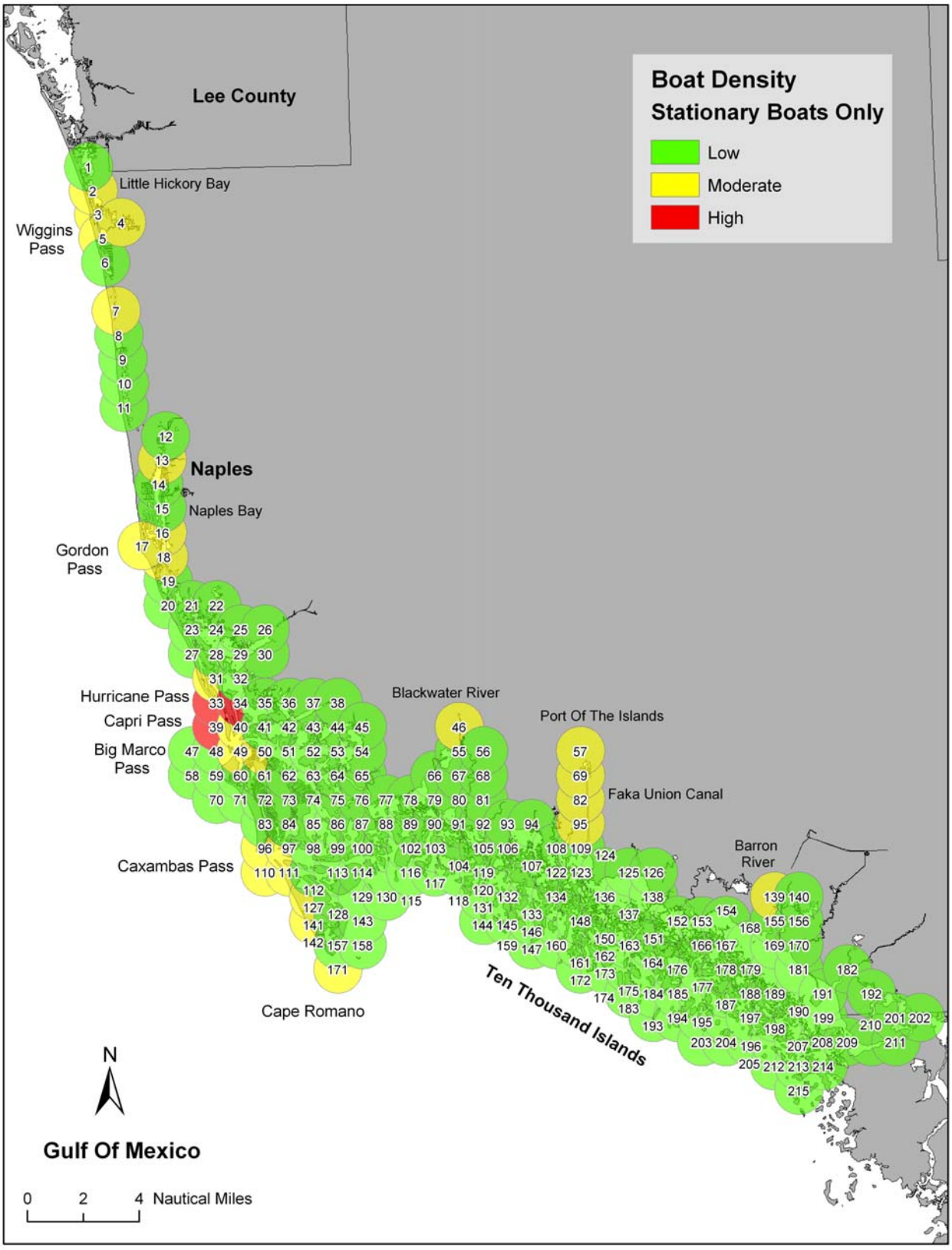


Figure 16. Expanded view of low, moderate, and high density boat traffic areas along the northern portion of Collier County. All survey flights are combined.

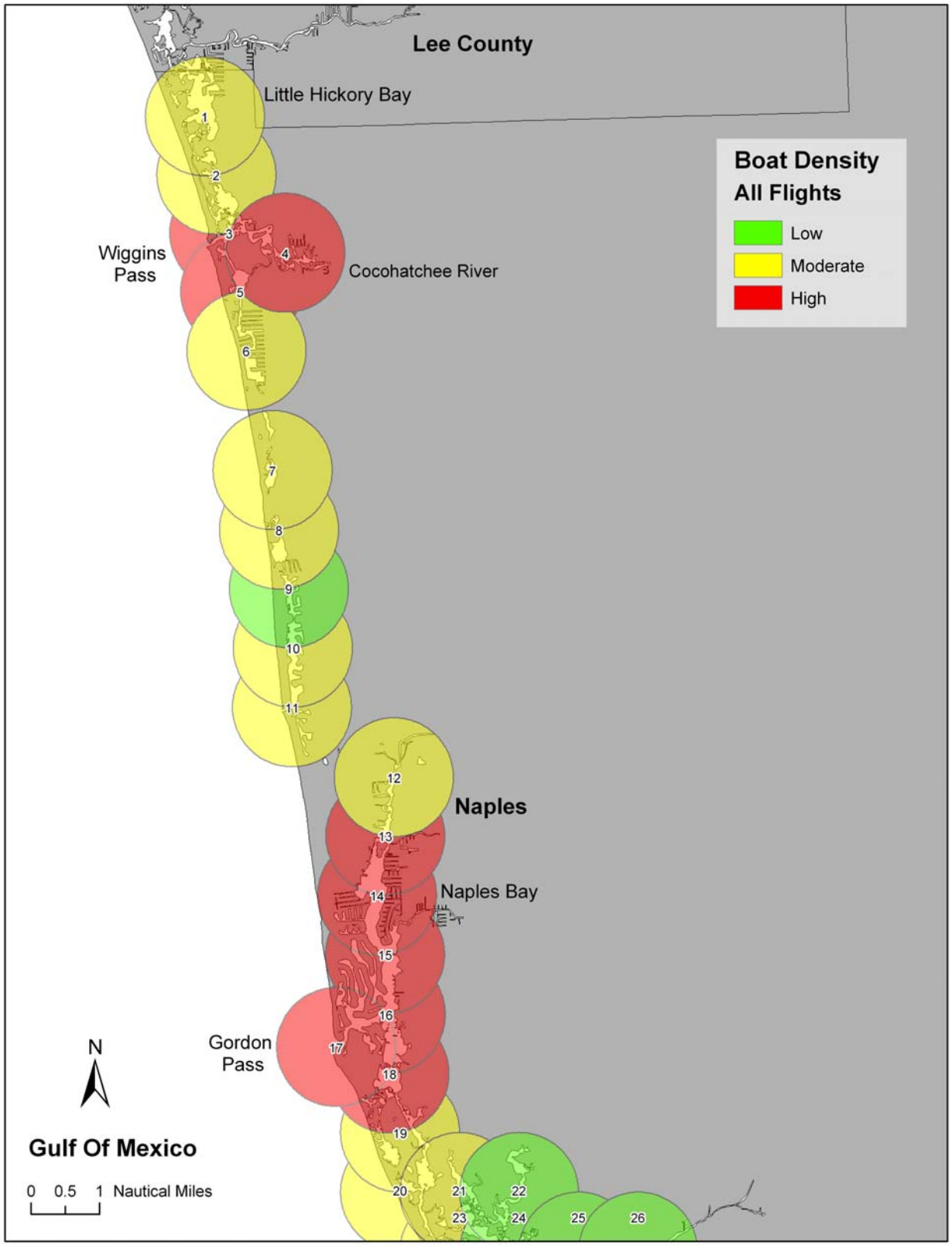


Figure 17. Expanded view of low, moderate, and high density boat traffic areas along the central portion of Collier County. All survey flights are combined.

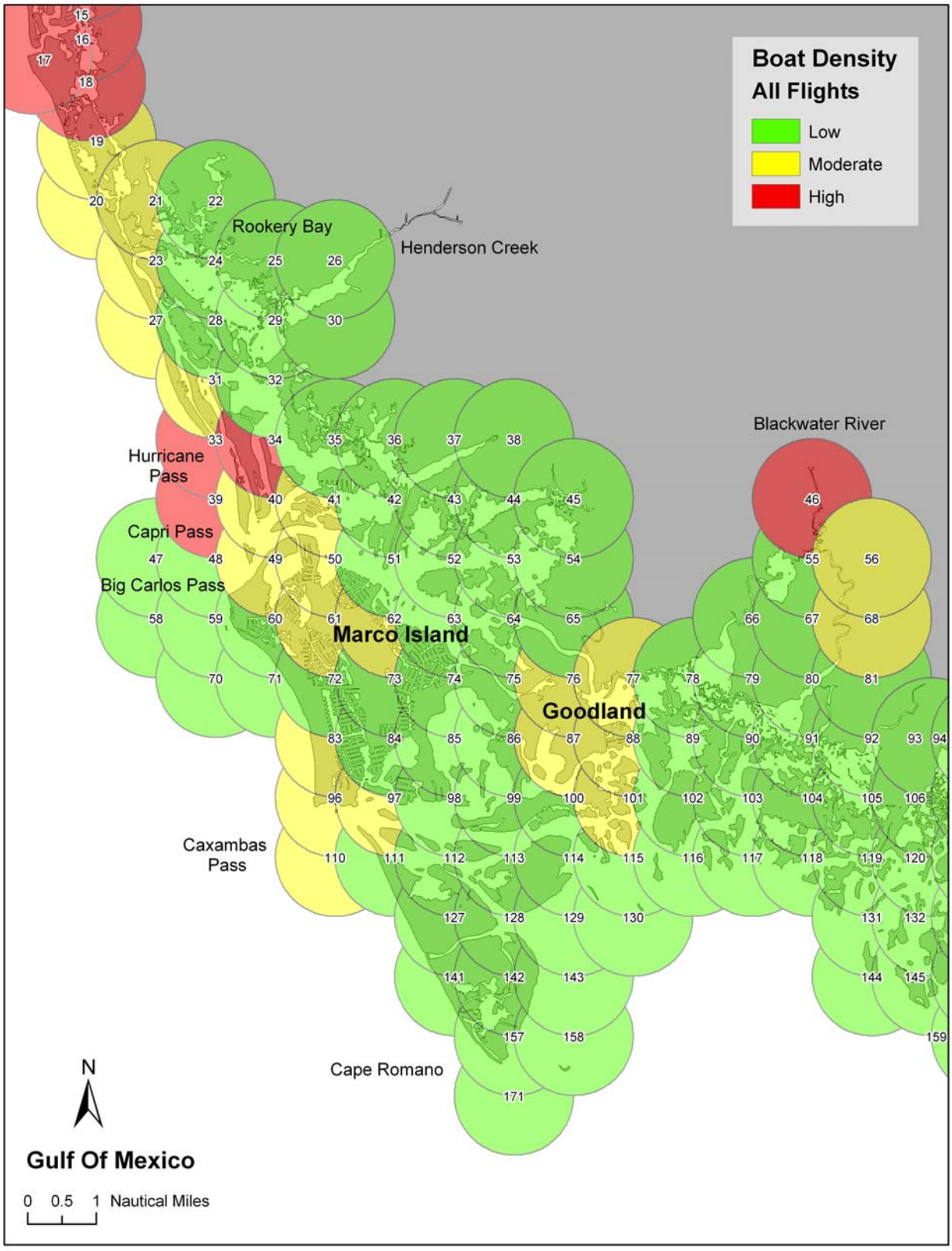


Figure 18. Expanded view of low, moderate, and high density boat traffic areas along the southern portion of Collier County. All survey flights are combined.

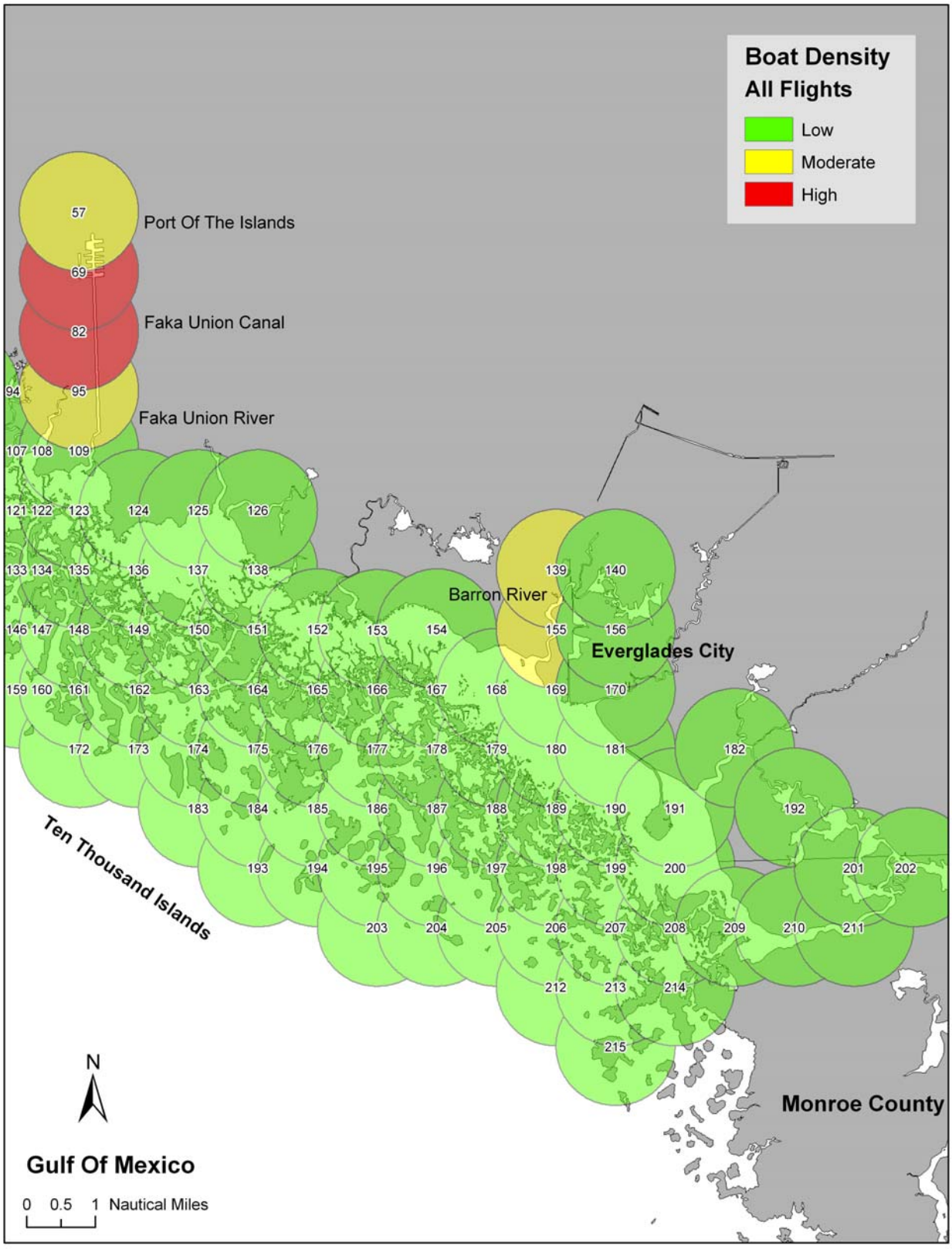


Figure 19. Expanded view of low, moderate, and high density boat traffic areas along the northern portion of Collier County. Weekday survey flights-only.

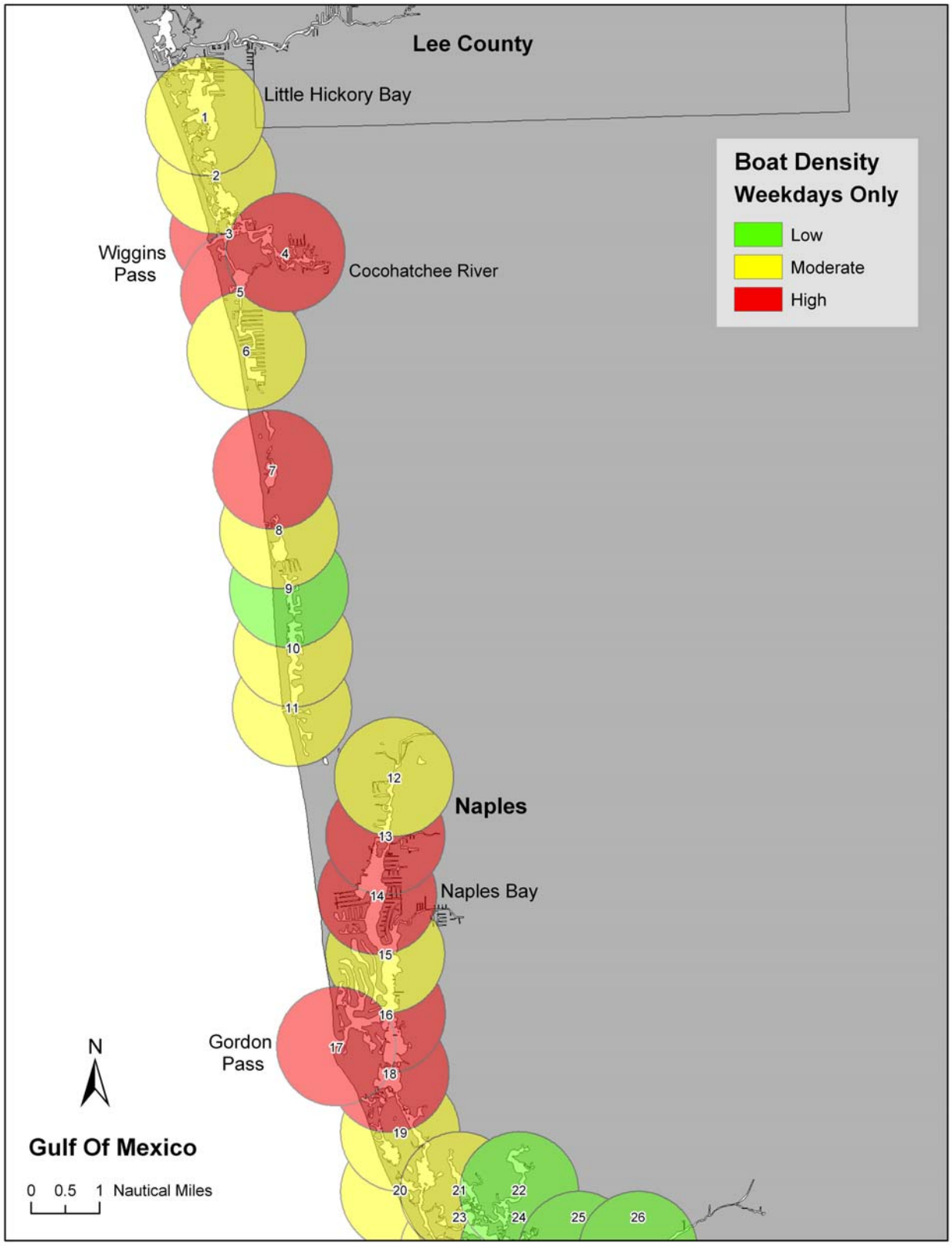


Figure 20. Expanded view of low, moderate, and high density boat traffic areas along the central portion of Collier County. Weekday survey flights-only.

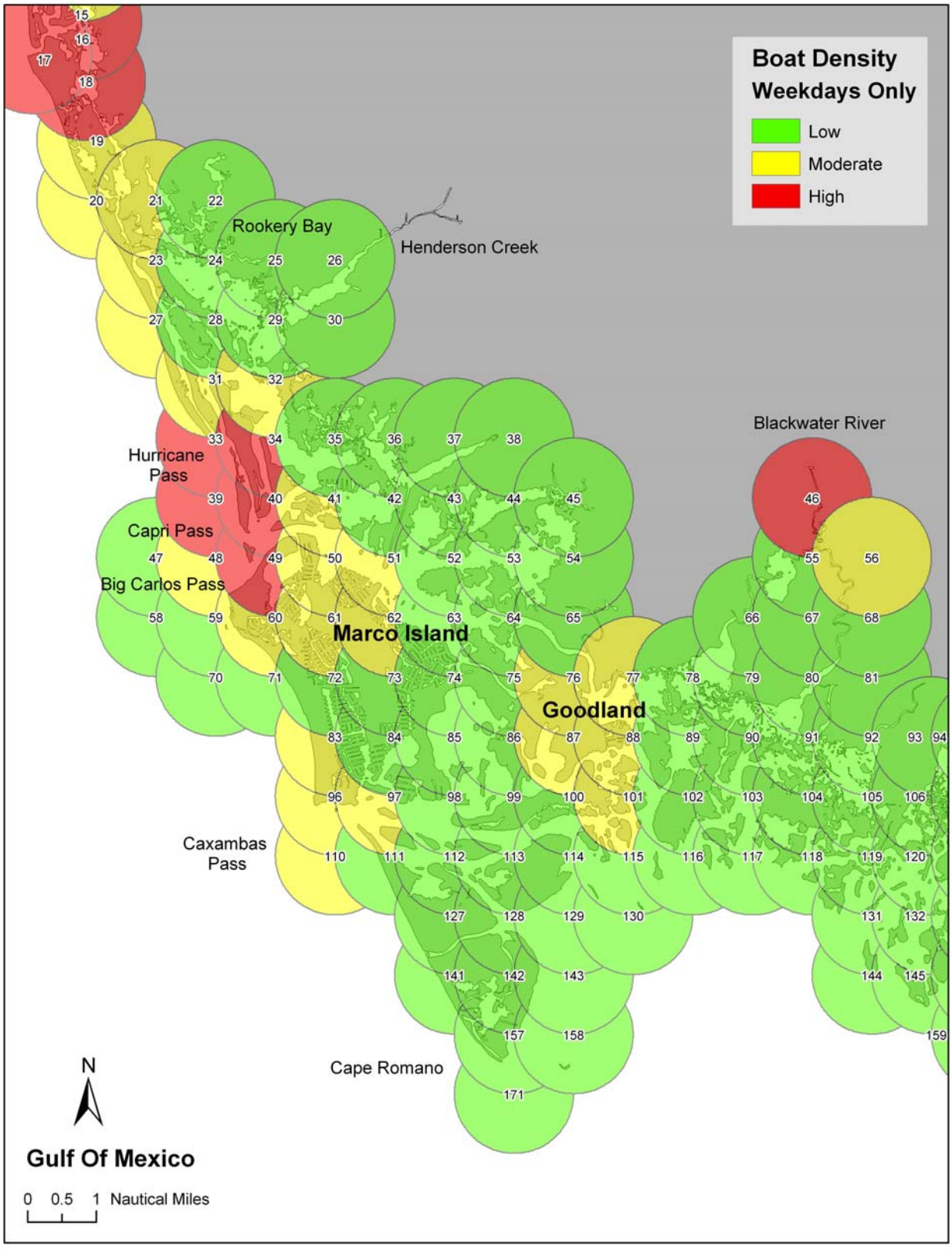


Figure 21. Expanded view of low, moderate, and high density boat traffic areas along the southern portion of Collier County. Weekday survey flights-only.

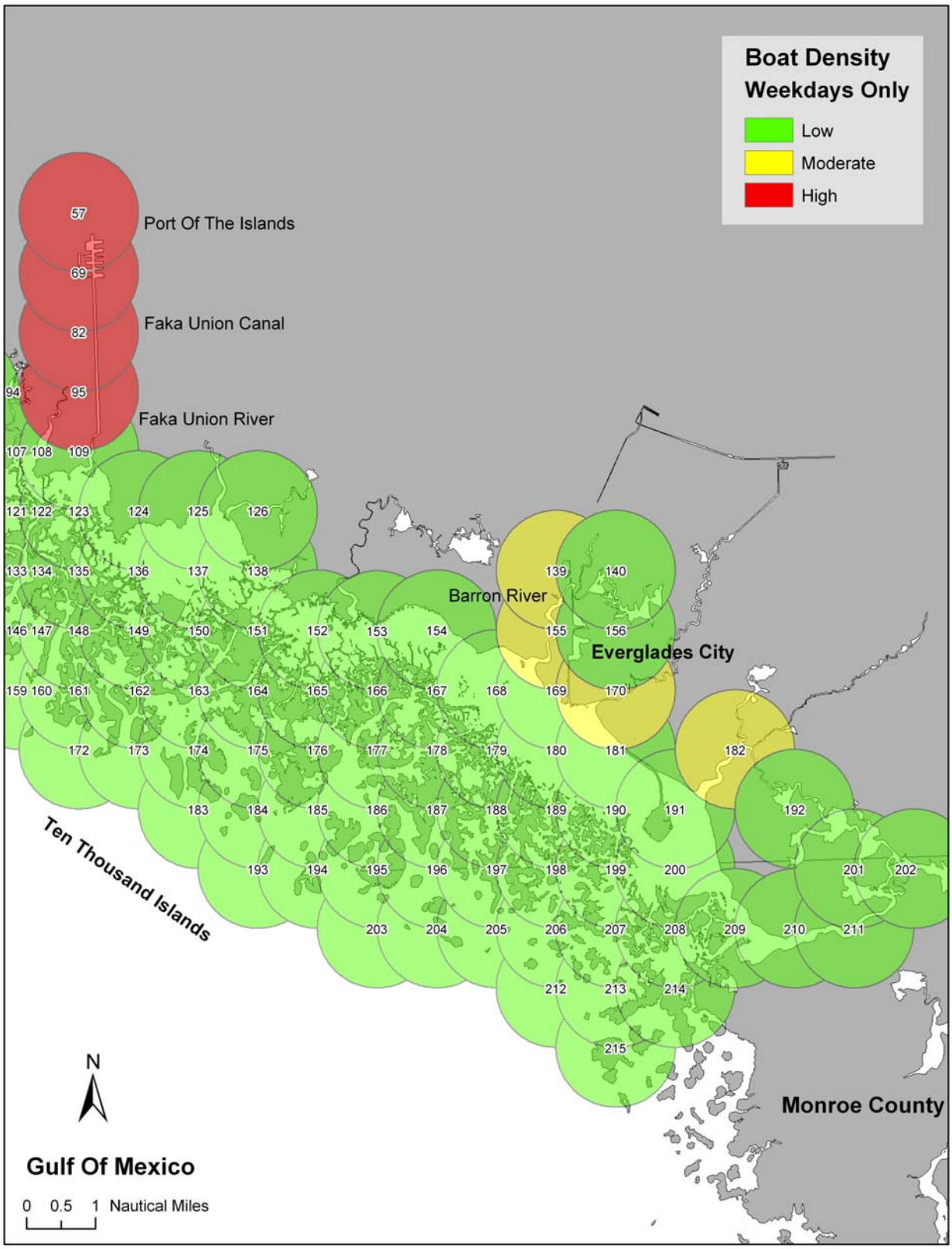


Figure 22. Expanded view of low, moderate, and high density boat traffic areas along the northern portion of Collier County. Weekend survey flights-only.

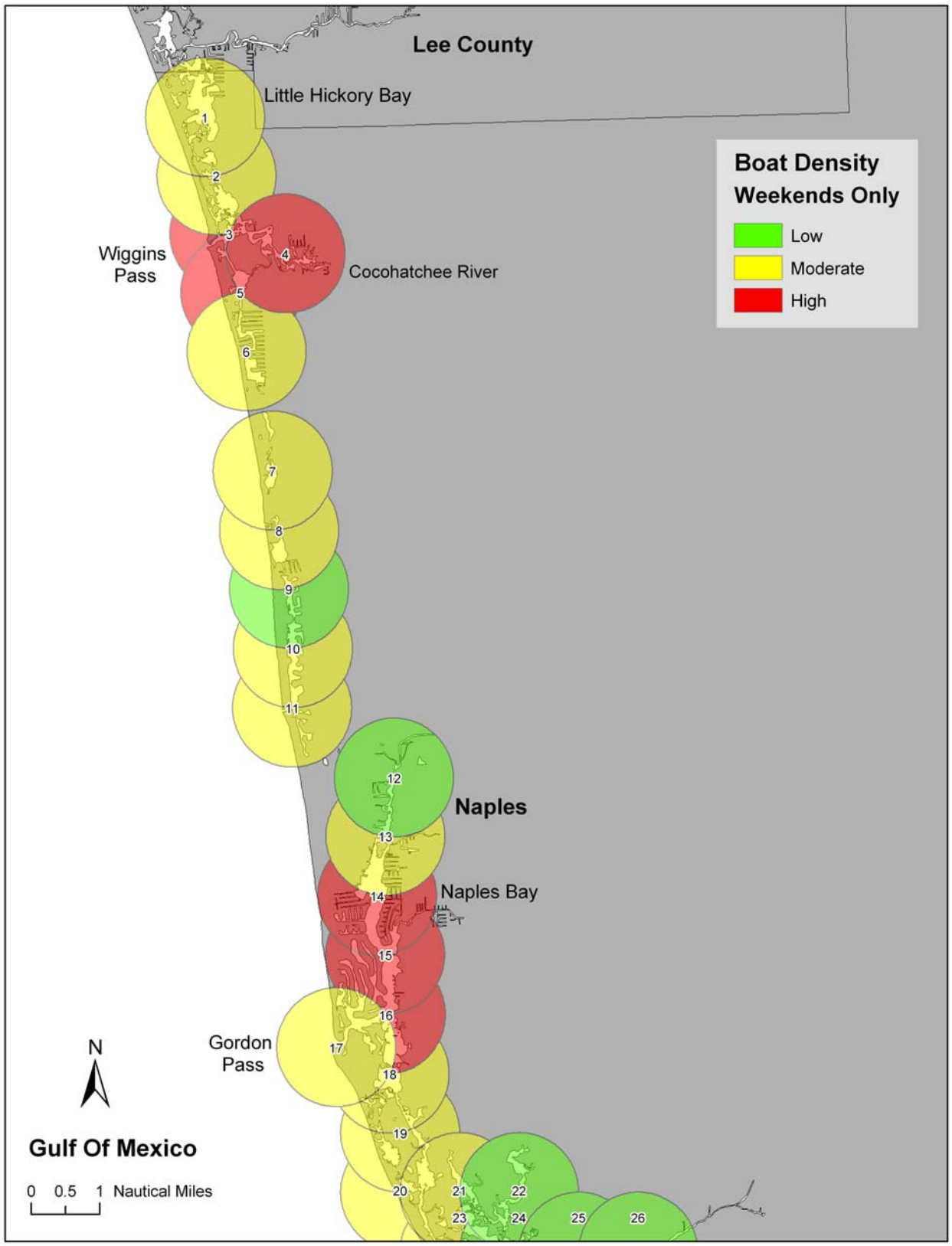


Figure 23. Expanded view of low, moderate, and high density boat traffic areas along the central portion of Collier County. Weekend survey flights-only.

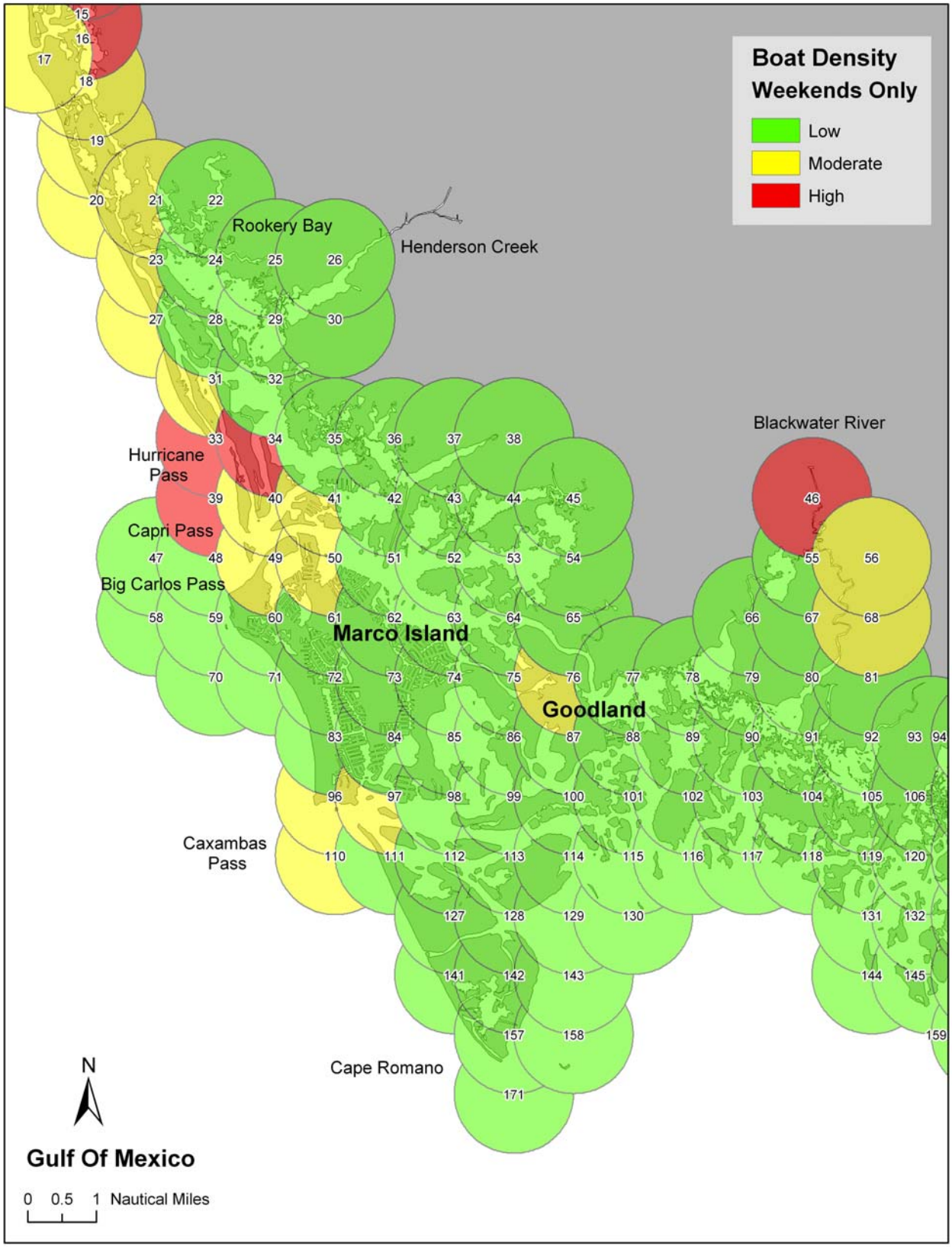


Figure 24. Expanded view of low, moderate, and high density boat traffic areas along the southern portion of Collier County. Weekend survey flights-only.

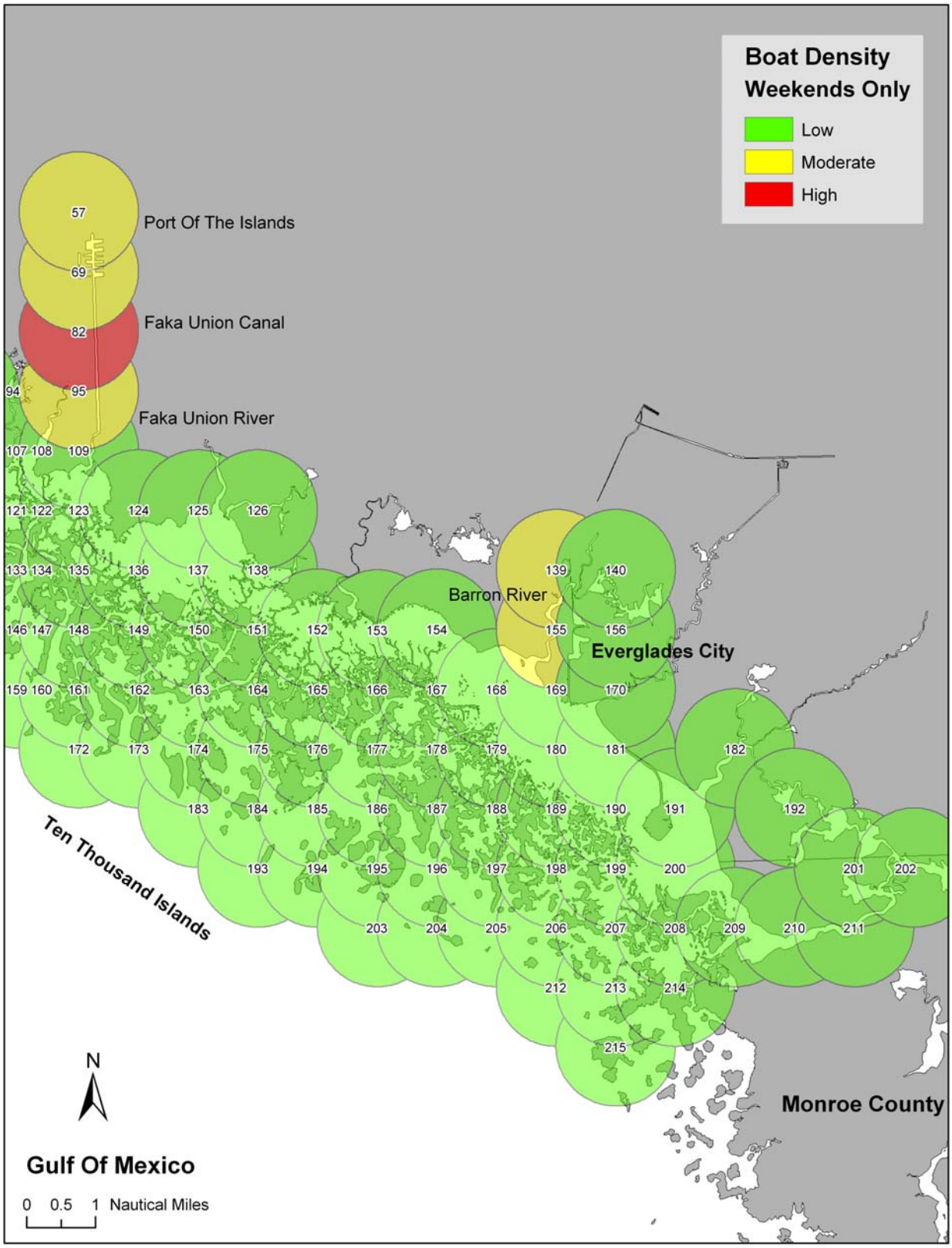


Figure 25. Expanded view of low, moderate, and high density boat traffic areas along the northern portion of Collier County. High-speed traffic-only.

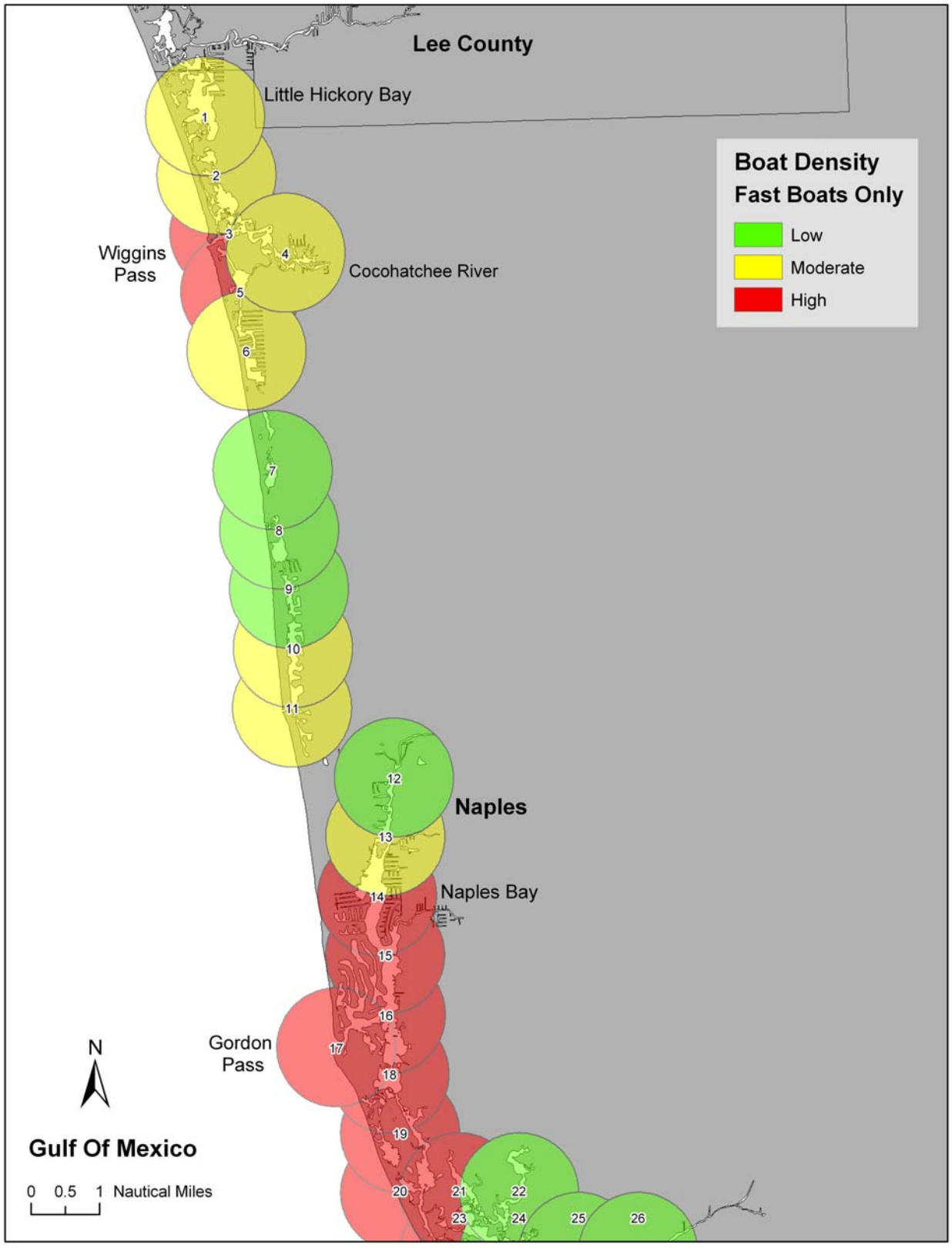


Figure 26. Expanded view of low, moderate, and high density boat traffic areas along the central portion of Collier County. High-speed traffic-only.

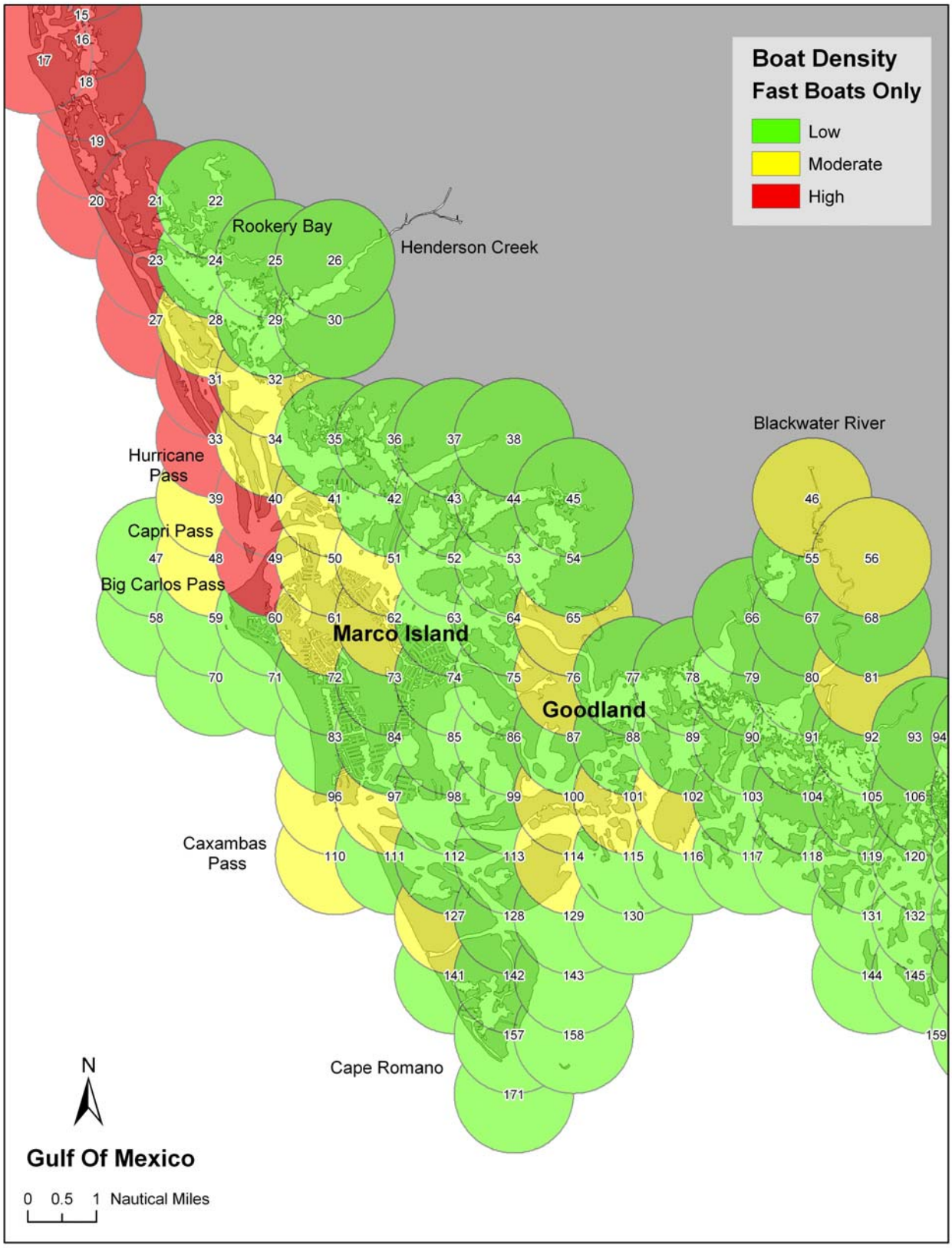


Figure 27. Expanded view of low, moderate, and high density boat traffic areas along the southern portion of Collier County. High-speed traffic-only.

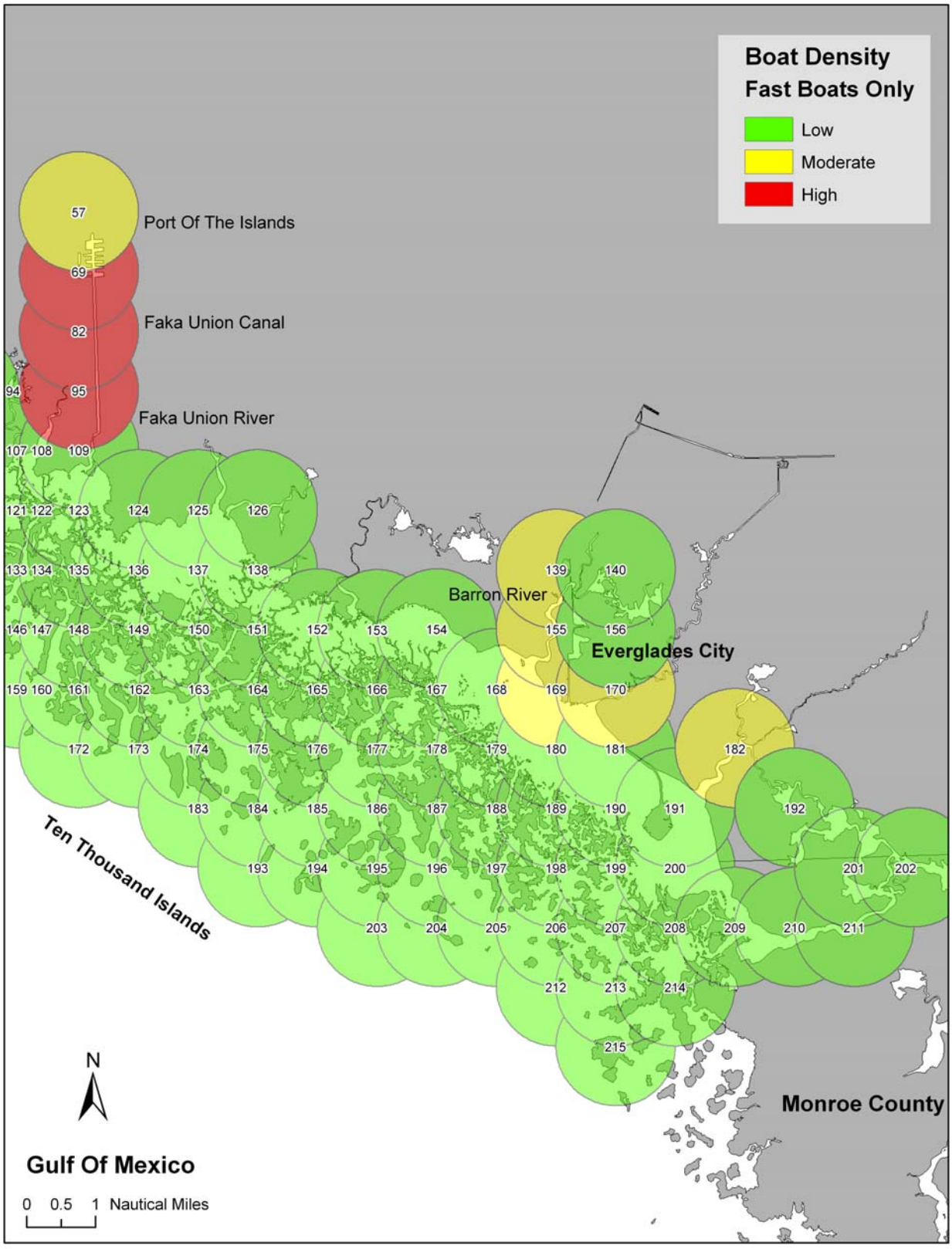


Figure 28. Expanded view of low, moderate, and high density boat traffic areas along the northern portion of Collier County. Anchored / drifting boats-only.

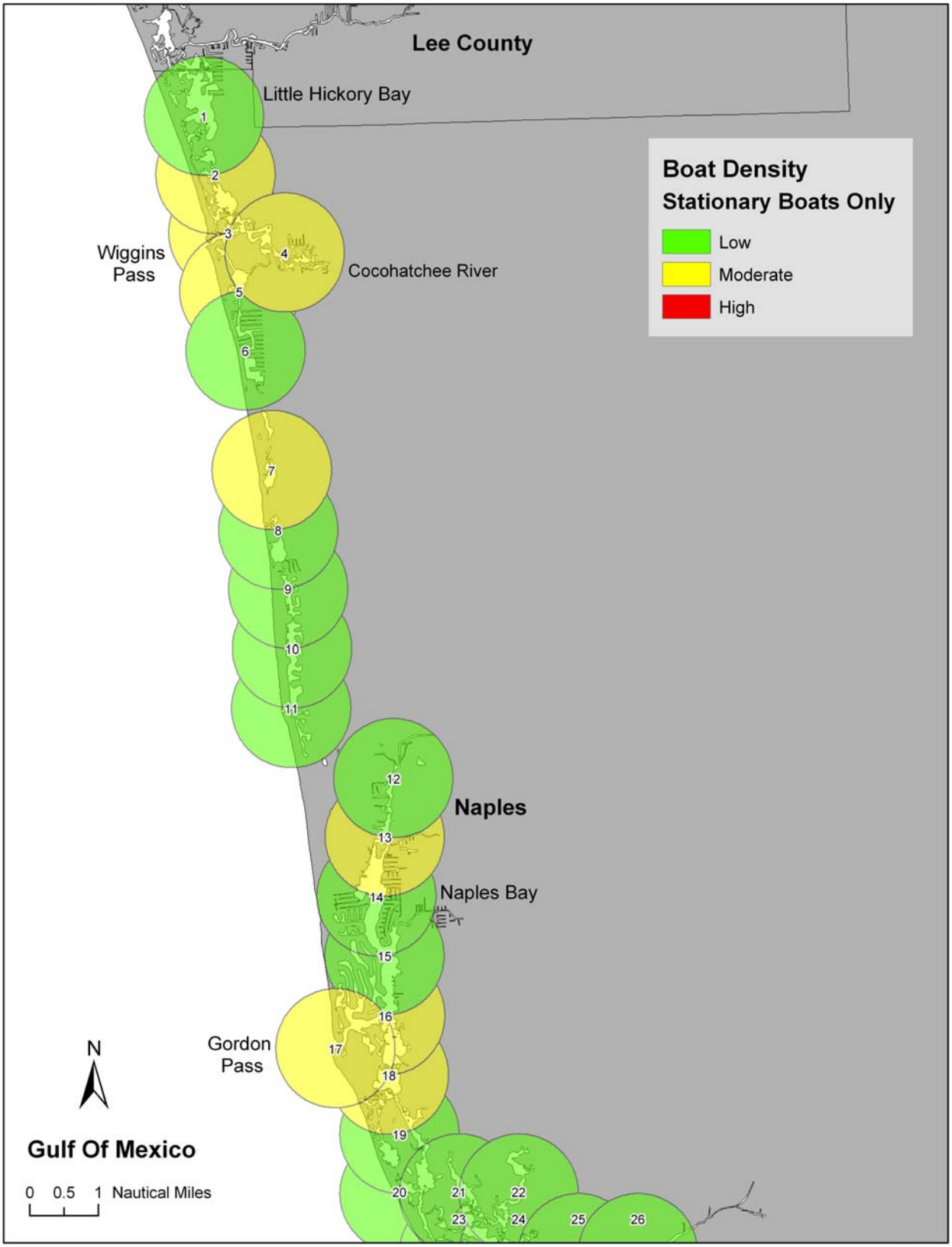


Figure 29. Expanded view of low, moderate, and high density boat traffic areas along the central portion of Collier County. Anchored / drifting boats-only.

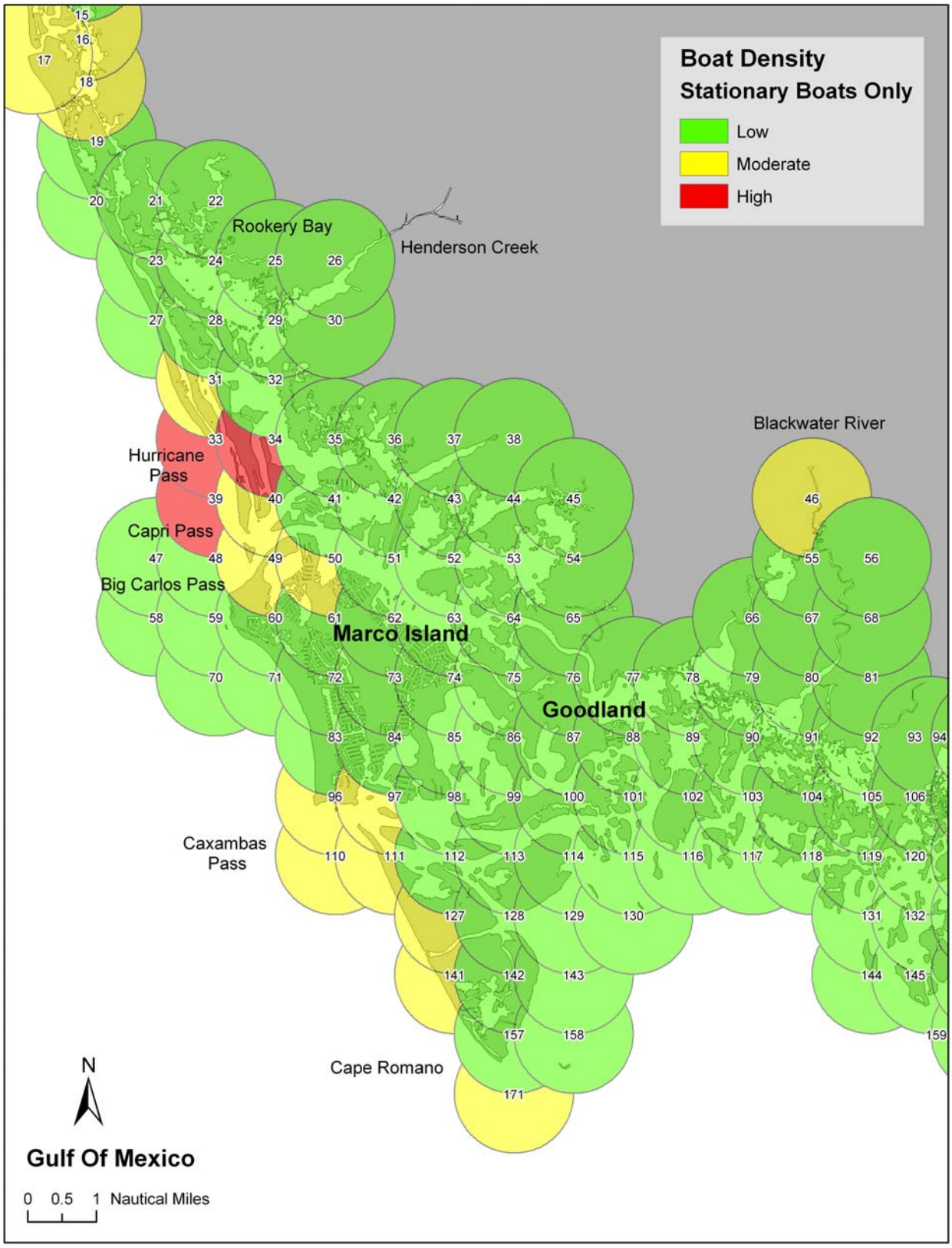


Figure 30. Expanded view of low, moderate, and high density boat traffic areas along the southern portion of Collier County. Anchored / drifting boats-only.

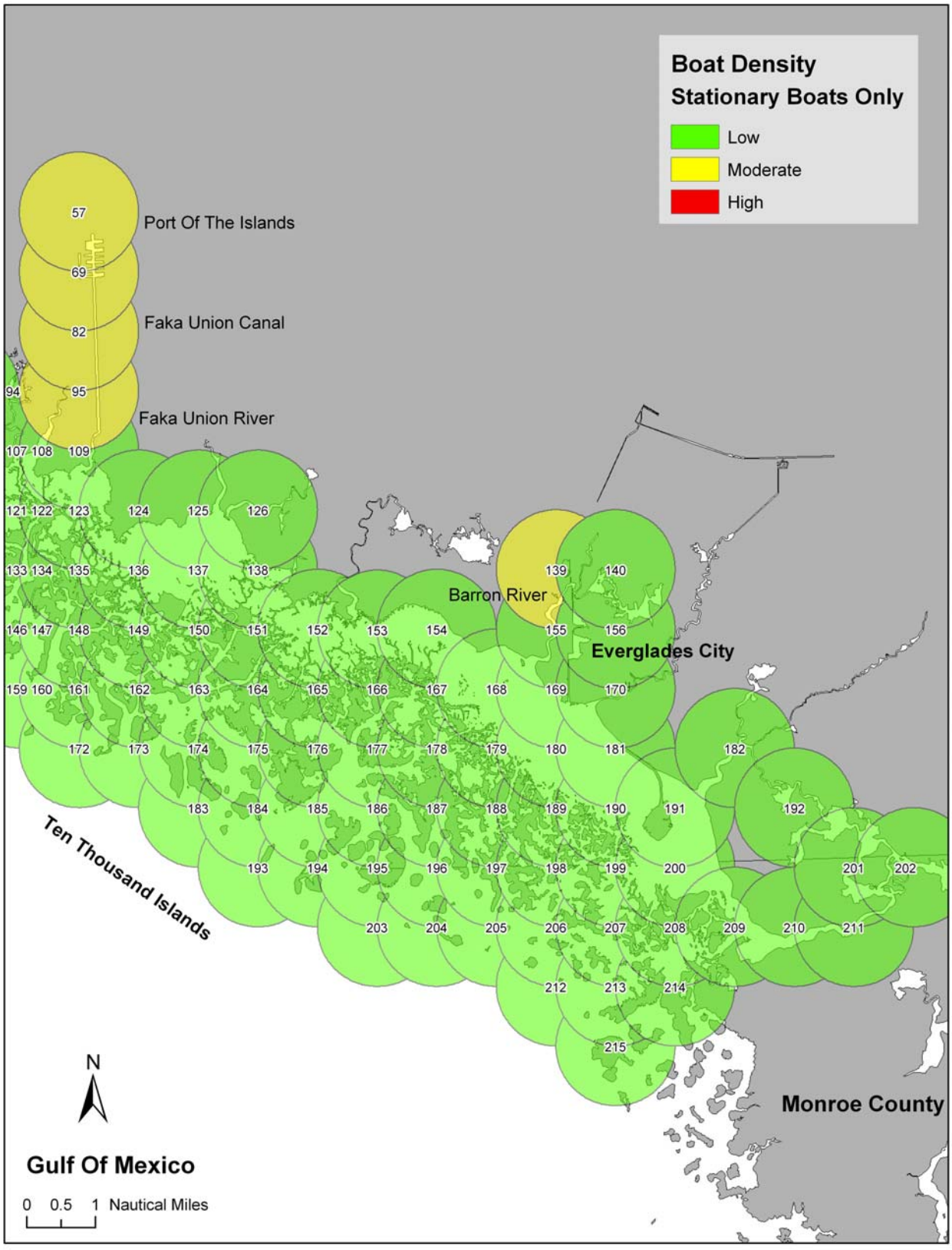


Figure 31. Distribution of high-speed (cruising / planing) and low-speed (idle / slow) boat traffic for all survey flights combined; Bonita Shores to Vanderbilt Shores.

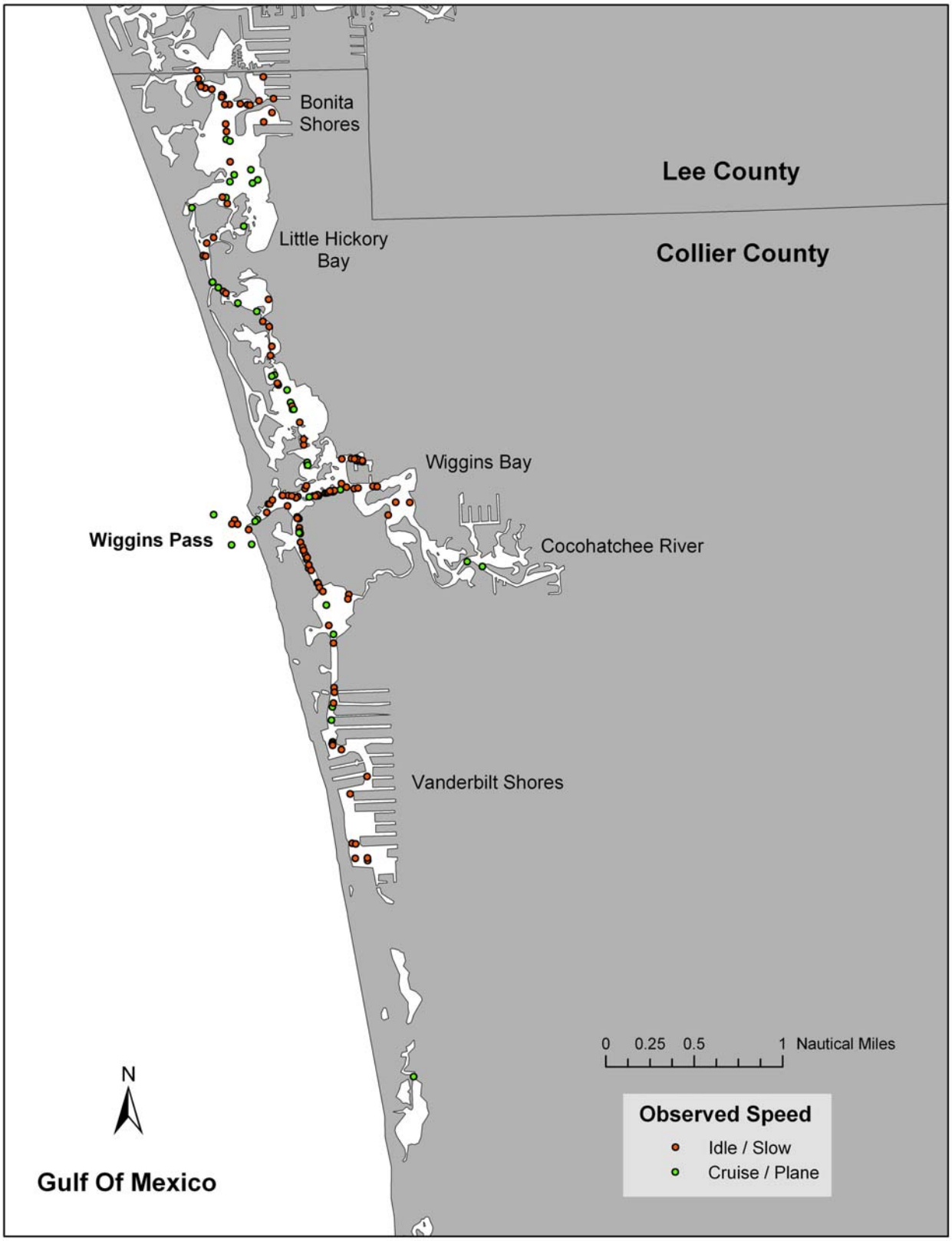


Figure 32. Designated manatee protection zones in Collier County (68C-22.023 FAC). Bonita Shores to Vanderbilt Shores. Source: Florida Fish and Wildlife Conservation Commission.

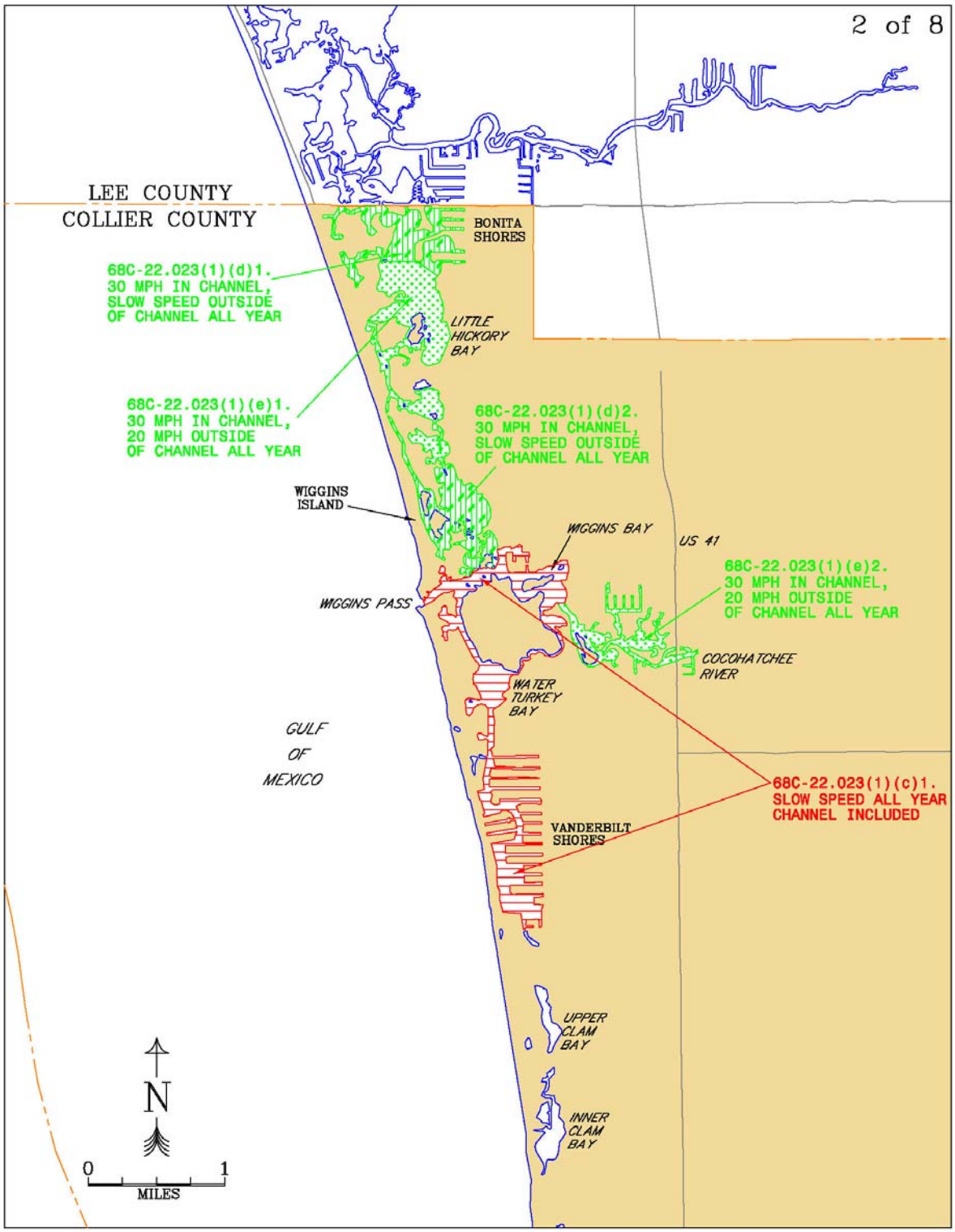


Figure 33. Distribution of high-speed (cruising / planing) and low-speed (idle / slow) boat traffic for all survey flights combined; Doctors Pass to Gordon Pass.

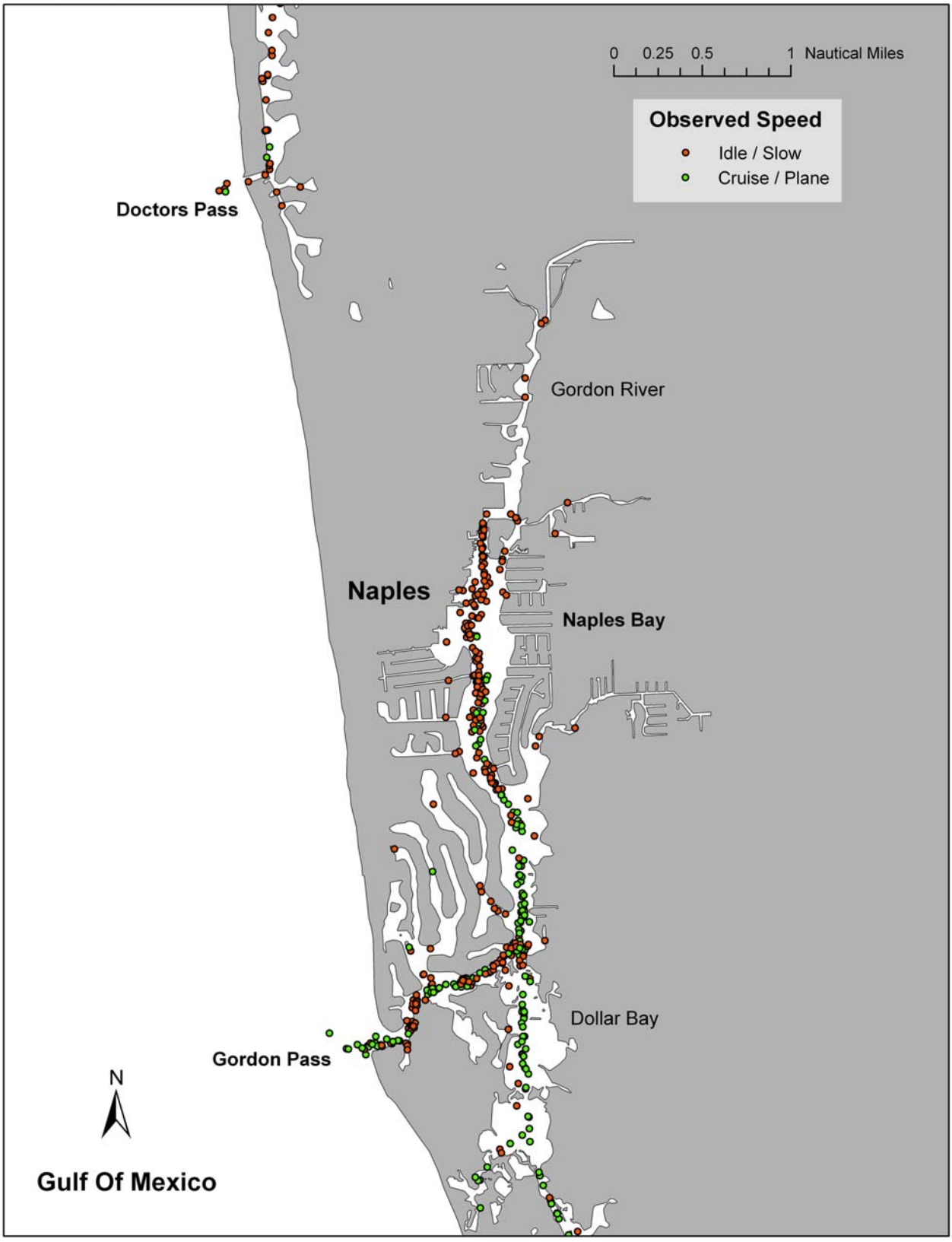


Figure 34. Designated manatee protection zones in Collier County (68C-22.023 FAC). Doctors Pass to Gordon Pass. Source: Florida Fish and Wildlife Conservation Commission.

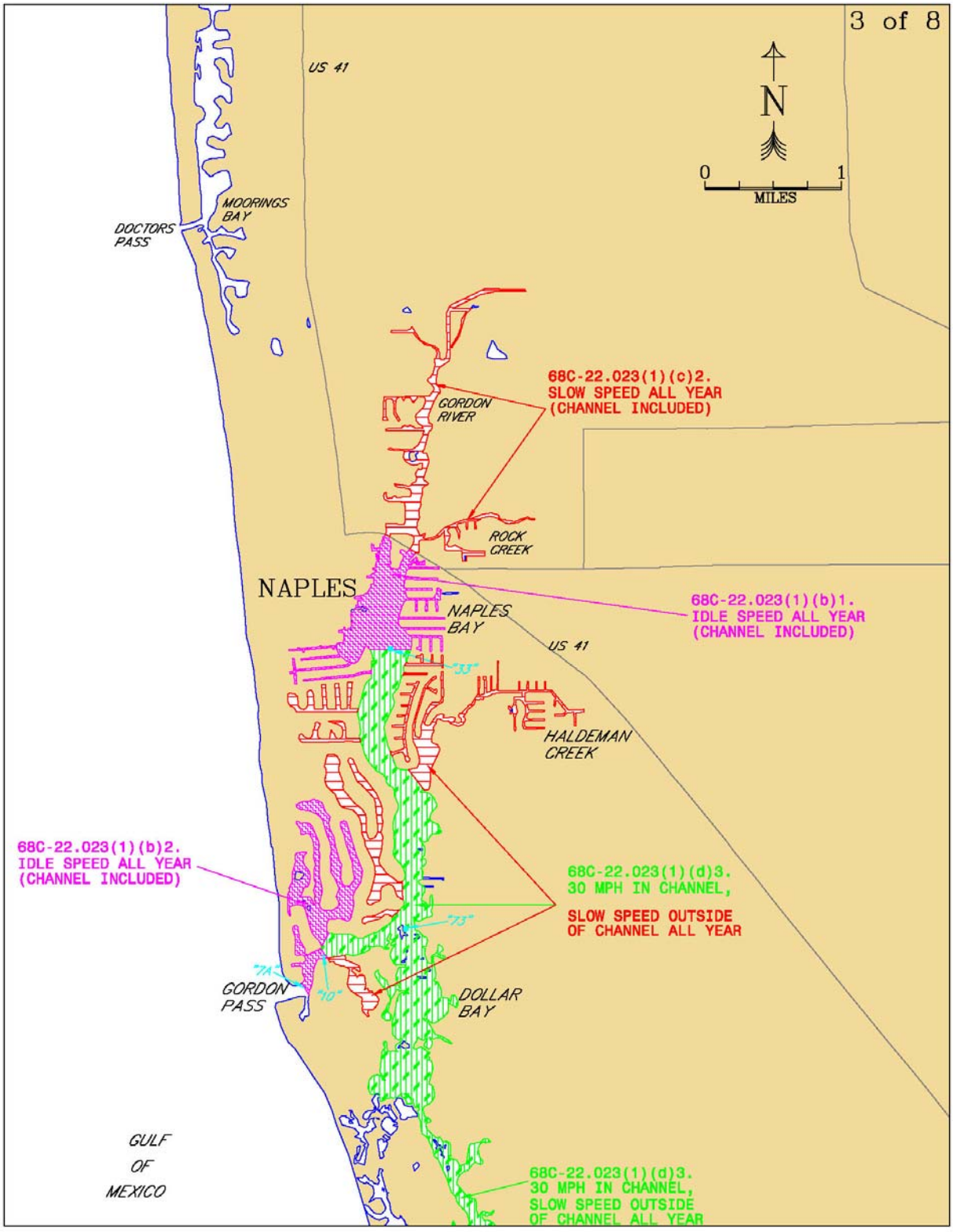


Figure 35. Distribution of high-speed (cruising / planing) and low-speed (idle / slow) boat traffic for all survey flights combined; Rookery Bay to Tarpon Bay.

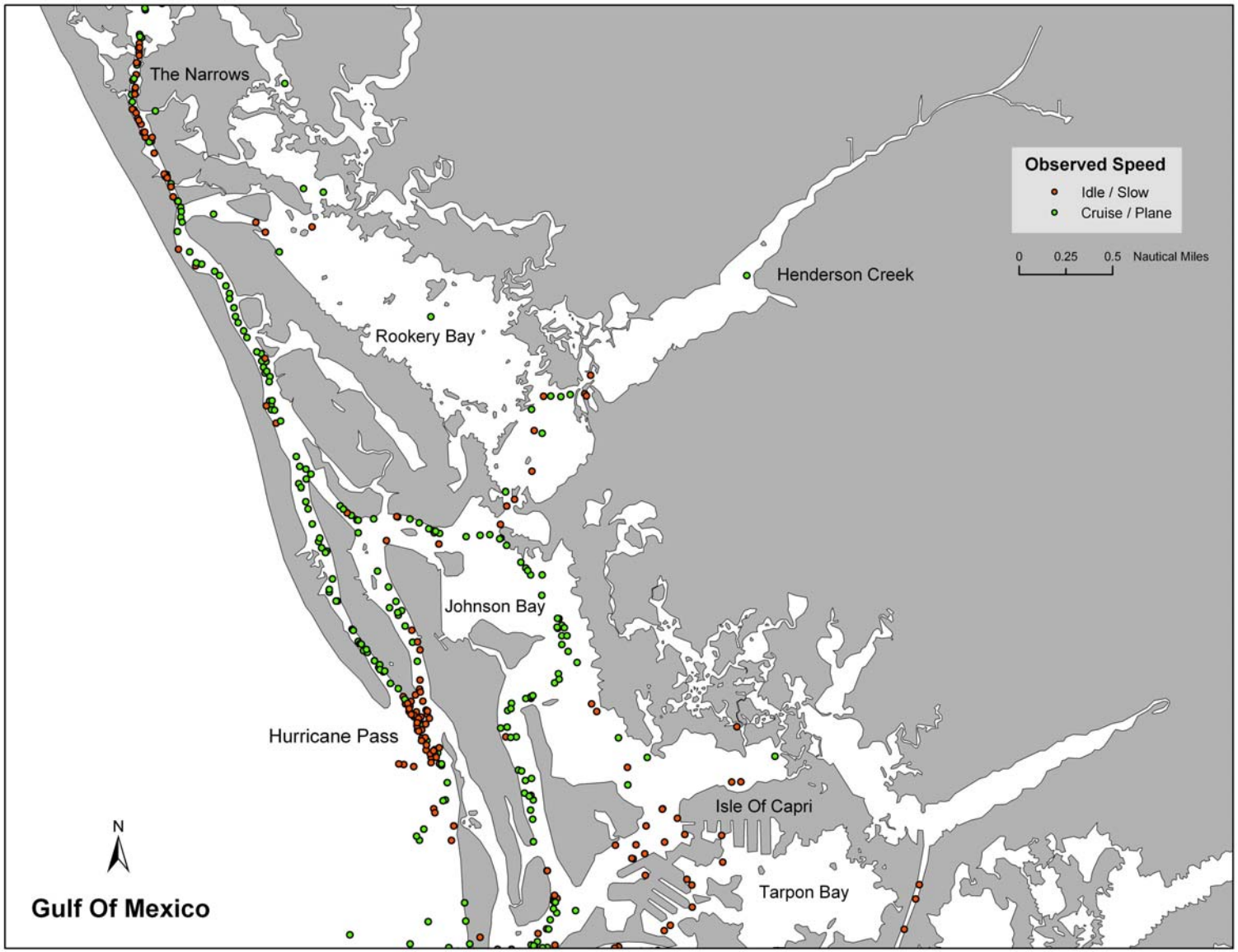


Figure 36. Designated manatee protection zones in Collier County (68C-22.023 FAC). Doctors Pass to Gordon Pass. Source: Florida Fish and Wildlife Conservation Commission.

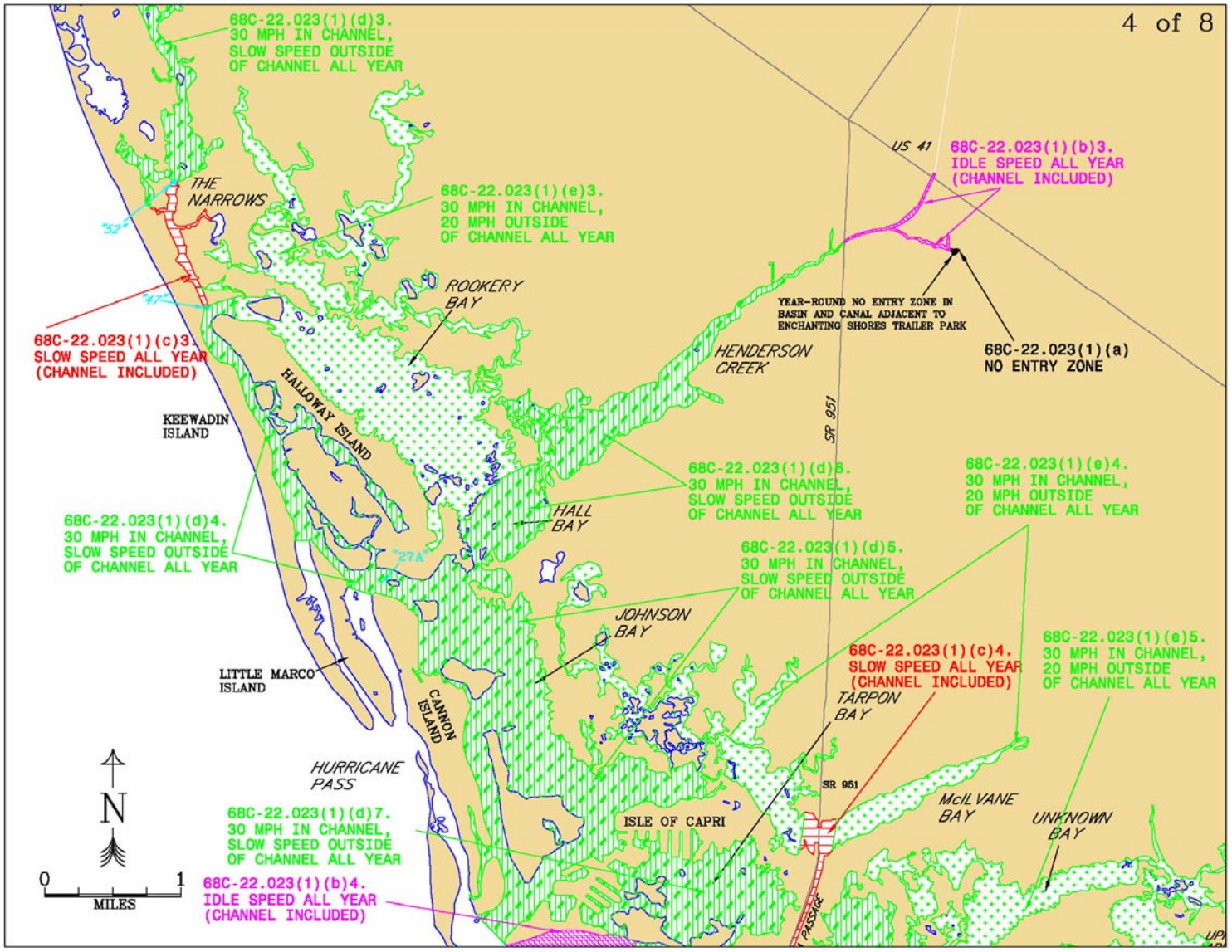


Figure 37. Distribution of high-speed (cruising / planing) and low-speed (idle / slow) boat traffic for all survey flights combined; Marco Island / Goodland.

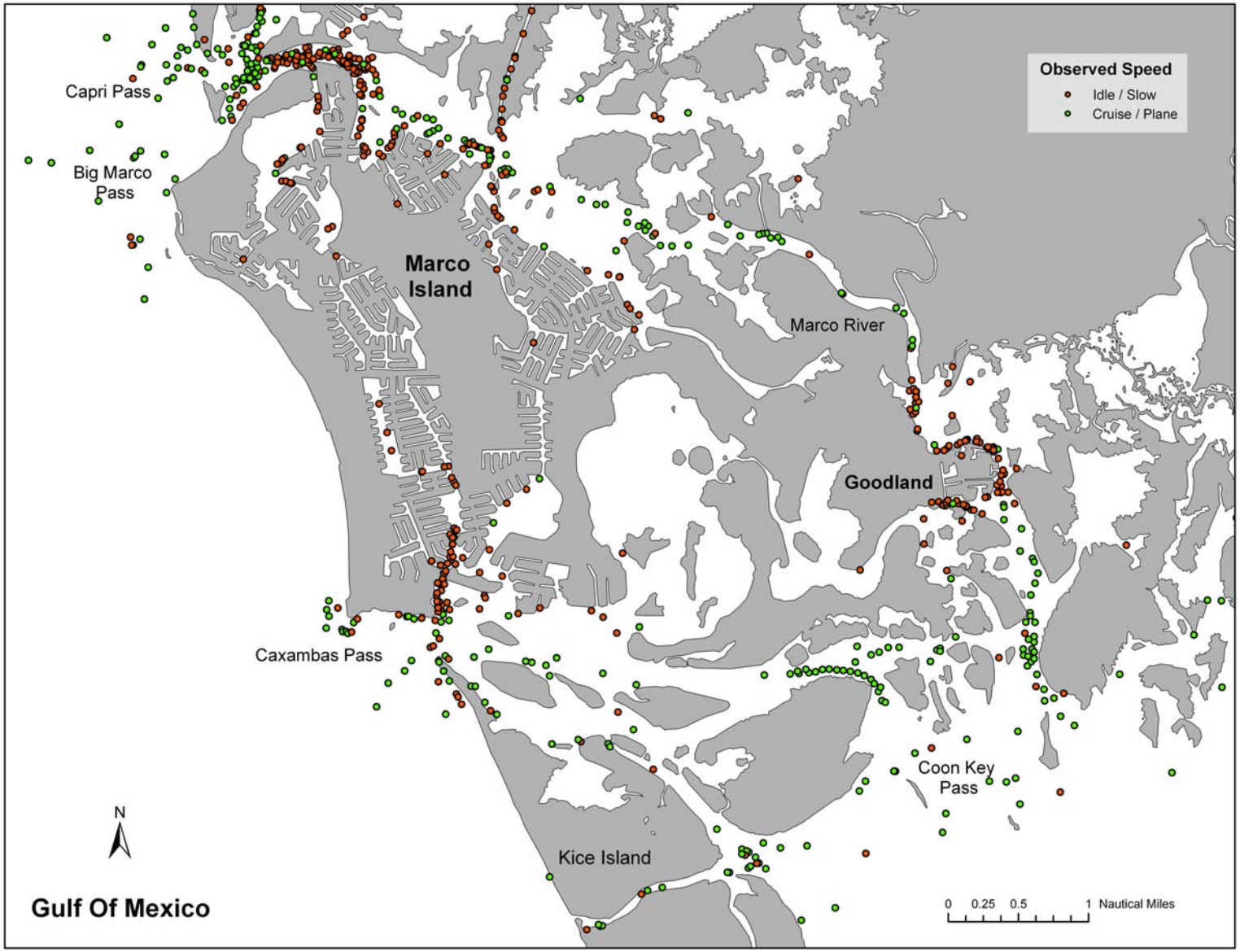


Figure 38. Designated manatee protection zones in Collier County (68C-22.023 FAC). Marco Island / Goodland. Source: Florida Fish and Wildlife Conservation Commission.

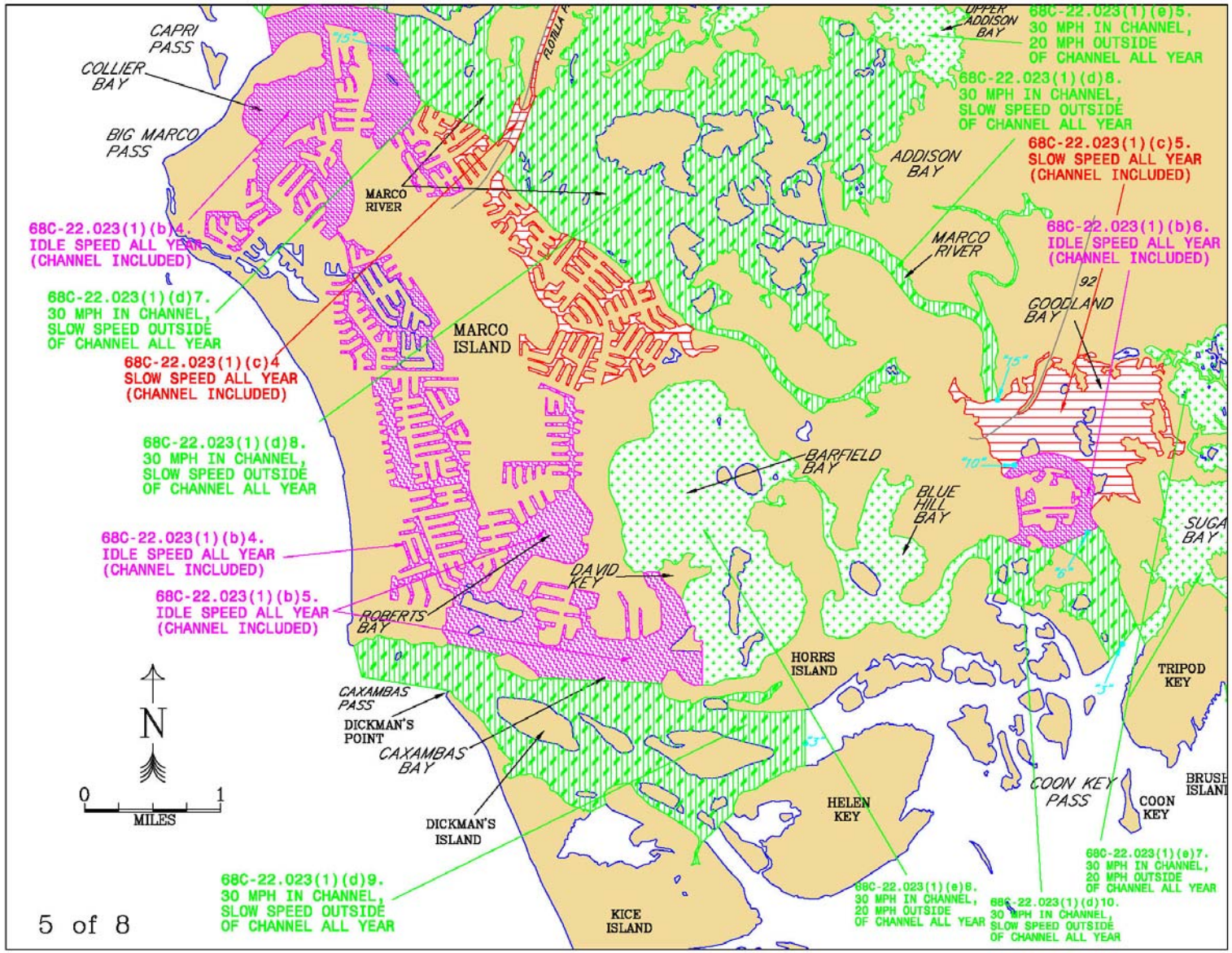


Figure 39. Distribution of high-speed (cruising / planing) and low-speed (idle / slow) boat traffic for all survey flights combined; Palm Bay to Panther Key.

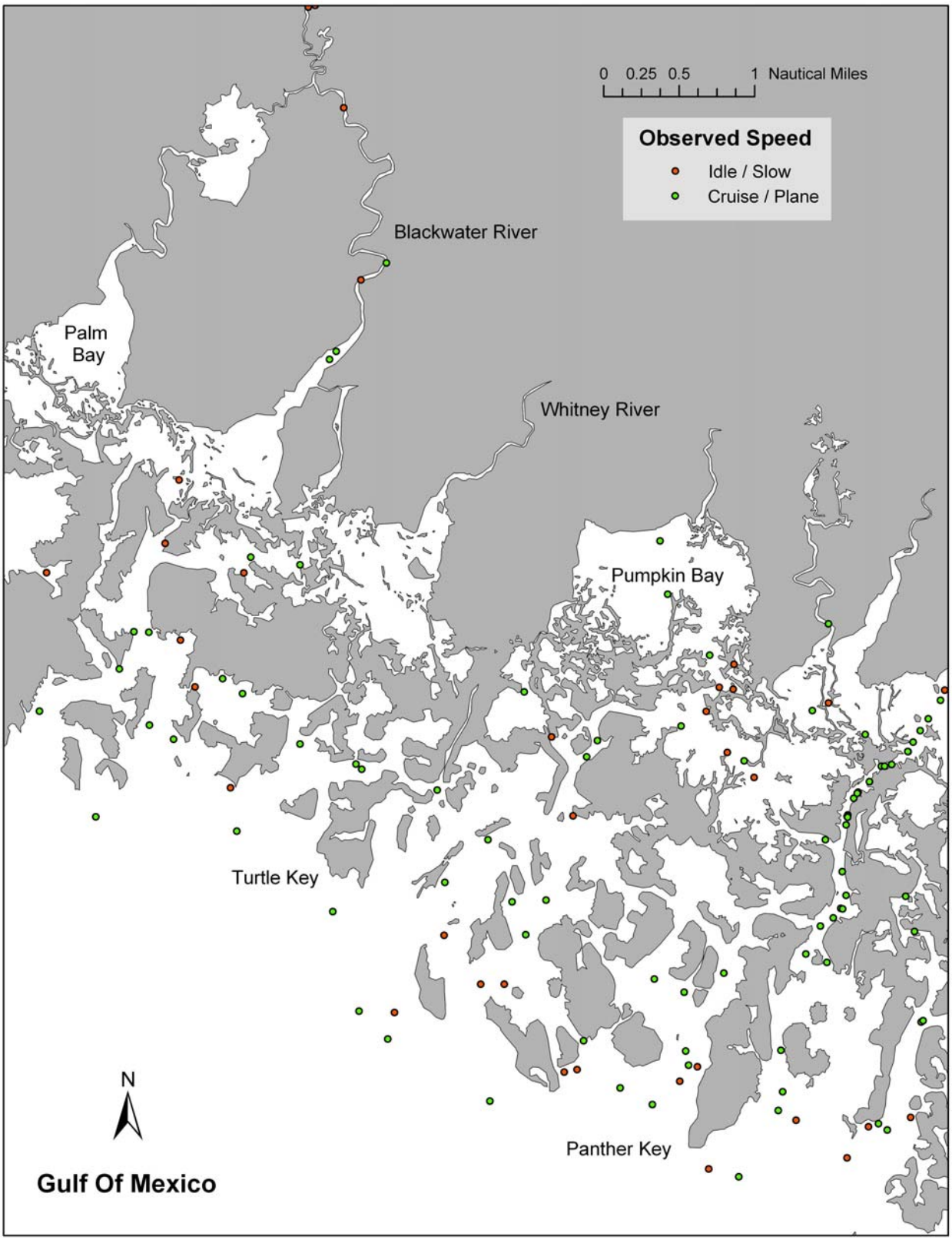


Figure 40. Designated manatee protection zones in Collier County (68C-22.023 FAC). Palm Bay to Panther Key. Source: Florida Fish and Wildlife Conservation Commission.

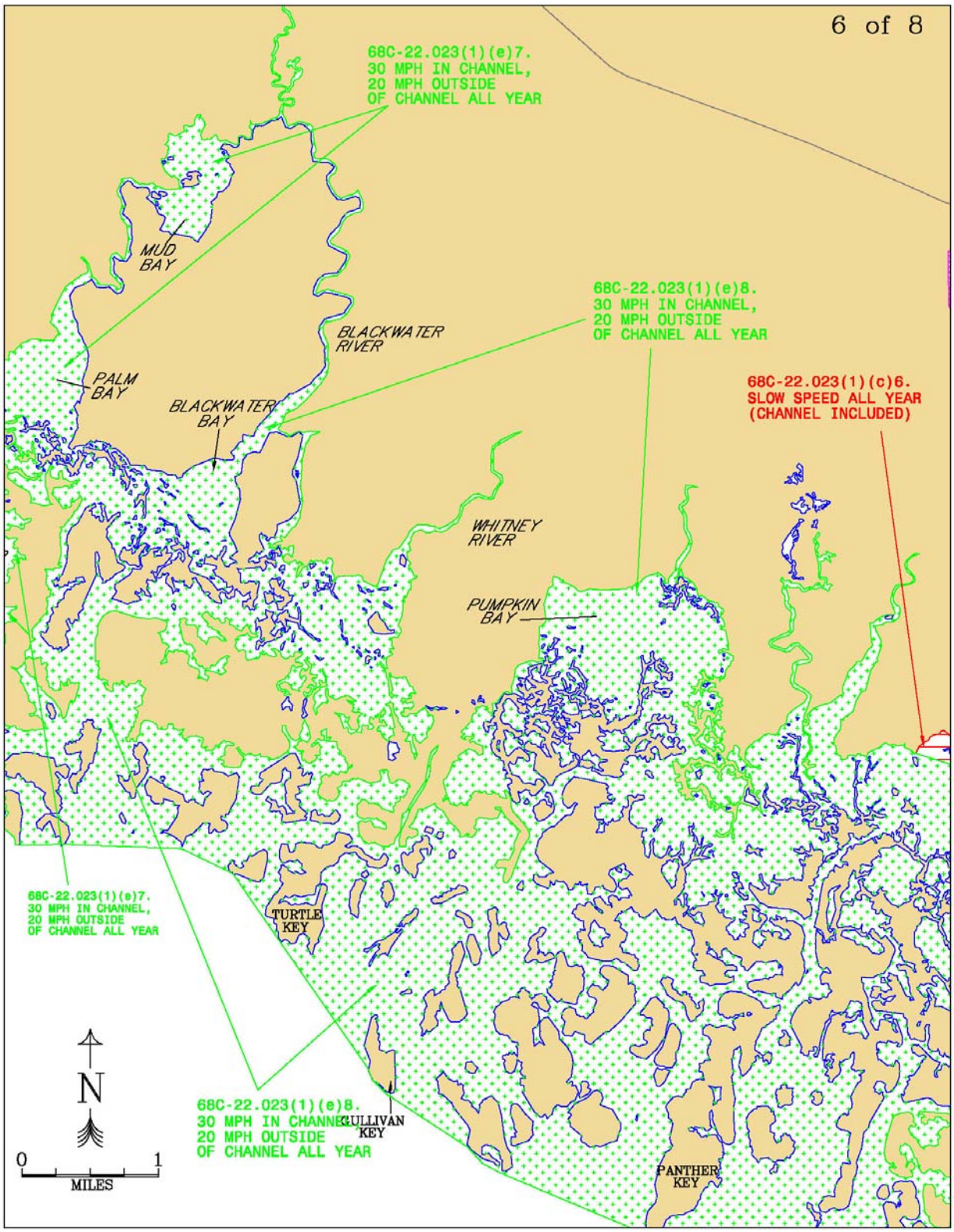


Figure 41. Distribution of high-speed (cruising / planing) and low-speed (idle / slow) boat traffic for all survey flights combined; Panther Key to Port Of The Islands.

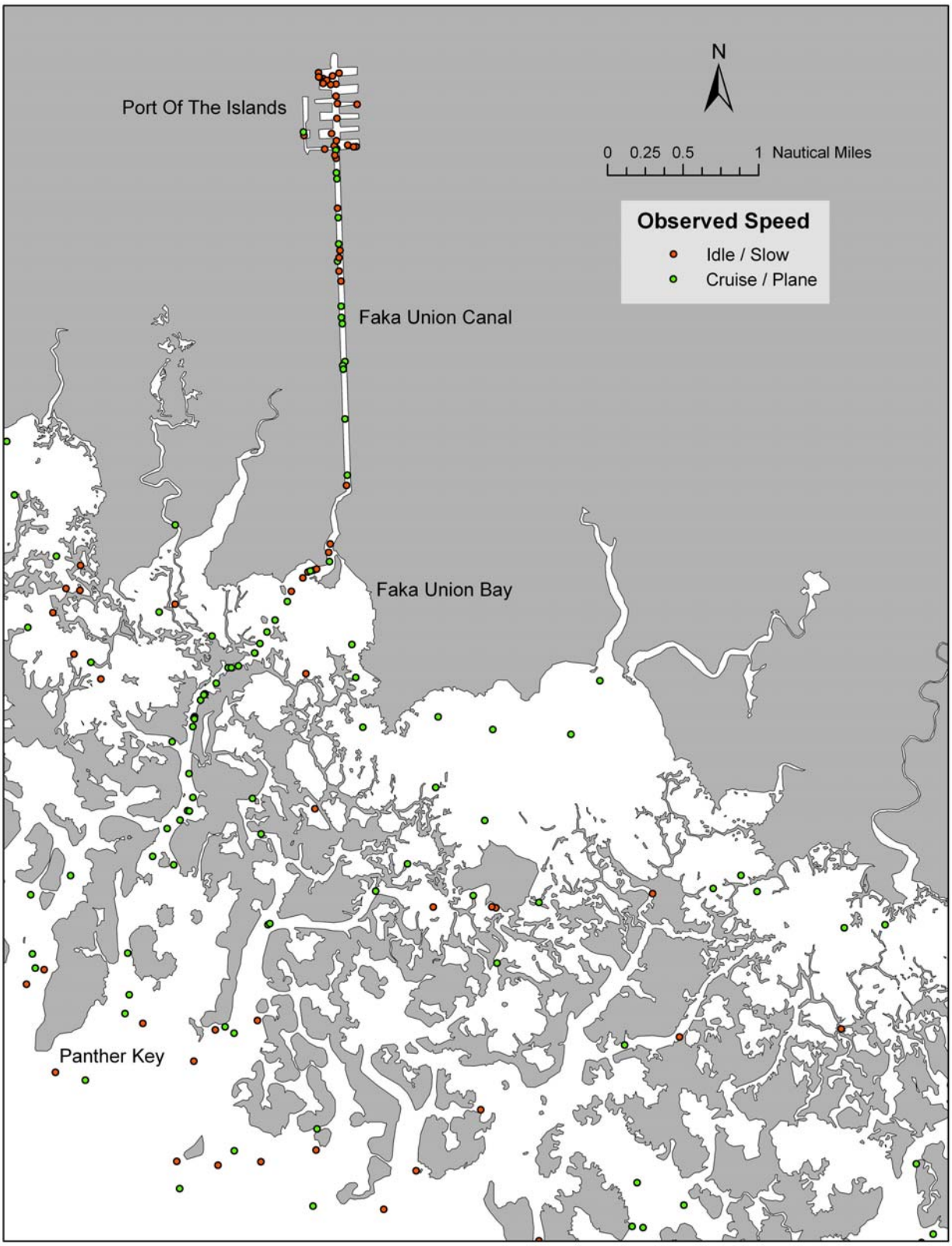


Figure 42. Designated manatee protection zones in Collier County (68C-22.023 FAC). Panther Key to Port Of The Islands.. Source: Florida Fish and Wildlife Conservation Commission.

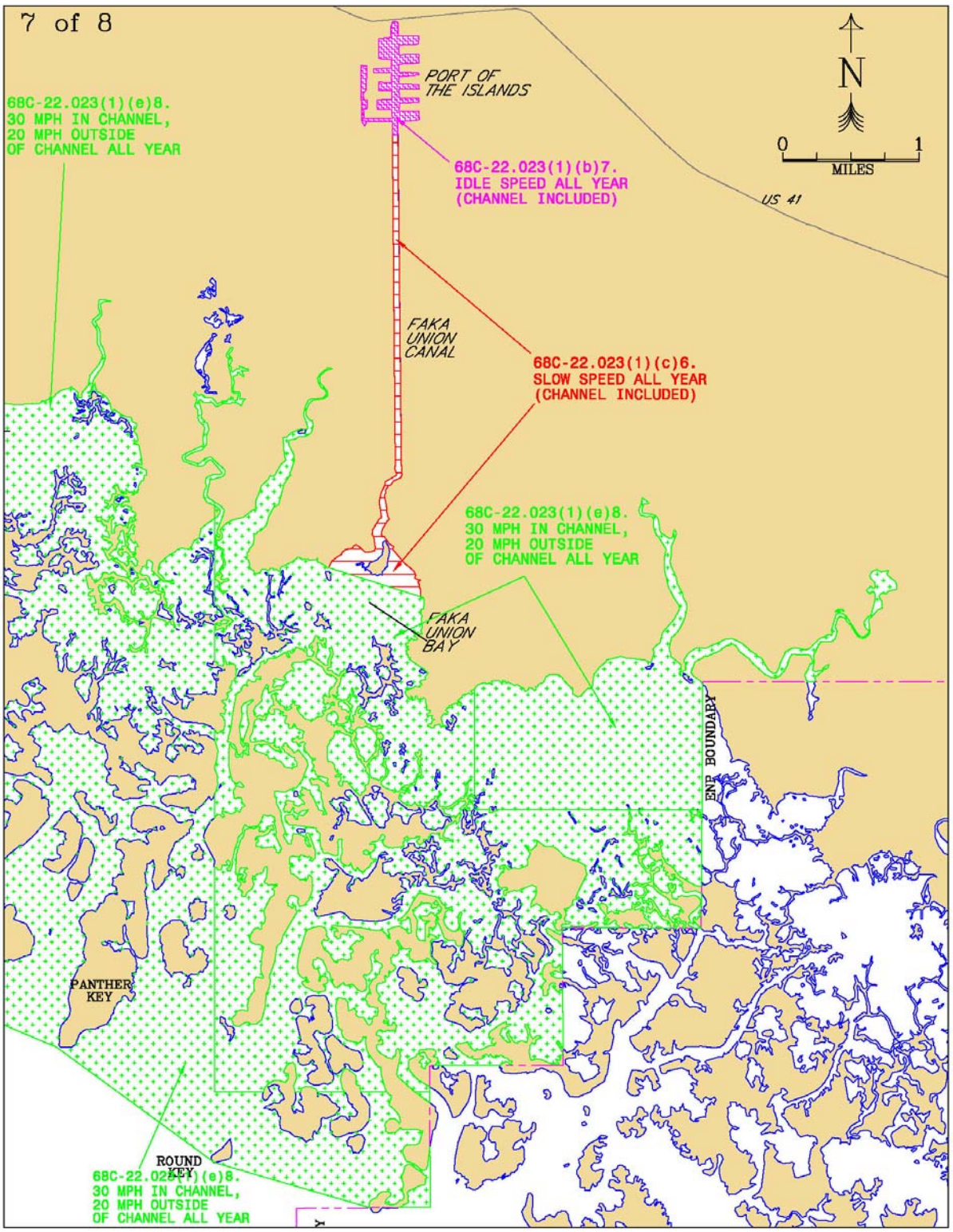


Figure 43. Distribution of high-speed (cruising / planing) and low-speed (idle / slow) boat traffic for all survey flights combined; Barron River / Chokoloskee Bay.

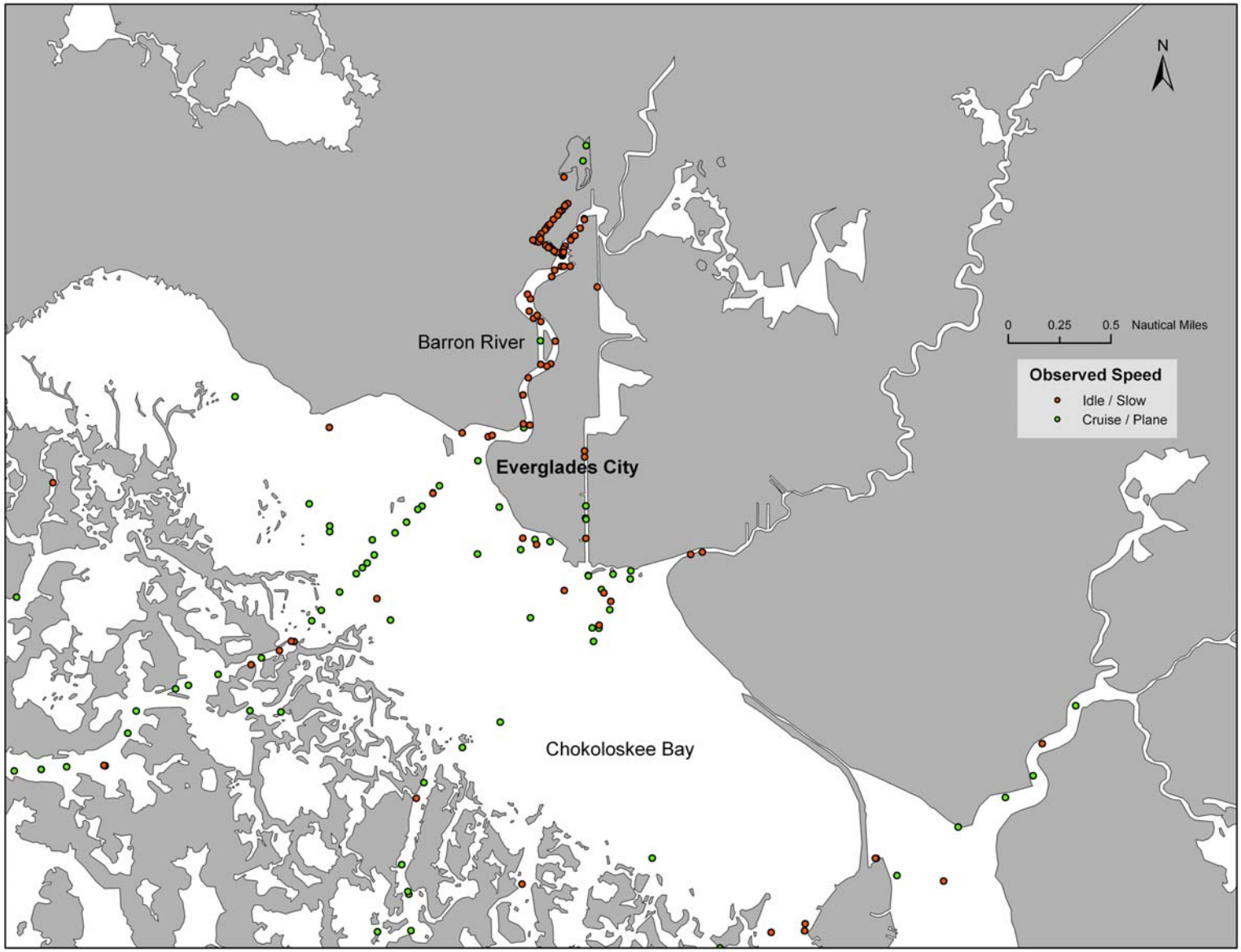
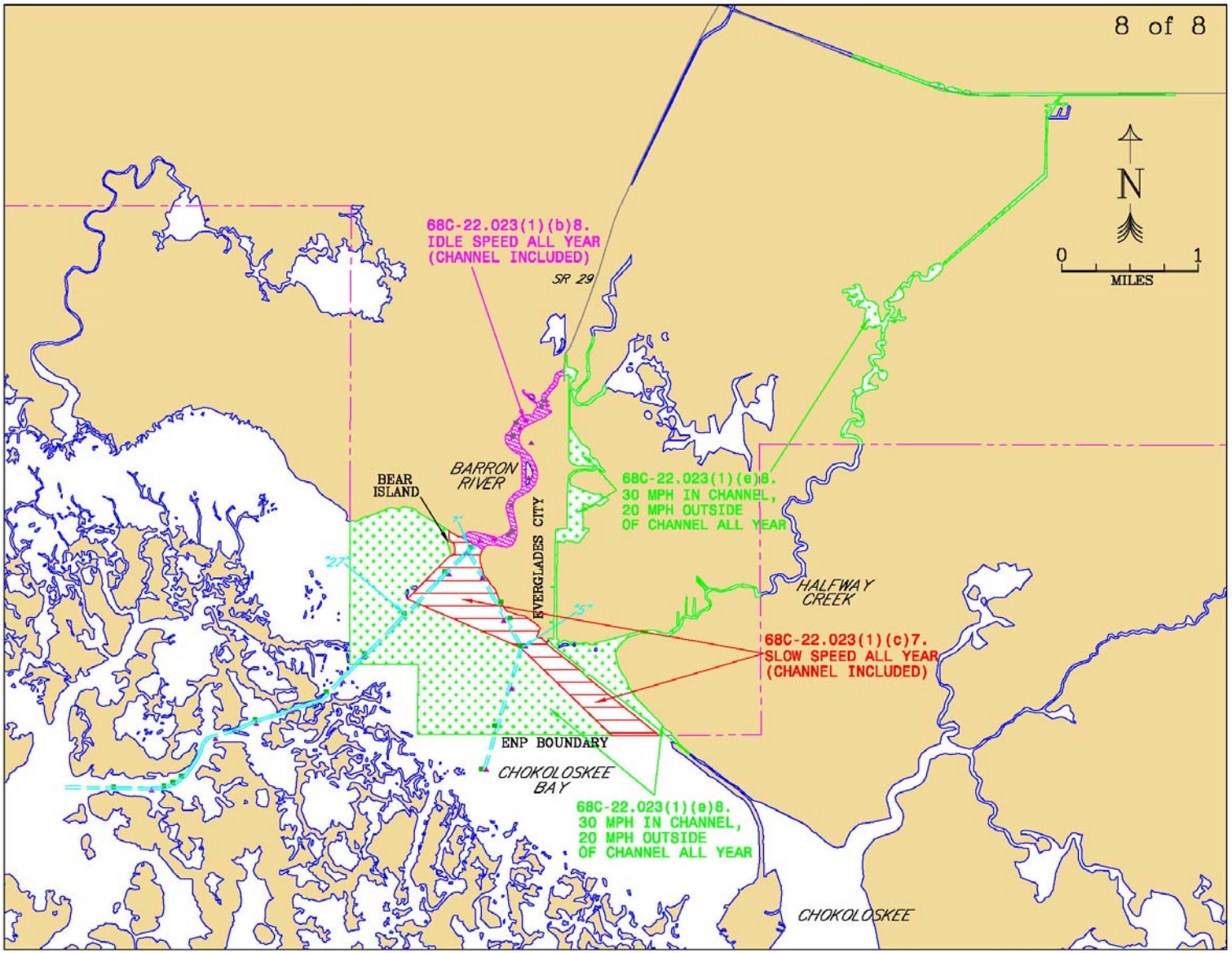


Figure 44. Designated manatee protection zones in Collier County (68C-22.023 FAC). Barron River / Chokoloskee Bay. Source: Florida Fish and Wildlife Conservation Commission.



Appendix A. Total water area and calculated boat densities for each survey area. Numbers in red correspond to calculated "high" boat density for that category.

Area	Identifiation	Total Water Area (km2)	Total Boats Density (km2)	Weekday Boats Density (km2)	Weekend Boats Density (km2)	Fast Boats Density (km2)	Stationary Boats Density (km2)
1	Little Hickory Bay	1.43938	2.953	2.518	3.387	0.868	0.695
2	Wiggins Island	1.21617	5.345	3.906	6.784	1.285	2.724
3	Wiggins Pass	1.86244	7.316	4.899	9.732	1.779	3.658
4	Cocohatchee River	1.06439	7.164	4.698	9.630	1.585	2.877
5	Water Turkey Bay	1.24726	6.865	4.710	9.020	2.055	2.305
6	Vanderbilt Shores	0.61940	3.128	3.229	3.027	1.110	0.202
7	Inner Clam Bay	0.28341	5.293	5.293	5.293	0.221	1.323
8	Clam Pass	0.57853	3.133	2.809	3.457	0.108	0.756
9	Outer Clam Bay	0.73690	1.951	1.187	2.714	0.254	0.339
10	Venetian Bay	0.79262	3.154	2.523	3.785	0.710	0.552
11	Doctors Pass	0.78313	3.751	3.352	4.150	0.878	0.798
12	Upper Gordon River	0.39099	2.238	2.238	2.238	0.320	0.639
13	Gordon River / Rock Creek	1.13498	7.544	7.269	7.820	1.046	1.542
14	Upper Naples Bay	2.06639	8.802	6.110	11.493	2.783	1.059
15	Lower Naples Bay	2.29358	7.575	3.869	11.281	3.815	0.736
16	Gordon Pass (inner)	2.54123	7.624	5.608	9.641	3.714	1.918
17	Gordon Pass (outer)	2.26414	6.625	5.355	7.895	2.733	2.374
18	Dollar Bay (north)	1.82659	6.946	5.680	8.212	3.285	2.600
19	Dollar Bay (south)	1.50912	2.816	2.236	3.396	1.739	1.118
20	The Narrows	1.11999	5.301	3.460	7.143	3.237	0.558
21	Periwinkle Bay	2.00108	3.623	2.561	4.685	1.968	0.781
22	Hill Bay	1.32983	0.423	0.564	0.282	0.094	0.329
23	First National Bay	2.72680	3.003	1.971	4.034	1.673	0.802
24	Rookery Bay	3.47316	0.432	0.288	0.576	0.090	0.270
25	Stopper Creek	1.74976	0.536	0.357	0.714	0.000	0.321
26	Upper Henderson Creek	0.95610	0.588	0.523	0.654	0.065	0.392
27	Keewadin Island	1.67419	2.837	2.315	3.360	1.717	0.859
28	Halloway Island	4.41061	1.375	1.190	1.559	0.709	0.482
29	Hall Bay	3.65291	0.975	0.958	0.992	0.188	0.513
30	Lower Henderson Creek	1.36662	0.869	0.732	1.006	0.137	0.366
31	Little Marco Island	3.22908	4.219	2.323	6.116	1.742	2.245
32	Hall Bay / Johnson Bay	3.55799	1.528	1.476	1.581	0.808	0.527
33	Hurricane Pass	2.96356	16.323	8.647	24.000	1.666	13.645
34	Johnson Bay	4.41335	10.465	5.948	14.983	0.963	8.653
35	Johnson Bay (south)	3.25301	1.268	0.999	1.537	0.192	0.480
36	Lower McIlvane Bay	2.05786	0.425	0.425	0.425	0.061	0.364
37	Upper McIlvane Bay	0.83697	0.075	0.000	0.149	0.000	0.000
38	Marco Island Airport	0.30393	0.000	0.000	0.000	0.000	0.000
39	Sea Oat Island	4.24954	10.751	6.471	15.031	1.015	8.972
40	Capri Pass	4.97290	5.266	4.550	5.982	1.835	1.621

Appendix A (Continued).

Area	Identification	Total Water Area (km2)	Total Boats Density (km2)	Weekday Boats Density (km2)	Weekend Boats Density (km2)	Fast Boats Density (km2)	Stationary Boats Density (km2)
41	Tarpon Bay	4.73588	3.431	2.824	4.038	0.765	0.950
42	Flotilla Passage	4.02017	0.840	0.808	0.871	0.093	0.544
43	Bear Point Cove	3.07321	0.732	0.691	0.773	0.000	0.671
44	Albert Island	2.56224	0.463	0.390	0.537	0.024	0.439
45	Upper Addison Bay	1.53526	0.326	0.326	0.326	0.041	0.326
46	Upper Blackwater River	0.13353	12.638	12.170	13.106	0.468	3.744
47	Outer Big Marco Pass (northwest)	4.52348	0.249	0.359	0.138	0.124	0.083
48	Big Marco Pass (northwest)	6.62447	1.878	1.623	2.132	0.632	1.113
49	Big Marco Pass (central)	5.02124	5.751	5.203	6.298	1.792	2.104
50	Marco Island (north)	4.52120	4.852	4.009	5.695	1.369	1.272
51	Marco Island / Flotilla Passage	5.25733	2.009	1.641	2.378	0.571	0.797
52	Charity Island / Addison Bay	4.70884	0.504	0.425	0.584	0.186	0.332
53	Addison Bay / Albert Island	4.19139	0.418	0.388	0.447	0.045	0.373
54	Addison Bay / Upper Addison Bay	2.42255	0.284	0.258	0.310	0.026	0.258
55	Mud Bay	0.97478	1.090	0.513	1.667	0.064	0.128
56	Blackwater River (mid upper)	0.13709	5.471	3.647	7.294	0.456	0.912
57	Port Of The Islands (upper)	0.26594	4.935	5.640	4.230	0.470	2.350
58	Outer Big Marco Pass (southwest)	4.11206	0.365	0.426	0.304	0.137	0.137
59	Big Marco Pass (southwest)	5.45296	1.032	1.100	0.963	0.195	0.699
60	Marco Island (northwest)	3.14776	1.886	1.787	1.986	0.218	1.211
61	Marco Island (central)	2.30017	2.527	2.282	2.772	0.734	0.489
62	Marco Island / Sanctuary Sound	3.79300	2.109	1.549	2.669	0.758	0.560
63	Charity Island / Sanctuary Sound	4.32083	0.839	0.376	1.302	0.333	0.231
64	Big Key / Big Marco River	3.09022	0.769	0.243	1.294	0.445	0.303
65	Turtle Island / Big Marco River	1.14178	1.150	0.766	1.533	0.766	0.438
66	Mud Bay / Palm Bay	1.22763	0.102	0.102	0.102	0.051	0.051
67	Mud Bay / Blackwater River	0.78529	0.875	0.318	1.433	0.239	0.080
68	Mid Lower Blackwater River	0.15880	3.149	0.787	5.510	0.394	0.394
69	Port Of The Islands (lower)	0.43553	6.888	7.749	6.027	1.722	2.727
70	Marco Island / Gulf	2.06581	0.575	0.847	0.303	0.121	0.151
71	Marco Island (northwest)	1.26648	0.691	1.382	0.000	0.049	0.099
72	Marco Island (central west)	1.15627	0.432	0.541	0.324	0.000	0.054
73	Marco Island (central east)	1.69781	0.552	0.589	0.515	0.294	0.037
74	Marco Island / Barfield Bay	3.55843	0.474	0.176	0.773	0.158	0.141
75	Georgia Fruit Farm Creek	2.19458	0.513	0.171	0.854	0.313	0.228
76	Big Marco River / Goodland Bay	1.73840	2.445	1.798	3.092	0.647	1.007
77	Goodland Bay	3.06904	2.220	1.833	2.607	0.367	0.998
78	Palm Bay / Lighter Bay	3.61693	0.276	0.138	0.415	0.017	0.259
79	Palm Bay / Southwest Gate	3.13245	0.299	0.080	0.519	0.020	0.259
80	Lower Blackwater River	1.12084	0.446	0.000	0.892	0.112	0.112
81	Blackwater River / Whitney River	0.35485	1.409	0.352	2.466	0.528	0.176

Appendix A (Continued).

Area	Identification	Total Water Area (km2)	Total Boats Density (km2)	Weekday Boats Density (km2)	Weekend Boats Density (km2)	Fast Boats Density (km2)	Stationary Boats Density (km2)
82	Upper Faka Union Canal	0.24142	9.320	7.249	11.391	5.437	1.812
83	Marco Island (southwest)	1.42199	2.154	2.110	2.198	0.132	0.527
84	Roberts Bay	2.94214	0.935	0.807	1.062	0.085	0.212
85	Barfield Bay	4.49685	0.111	0.056	0.167	0.014	0.069
86	Blue Hill Bay	3.67934	0.034	0.000	0.068	0.017	0.017
87	Goodland (west)	2.99180	2.173	1.755	2.590	0.292	0.815
88	Goodland (east)	4.47270	2.124	1.845	2.403	0.405	0.866
89	Sugar Bay	3.97383	0.802	0.629	0.975	0.126	0.488
90	Southwest Gate	3.86282	0.582	0.227	0.938	0.049	0.534
91	Gill Rattle Creek	3.72104	0.420	0.168	0.672	0.034	0.370
92	Whitney River	1.81779	0.378	0.275	0.481	0.000	0.378
93	Whitney River / Pumpkin Bay	1.47570	0.381	0.085	0.678	0.042	0.339
94	Pumpkin River / Pumpkin Bay	2.19653	0.256	0.114	0.398	0.057	0.199
95	Lower Faka Union Canal	0.37719	5.634	4.971	6.297	2.651	2.320
96	Caxambas Pass (outer north)	3.79224	3.115	2.835	3.395	0.659	1.632
97	Caxambas Pass (inner)	4.89024	2.582	2.122	3.042	0.460	1.380
98	Caxambas Bay	5.37964	0.407	0.349	0.465	0.093	0.244
99	Horrs Island	4.54420	0.358	0.468	0.248	0.206	0.165
100	Horrs Island / Blue Hill Creek	3.78653	1.089	1.320	0.858	0.561	0.462
101	Coon Key Pass / Neal Key	3.81021	2.116	2.001	2.231	0.705	1.001
102	Tripod Key	3.80333	1.232	1.085	1.380	0.542	0.641
103	Shell Key	3.72610	0.839	0.436	1.241	0.185	0.637
104	Buttonwood Bay	4.00549	0.343	0.187	0.499	0.078	0.265
105	Gator Bay	3.31475	0.264	0.226	0.302	0.019	0.264
106	Gator Bay / Pumpkin Bay	3.39777	0.607	0.331	0.883	0.110	0.515
107	Pumpkin Bay	4.69938	0.532	0.106	0.958	0.053	0.439
108	Wood River / Little Wood River	3.23764	0.347	0.116	0.579	0.077	0.193
109	Wood River / Faka Union River	2.44388	1.151	1.023	1.279	0.409	0.486
110	Caxambas Pass (outer south)	3.38830	2.822	2.435	3.210	0.664	1.918
111	Dickmans Island	4.89658	1.685	1.327	2.042	0.370	1.276
112	Fred Key	4.84078	0.542	0.516	0.568	0.168	0.362
113	Helen Key (inner)	3.16971	0.552	0.749	0.355	0.315	0.217
114	Ramsey Key	4.84501	0.838	1.058	0.619	0.490	0.335
115	Neal Key / Coon Key	6.33978	0.996	1.006	0.986	0.424	0.513
116	Coon Key / Brush Key	5.99829	0.802	0.646	0.959	0.292	0.448
117	Gullivan Bay	5.47861	0.559	0.319	0.799	0.125	0.388
118	Fish Hawk Creek / Gullivan Bay	4.50623	0.402	0.194	0.610	0.111	0.277
119	Fish Hawk Creek	4.73250	0.423	0.502	0.343	0.079	0.291
120	Dismal Key	4.29976	0.654	0.523	0.785	0.087	0.509
121	Santina Bay	4.59134	0.640	0.163	1.116	0.082	0.504
122	Faka Union River / Faka Union Bay	5.15584	0.570	0.339	0.800	0.279	0.255

Appendix A (Continued).

Area	Identification	Total Water Area (km2)	Total Boats Density (km2)	Weekday Boats Density (km2)	Weekend Boats Density (km2)	Fast Boats Density (km2)	Stationary Boats Density (km2)
123	Faka Union Bay	4.57484	0.642	0.437	0.847	0.383	0.191
124	Faka Union Bay / Fakahatchee Bay	3.62124	0.173	0.104	0.242	0.121	0.052
125	Fakahatchee Bay / Fakahatchee River	3.40574	0.202	0.110	0.294	0.055	0.092
126	Fakahatchee River / East River	1.77791	0.316	0.281	0.352	0.035	0.246
127	Kice Island	2.25958	1.577	1.272	1.881	0.526	1.383
128	Blind Pass	3.39602	0.736	0.663	0.810	0.423	0.276
129	Helen Key (outer)	6.67005	0.328	0.262	0.394	0.159	0.150
130	Coon Key	5.77377	0.303	0.368	0.238	0.119	0.162
131	Turtle Key	6.40596	0.605	0.527	0.683	0.098	0.429
132	Dismal Key Pass / Four Brothers Key	5.26959	0.522	0.498	0.546	0.107	0.320
133	Four Brothers Key	4.21449	0.519	0.415	0.623	0.074	0.460
134	Faka Union Bay / Fakahatchee Pass	4.08171	0.766	0.490	1.041	0.291	0.536
135	Fakahatchee Pass / Fakahatchee Bay	4.08216	0.551	0.306	0.796	0.230	0.352
136	Fakahatchee Bay / Fakahatchee Island	5.73558	0.458	0.283	0.632	0.098	0.305
137	Fakahatchee Bay	6.84510	0.201	0.164	0.237	0.055	0.146
138	Gate Bay	4.34609	0.129	0.144	0.115	0.043	0.101
139	Barron River (mid)	0.55610	4.608	3.821	5.395	1.236	1.798
140	Barron River (upper)	0.86400	0.868	0.434	1.302	0.362	0.434
141	Morgan Bay	1.59022	1.611	1.100	2.122	0.314	1.926
142	Morgan River	4.25694	0.969	0.852	1.086	0.382	0.529
143	Cape Romano Island	6.60312	0.379	0.379	0.379	0.095	0.265
144	Dismal Key Pass	6.60938	0.501	0.340	0.662	0.066	0.369
145	White Horse Key	5.82239	0.698	0.601	0.794	0.129	0.526
146	Panther Key / Fakahatchee Pass	4.74408	1.001	0.896	1.107	0.198	0.817
147	Fakahatchee Pass (mid)	4.63854	0.808	0.566	1.051	0.229	0.579
148	Fakahatchee Pass (inner)	3.95490	0.427	0.190	0.664	0.126	0.284
149	Fakahatchee Pass / Fakahatchee Island	4.59846	0.625	0.326	0.924	0.095	0.489
150	Fakahatchee Island	4.60434	0.502	0.271	0.733	0.054	0.421
151	Gate Bay / West Pass Bay	4.88823	0.230	0.153	0.307	0.038	0.205
152	West Pass Bay	5.25223	0.167	0.143	0.190	0.059	0.143
153	Ferguson River	4.71018	0.172	0.080	0.265	0.027	0.146
154	Lane Cover	4.04271	0.108	0.000	0.216	0.031	0.062
155	Barron River (lower)	1.27921	3.420	2.345	4.495	1.026	0.879
156	Everglades City	1.10143	0.965	0.794	1.135	0.057	0.454
157	Cape Romano (inner)	5.87349	1.202	1.043	1.362	0.223	1.043
158	Cape Romano Shoals	7.34864	0.570	0.561	0.578	0.060	0.476
159	Panther Key	6.61814	0.519	0.397	0.642	0.094	0.397
160	Fakahatchee Pass (outer)	6.40095	0.508	0.234	0.781	0.088	0.361
161	Fakahatchee Pass	5.18938	0.349	0.289	0.409	0.048	0.229
162	West Pass / Camp Lulu Key	4.61793	0.244	0.108	0.379	0.014	0.271
163	West Pass / Gaskin Bay	4.58721	0.300	0.136	0.463	0.027	0.259

Appendix A (Continued).

Area	Identification	Total Water Area (km2)	Total Boats Density (km2)	Weekday Boats Density (km2)	Weekend Boats Density (km2)	Fast Boats Density (km2)	Stationary Boats Density (km2)
164	Russell Key / West Pass Bay	3.63765	0.172	0.137	0.206	0.017	0.172
165	Russell Key	4.74135	0.264	0.290	0.237	0.026	0.290
166	Russell Pass / Indian Key Pass	4.76129	0.354	0.341	0.368	0.026	0.354
167	Russell Pass / Chokoloskee Bay	5.91288	0.338	0.233	0.444	0.159	0.116
168	Everglades City Airport / Bear Island	6.38010	0.519	0.313	0.725	0.333	0.069
169	Barron River / Everglades City	4.59929	1.060	0.870	1.250	0.489	0.136
170	Halfway Creek	1.42187	1.670	1.582	1.758	0.527	0.220
171	Cape Romano (outer)	4.01400	1.386	1.028	1.744	0.202	1.261
172	Round Key / Camp Lulu Key	3.96179	0.694	0.631	0.757	0.079	0.505
173	West Pass / Tiger Key	4.81740	0.441	0.337	0.545	0.026	0.363
174	Gaskin Bay	5.51877	0.385	0.181	0.589	0.079	0.272
175	Gaskin Bay / Russell Bay	4.14425	0.181	0.121	0.241	0.090	0.090
176	Russell Bay	4.11877	0.668	0.759	0.577	0.167	0.531
177	Russell Pass	4.63366	0.782	0.809	0.755	0.216	0.607
178	Indian Key Pass / Chokoloskee Bay	4.49944	0.500	0.500	0.500	0.181	0.236
179	Chokoloskee Bay / Everglades City	6.04463	0.424	0.372	0.476	0.227	0.114
180	Chokoloskee Bay / Halfway Creek	7.20460	0.356	0.347	0.364	0.174	0.052
181	Chokoloskee Bay (north)	4.95176	0.341	0.353	0.328	0.114	0.076
182	Turner River	0.63208	1.681	2.175	1.187	0.494	0.198
183	Tiger Key / Picnic Key	4.59502	0.462	0.326	0.598	0.082	0.313
184	Stop Keys / Indian Key	6.03065	0.622	0.643	0.601	0.155	0.352
185	Jenkins Key / Indian Key	5.70496	0.614	0.679	0.548	0.175	0.340
186	Jenkins Key / Indian Key Pass	4.67231	0.548	0.482	0.615	0.187	0.361
187	Indian Key Pass / Sandfly Pass	3.97840	0.346	0.314	0.377	0.063	0.220
188	Sandfly Pass (inner)	4.34538	0.417	0.403	0.431	0.115	0.230
189	Sandfly Pass / Chokoloskee Bay	5.60162	0.357	0.245	0.469	0.145	0.245
190	Chokoloskee Bay / Chokoloskee Island	6.37005	0.255	0.196	0.314	0.098	0.137
191	Chokoloskee Island	5.12004	0.305	0.391	0.220	0.110	0.073
192	Hurdles Creek	1.07862	0.116	0.000	0.232	0.000	0.058
193	Indian Key Pass	6.09087	0.626	0.657	0.595	0.123	0.400
194	Indian Key / Kingston Key	6.57493	0.551	0.570	0.532	0.095	0.390
195	Kingston Key / Comer Key	5.84316	0.203	0.150	0.257	0.021	0.214
196	Kingston Key / Sandfly Pass	5.41668	0.162	0.069	0.254	0.012	0.138
197	Sandfly Pass (outer)	5.28648	0.296	0.166	0.426	0.106	0.177
198	Sandfly Pass / Chokoloskee Pass	4.92595	0.431	0.279	0.584	0.140	0.406
199	Chokoloskee Pass / Chokoloskee Bay	5.92149	0.443	0.296	0.591	0.243	0.253
200	Chokoloskee Bay (south)	5.82318	0.279	0.172	0.386	0.182	0.086
201	Cross Bays	2.03271	0.307	0.307	0.307	0.092	0.215
202	Lopez River (upper)	1.78450	0.280	0.280	0.280	0.105	0.175
203	Comer Key	5.70046	0.351	0.373	0.329	0.033	0.208
204	Comer Key / Jewel Key	6.57832	0.409	0.361	0.456	0.048	0.228
205	Chokoloskee Pass (outer)	6.74474	0.287	0.185	0.389	0.083	0.185

Appendix A (Continued).

Area	Identification	Total Water Area (km2)	Total Boats Density (km2)	Weekday Boats Density (km2)	Weekend Boats Density (km2)	Fast Boats Density (km2)	Stationary Boats Density (km2)
208	Rabbit Key Pass (inner)	4.77861	0.484	0.262	0.706	0.157	0.249
209	Lopez River / Rabbit Key Pass	3.25820	0.403	0.230	0.575	0.019	0.269
210	Lopez River (lower)	1.51280	0.207	0.248	0.165	0.041	0.165
211	Lopez River (mid)	1.06477	0.528	0.587	0.470	0.117	0.411
212	Chokoloskee Pass / Rabbit Key Pass	6.68137	0.365	0.262	0.468	0.075	0.271
213	Rabbit Key Pass (outer)	5.97295	0.502	0.335	0.670	0.146	0.314
214	Rabbit Key Pass (mid)	3.41591	0.567	0.293	0.842	0.128	0.329
215	Lumber Key	3.67593	0.425	0.238	0.612	0.170	0.255