MIAMI-DADE MANATEE PROTECTION PLAN DATA AND INFORMATION COLLECTION
FINAL REPORT
July 2009

INTRODUCTION

Background

The Miami-Dade Manatee Protection Plan (MPP) was developed over a 6-year period with assistance of a citizen's advisory committee, and approved by the Miami-Dade County Board of County Commissioners (BCC) and the Florida Department of Environmental Protection (predecessor agency to the Florida Fish and Wildlife Conservation Commission) in 1995. This plan was developed in accordance with Attachment K of the Governor and Cabinet 1989 Policy Directive, Manatee Protection Plan Guidelines. The policy document, Attachment K, was subsequently incorporated into Florida Statutes by reference and establishes objectives and the foundation requirements for local MPPs. It states in part:

> *Area specific manatee protection plans need to be developed by all counties in which manatees regularly occur to ensure the long-range protection of the species and its habitat. The objectives of manatee protection plans are: to reduce the number of boat-related manatee mortalities; to achieve an optimal sustainable manatee population (the goal of the Marine Mammal Protection Act); to protect manatee habitat; to promote boating safety; and to increase public awareness of the need to protect manatees and their environment. The plans will address manatee-human interactions, land use (including boat facility siting), and the protection of suitable habitat (including water quality, thermal refugia, freshwater sources, and grass beds). The information needed to prepare manatee protection plans will include manatee studies, habitat assessments, and if available, boating studies to evaluate boater use patterns and activities. Boat facility siting elements are necessary components of area-specific manatee protection plans. Boat facility siting must address marinas with wet slips and dry storage, and boat ramps.*

In October 2007, the Miami-Dade BCC adopted Ordinance 07-144 establishing the Miami-Dade Manatee Protection Plan Review Committee "for the purpose of providing advisory recommendations to the Board of County Commissioners as to the need for amendments, revisions and additions to the Miami-Dade County Manatee Protection Plan (MPP), consistent with manatee protection regulations as may be proposed or adopted by the State of Florida". The ordinance also authorized funding for the Miami-Dade Department of Environmental Resources Management (DERM) "for the purpose of compiling such information and data as is necessary to update the MPP, including empirical data on manatee deaths and injuries, boating patterns, habitat values and other factors affecting manatees and their habitat, as well as to document significant changes in the trend of waterfront development in the County since the adoption of the MPP…". DERM has provided data and information as it became available at each of the regular meetings of the Committee, and has provided supplemental information, including scientific and technical reports, educational materials, statutes and regulations, and interagency correspondence since the Committee's first organizational meeting in December 2007. Materials and information provided to the committee are available on a Miami-Dade County web page.

Ordinance 07-144 requires DERM to provide the Committee with periodic reports on the data collection process (which have been regularly provided) and: *"Within 60 days of completion of the process of data collection, DERM shall submit to the Committee a final report documenting the same."* This document serves as the final DERM report as required by the Ordinance.

MPP Data Updates

The Florida Fish and Wildlife Conservation Commission (FWC) provides specific guidance to counties in the Florida Manatee Management Plan (2007) as to the objectives of MPP's, the type of information that is to be included in their development, and evaluation of the data. FWC has also provided Miami-Dade County with correspondence containing recommendations concerning priorities for updated information. Additionally, regulations, reports and scientific journal articles on manatee population biology and threats analysis, causes of manatee death and forensic methods, signage and enforcement have been made available to the Committee as background information.

The following types of data specific to Miami-Dade County waters have been compiled and provided to the Committee in tabular and mapped forms, with emphasis on comparison of data considered for the development of the 1995 MPP, to the more recent or current information:

- Manatee use patterns, including but not limited to relative density or use, cold-weather aggregation areas, feeding areas, travel corridors and seasonal patterns.
- Manatee causes of death over time, and spatial patterns.
- Seagrass distribution
- Inventory of marine facilities with operating permits (including residential and commercial marinas, dry storage facilities, boatyards, ship terminals, and other multifamily-docking facilities), and assessment of changes that have occurred between 1995 and 2008.
- Inventory of public ramps, and data on use of county-owned ramps and dry storage facilities.
- Boating activity study, identifying seasonal variations in boat patterns, major destinations, types of boats and rates of compliance.

DATA UPDATE

Manatee Use Patterns

Miami-Dade DERM, with assistance of the Miami-Dade Police Department and the Public Works Department, has conducted helicopter surveys of county nearshore tidal waters and tributaries in all seasons, beginning in 1989 and continuing to the present. The purpose of these surveys is to determine manatee distribution and habitat use patterns. Miami-Dade participates in winter-time state-wide synoptic surveys, as directed by the FWC. Transects over deeper offshore waters of south Biscayne Bay were randomly surveyed during the initial phases of the study, but no manatees were observed, and the open water transects were discontinued. Two or more observers in the survey aircraft record location of manatees, number of individual adults and calves, and behavior (eg. resting, feeding, mating, nursing, traveling) using protocols consistent with FWC guidelines. The data is maintained in a Geographic Information System (GIS) to facilitate mapping and spatial analysis.

Manatee aerial survey results vary greatly by season, from year to year, and by preceding weather conditions. However, composited data collected repeatedly over a long period provides information on

preferred habitats (those used most frequently and by the greatest number of individuals), sites where larger numbers of animals aggregate in winter, and locations where sensitive behaviors occur repeatedly.

In addition to aerial survey data, some data from tracking of individual manatees tagged with satellite telemetry devices is also available from federal agency scientists. This information also contributes to understanding of distribution or preferred sites, and provides insight concerning travel patterns.

General Distribution

The results demonstrate that manatees may occur in almost any accessible water body, but are sighted most consistently in tributaries and in adjoining shallow vegetated areas of north Biscayne Bay and the western shoreline of south Biscayne Bay (Figure 1). Manatees are sighted on the majority of all surveys in canals and rivers, with highest frequencies in the Miami River and its tributaries and Little River, where manatees were observed in 97% and 72% of surveys respectively (Figure 2).

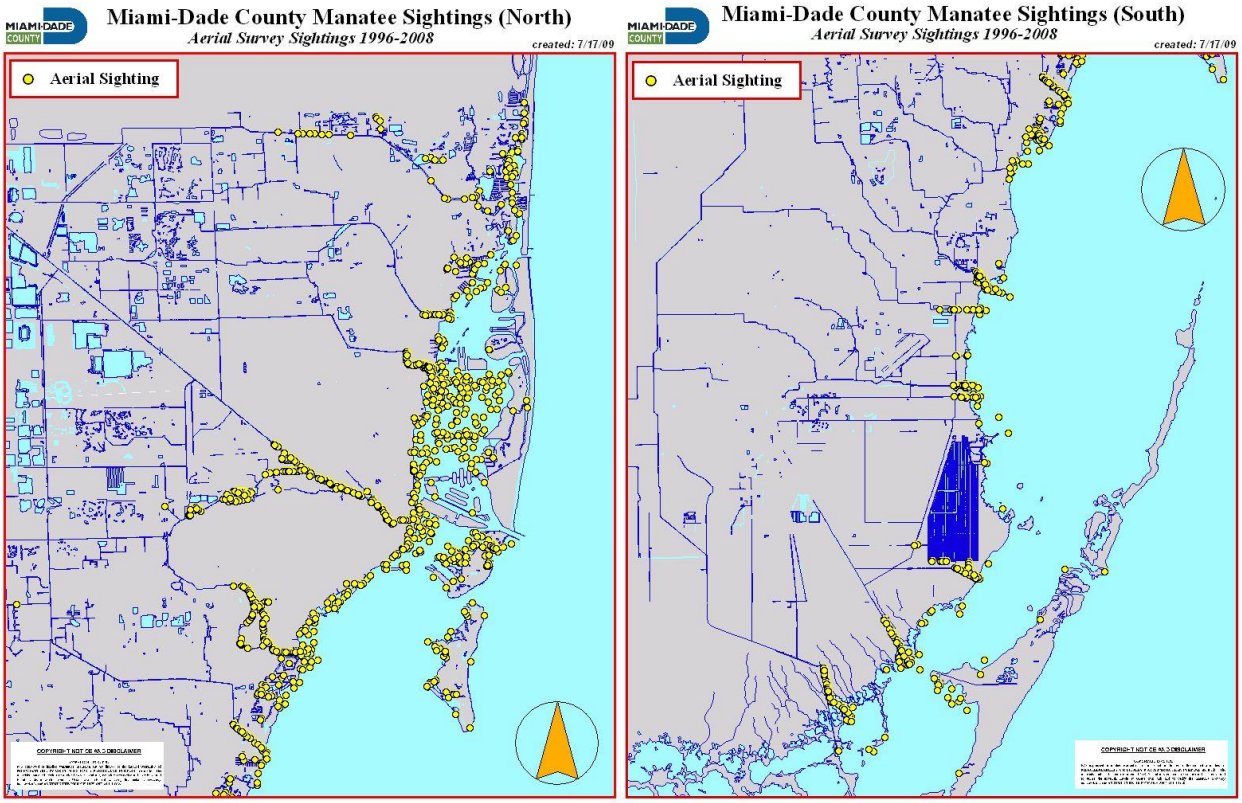


Figure 1. Composite manatee aerial survey data, showing locations of manatee sightings in all seasons.

Manatees occur year around, but are most abundant from November through April, with highest counts occurring in January or February during the coldest winters, when as many as 169 were recorded on a single day in 2003. In summer, manatees disperse throughout their range along the Atlantic coast, with

typical counts in Miami-Dade averaging 20 (Figure 3). The overall spatial distribution of the animals has not changed since the 1995 MPP was approved. Counts per survey are not a reliable census. Counts vary widely depending on weather conditions, water clarity, time of day, flight route, and other factors, as well as on number of animals actually present. However, during the period since the 1995 MPP was approved, maximum (winter season) annual counts vary widely but have not shown an increasing trend over time. Minimum (warmer seasons) counts have shown a small increase over time.

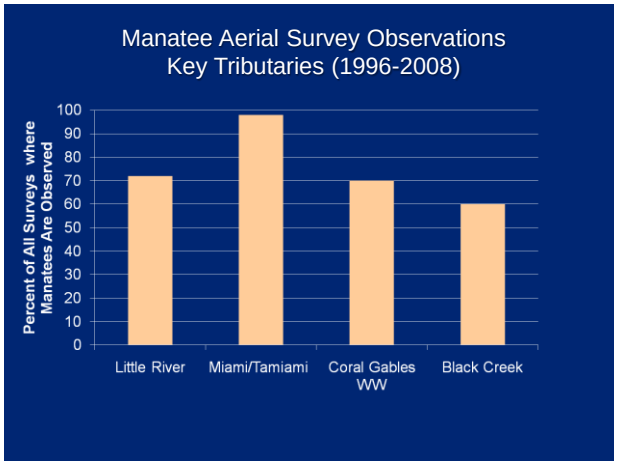


Figure 2. Frequency of manatee observation in key tributaries.

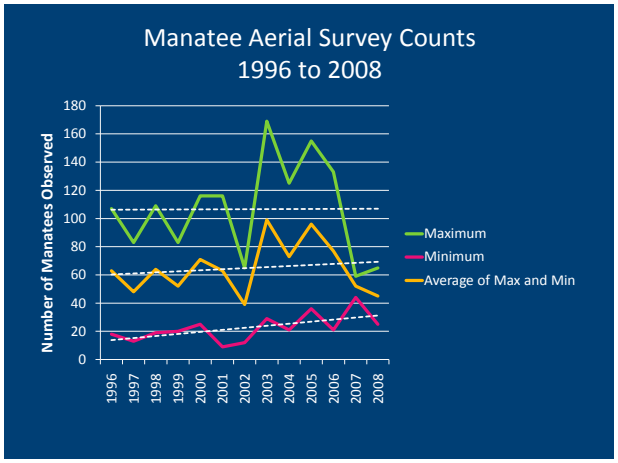


Figure 3. Seasonal differences in manatee abundance.

Aggregation

During the coldest periods, manatees aggregate in larger numbers in rivers and canals, where water temperatures remain a few degrees warmer due to seepage of ground water. They are recorded throughout the tributaries, traveling to and from resting areas, with highest winter counts in upstream reaches or basins. Highest counts have been recorded in the Coral Gables Waterway, Miami River, and Little River, with smaller aggregations noted in Black Creek and Biscayne Canals (Figure 4 and 5). An increasing number of manatees aggregate near the southern extent of the cooling canal system at FPL's Turkey Point facility in south Biscayne Bay. Manatees continue to aggregate in shallow seagrass beds west of Virginia Key.

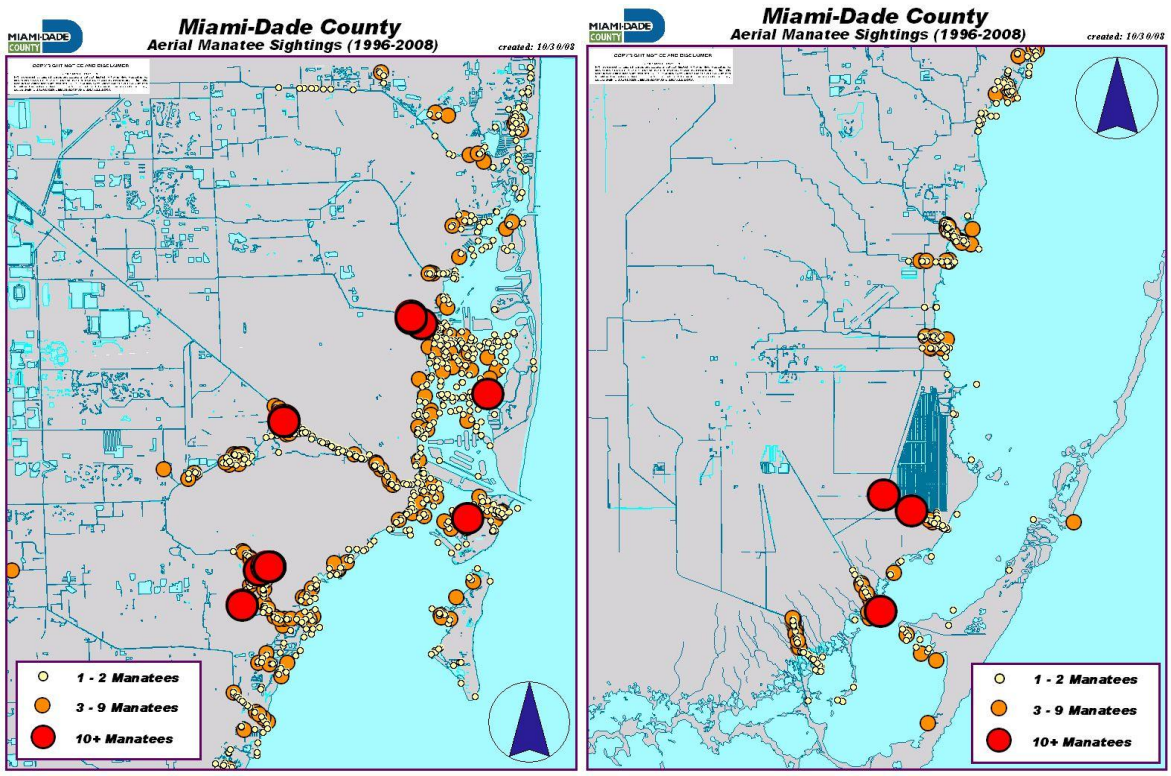


Figure 4. Composite manatee aerial survey data documenting locations of major aggregation sites (where 10 or more individuals have been sighted on a single occasion).

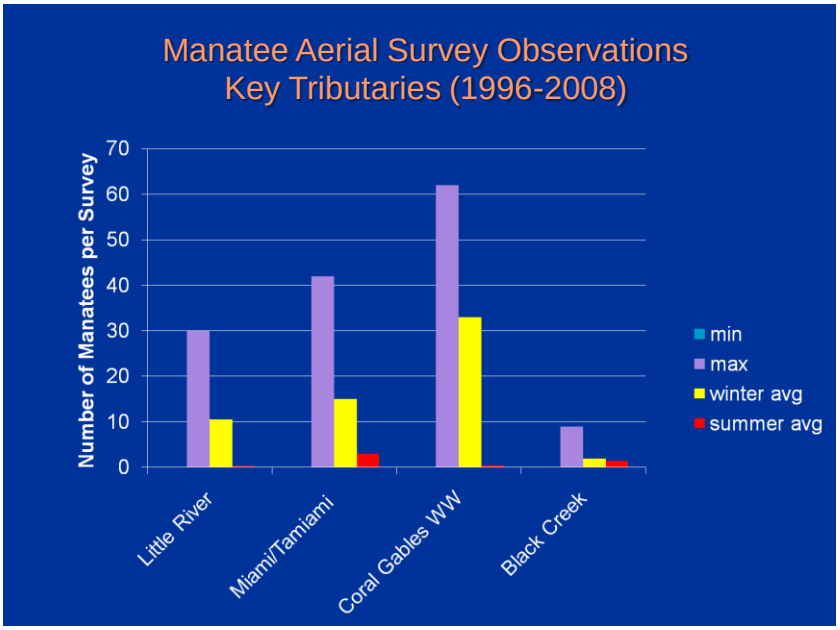


Figure 5. Numbers of manatees observed in key tributaries during aerial surveys.

Feeding Locations

Manatees feed consistently in seagrass beds in Dumfoundling Bay, north Biscayne Bay (especially in the basin north of Julia Tuttle Causeway, near the Miami River and west of Virginia Key, near the mouth of Coral Gables Waterway, and nearshore waters of Black Point (Figure 6). There has been no change in this pattern from 1995 to present.

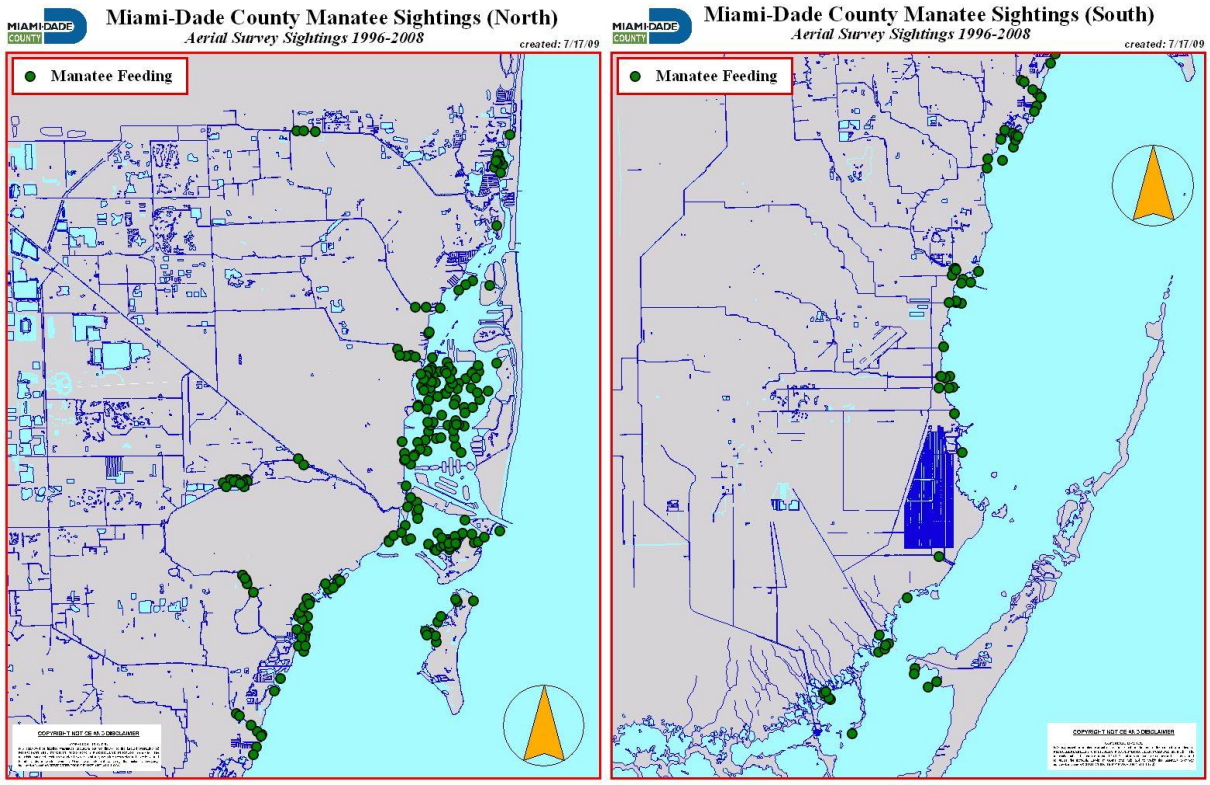


Figure 6. Composite manatee aerial survey data showing locations of documented manatee feeding sites.

Nursing, Calves, and Mating

Cow-calf pairs are commonly observed in the same frequently used habitats described above: tributaries, north Biscayne Bay seagrass beds, and seagrass near canal mouths (Figure 7). Sensitive behavior, such as nursing of calves or mating, has been recorded in areas less likely to be disturbed by human activity, such as protected basins, and remote canals and grass beds.

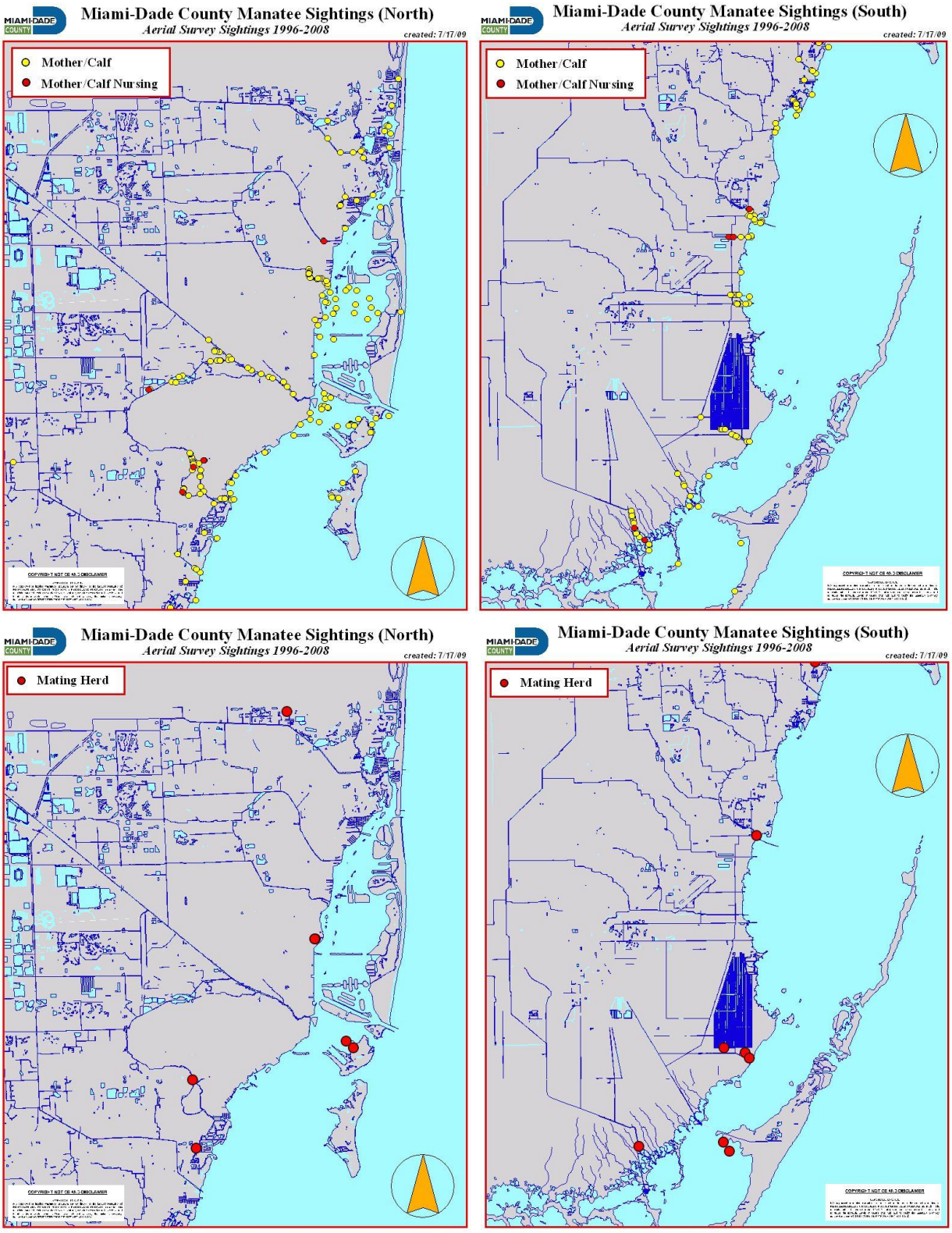


Figure 7. Composite manatee aerial survey showing documented locations of sensitive behaviors, such as cow-calf pairs, nursing calves, and mating herds.

Manatee Travel

Manatee travel patterns include seasonal and daily movements. Manatees migrate south to Miami-Dade in the fall and winter, primarily through the Intracoastal Waterway or along the western shoreline, and disperse by the same route in spring and summer. Manatees also travel in other major navigation channels and small channels leading to marina basins or some tributaries. Manatees are consistently observed moving upstream or downstream in tributaries (Figure 8).

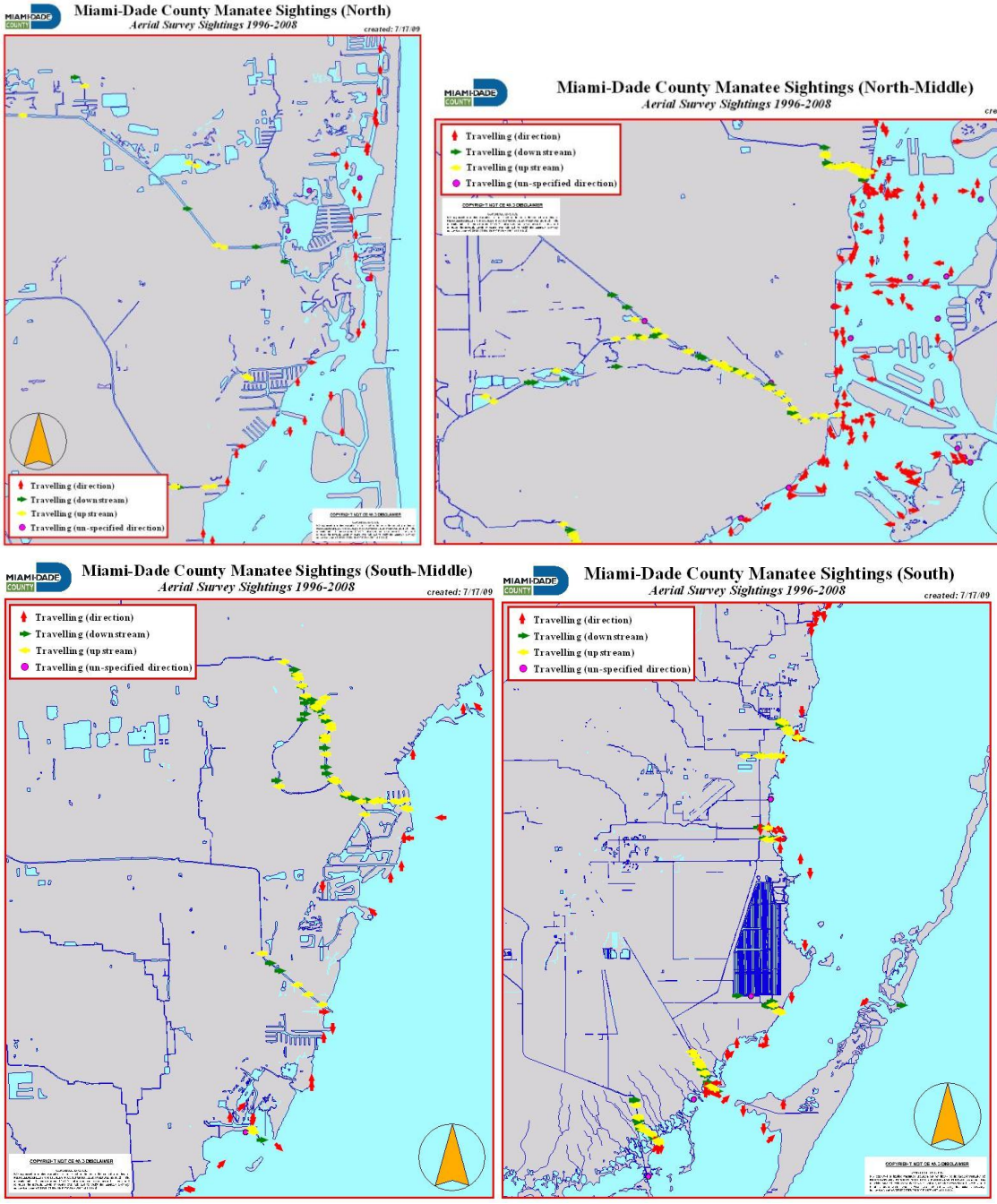


Figure 8. Composite manatee aerial survey data showing manatee travelling direction.

Tracking of tagged or scarred manatees has documented that manatees move into and among tributaries, for resting and freshwater, and move to nearby seagrass beds to feed (Figure 9). These travel patterns involve crossing or overlap with major navigation channels, including the Intracoastal Waterway and federal channels.

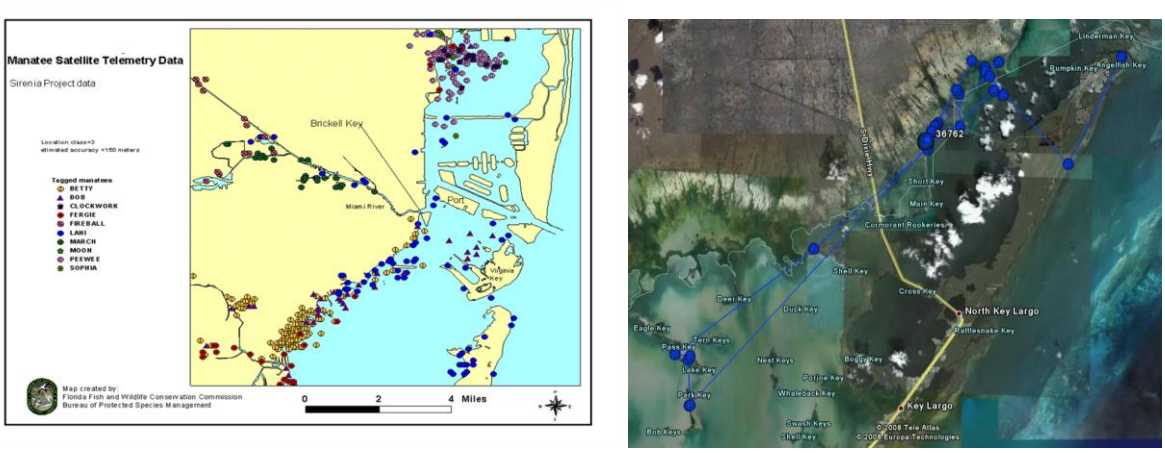


Figure 9. Satellite telemetry data from individual tagged manatees (Source: USGS Sirenia Project).

Aggregated Relative Density

Aggregated data from 34 aerial surveys conducted from 2000-2008 were analyzed to determine the relative density of manatees per area of water per survey. This type of graphic analysis synthesizes both frequency of observations and number of individual manatees sighted. Results for all areas where manatees have been observed were sorted into five equivalent quantiles. Areas that were surveyed, but where no manatees were ever observed are also displayed. As suggested by other more simplistic data depictions, the spatial analysis of relative density shows that manatees most heavily use all tributaries and canals, north Biscayne Bay seagrass beds, and nearshore seagrass beds adjoining canals (Figure 10).

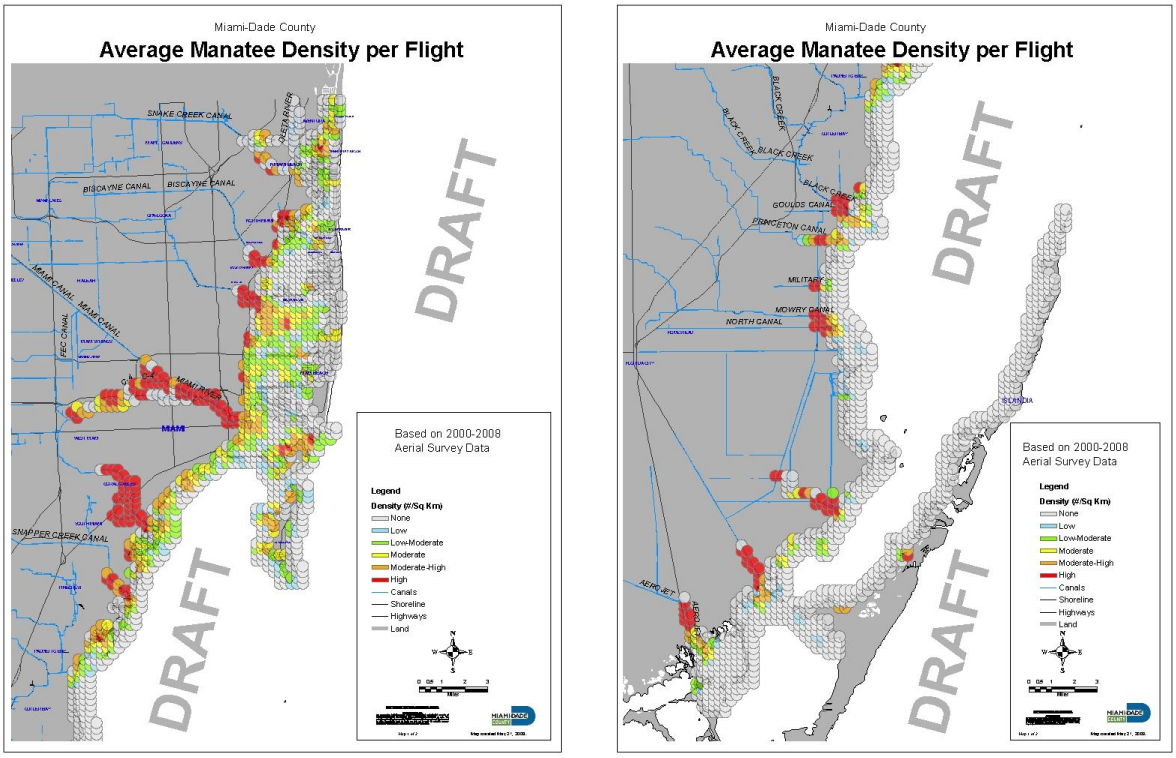


Figure 10. Spatial analysis of relative abundance of manatees, based composited data from all seasons.

Manatee Deaths

Causes of Manatee Death

The Florida Fish and Wildlife Conservation Commission collects manatee carcasses and determines cause of death. Manatees die from both natural and human-related causes. In Miami-Dade, natural causes include cold-stress and disease (red tide related deaths have not occurred on the east coast of Florida); however natural deaths constitute a relatively minor proportion of total mortality. Dependent calf deaths are poorly understood, but include both human-related (eg. separation from or death of mother) or natural (eg. developmental or genetic problems) causes. Human-related causes in Miami-Dade include entrapment or crushing in flood control structures, vessel collisions, entanglement, entrapment in drainage structures, or poaching. A significant number of carcasses are too decomposed to determine cause of death.

Average number of deaths from all causes combined within Miami-Dade County per year over the period of record increased from 6.8 per year from 1974 to 1995, to 9.3 per year from 1996 through July 2009 an increase of approximately 37%. Prior to the implementation of the 1995 MPP, the leading known cause of manatee death in Miami-Dade County was crushing or entrapment in flood gates. Since the implementation of the plan, the leading known cause of manatee death in Miami-Dade is vessel collision (Figure 11). The following review will focus on temporal and spatial patterns of human-related manatee deaths.

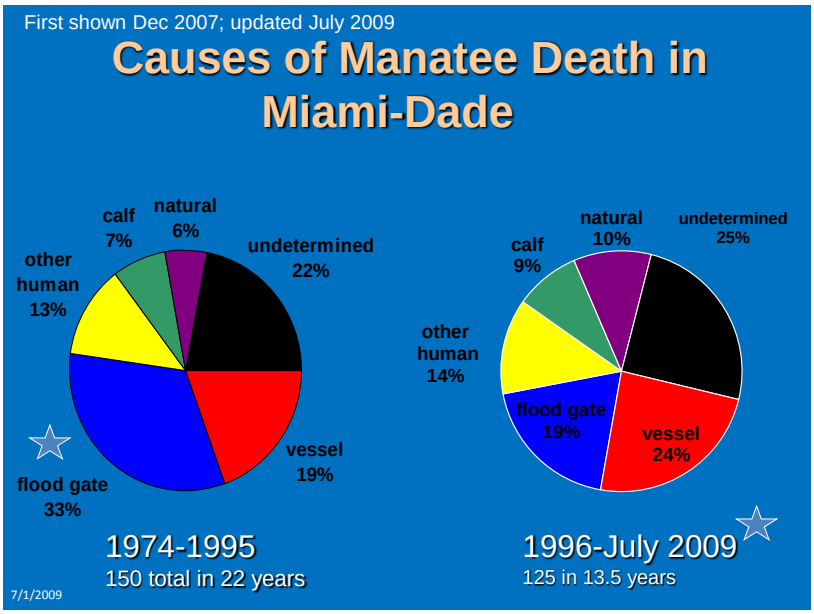
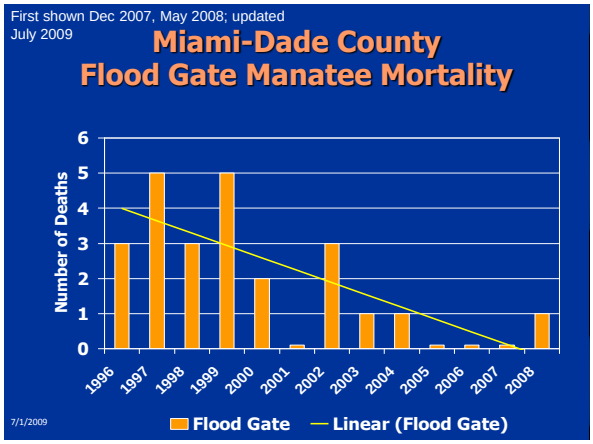


Figure 11. Relative proportion of manatee causes of death from the period before the 1995 MPP was approved to the period after it was approved.

Over the last decade, manatee deaths due to flood gates have decreased dramatically. The U.S. Army Corps of Engineers and the South Florida Water Management District have retrofitted coastal structures responsible for manatee deaths with pressure sensitive devices that cause the gates to reopen if there is an obstruction in the opening. This improvement has prevented the majority of such deaths. In contrast, the number of vessel-related deaths per year has varied since approval of the MPP in 1995, but the average has remained fairly stable over the period 1996 to 2008 (Figure 12).



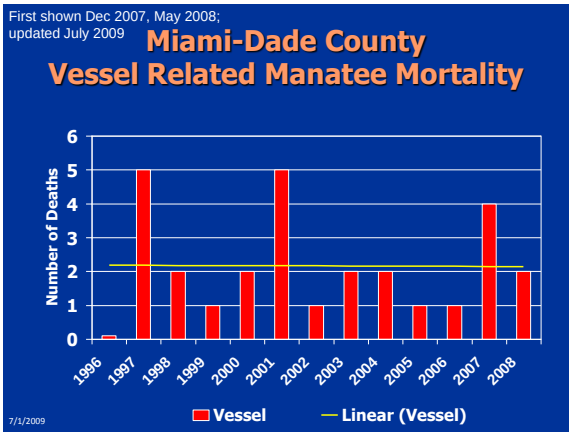


Figure 12. Manatee deaths caused by flood gates and vessel collisions over time since approval of the 1995 MPP.

A comparison of the annual rate of vessel-related deaths from before approval of the 1995 MPP to the rate after approval indicates that the absolute number of deaths per year has increased (Figure 13). From 1974 through 1995, 29 manatees killed by vessels were recovered county-wide, an average rate of 1.3 per year. From 1996 through 2008, 28 manatees killed by vessels have been recovered, an average rate of 2.2 per year, and increase of approximately 69%. Vessel-related death is increasing at a higher rate than all causes of mortality combined.

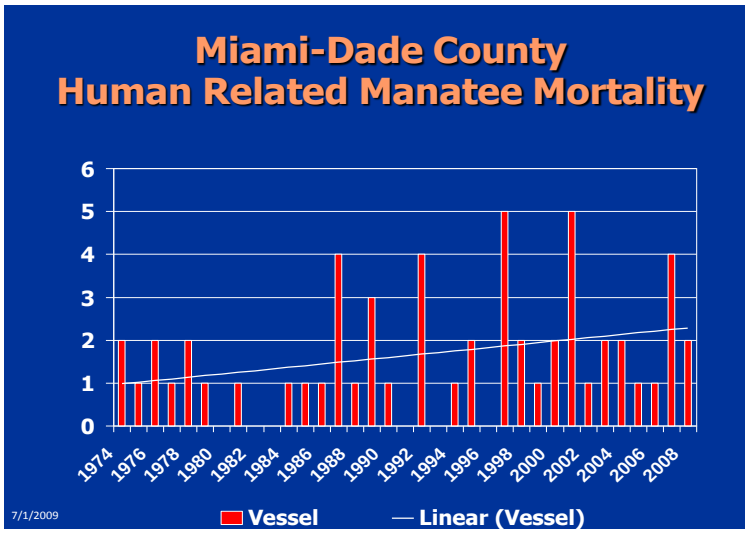


Figure 13. Vessel related manatee death over the period of record (since the inception of the State of Florida carcass salvage program to present.

Manatee deaths occur in all months of the year in Miami-Dade, with relatively higher numbers of carcasses recovered in winter months, and a secondary peak in deaths in summer months (Figure 14). Number of animals present in Miami-Dade and levels of human-related activity influence this pattern. Please see the discussion of Public Ramps and Boating Activity Study for more data on seasonal patterns of boating.

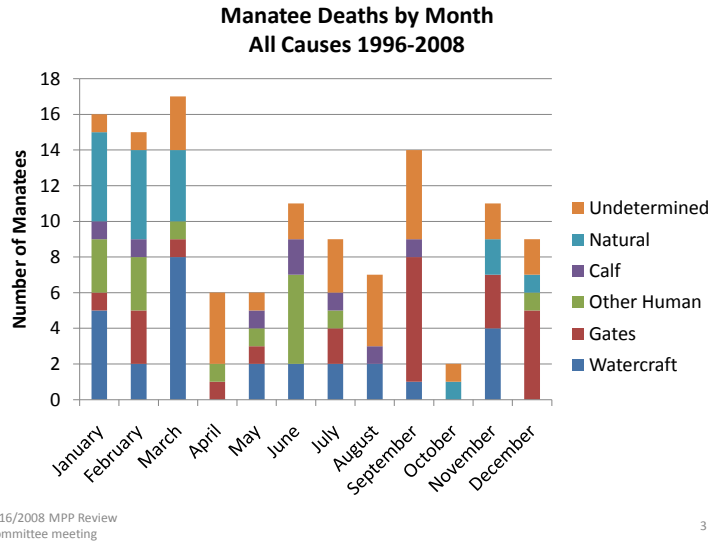


Figure 14. Seasonal distribution of all causes of manatee death in Miami-Dade, composited for the period of time since approval of the 1995 MPP.

Human-Related Manatee Death Carcass Recovery Location

It is understood that manatee carcasses may drift after death, or that in some cases injured animals may be able to move from the location of injury prior to dying. However, distribution of carcass recovery

locations still provides the best available frame of reference for evaluating geographic patterns related to human impacts on manatees.

Vessel-Related

The carcasses of manatees killed by watercraft collisions have been collected most frequently in north Biscayne Bay and its tributaries, prior to and after adoption of the 1995 MPP (Figure 15). Although it is not possible to determine exactly what vessel struck a manatee, FWC has developed forensic methods for identification of manatees killed by large propeller wounds, or by extensive blunt trauma from large vessel crushing. Necropsy reports and other studies by FWC pathologists indicate that carcasses exhibiting evidence of large vessel injury have been collected within north central Biscayne Bay, in the general vicinity of the Port of Miami and Miami River (Figure 16).

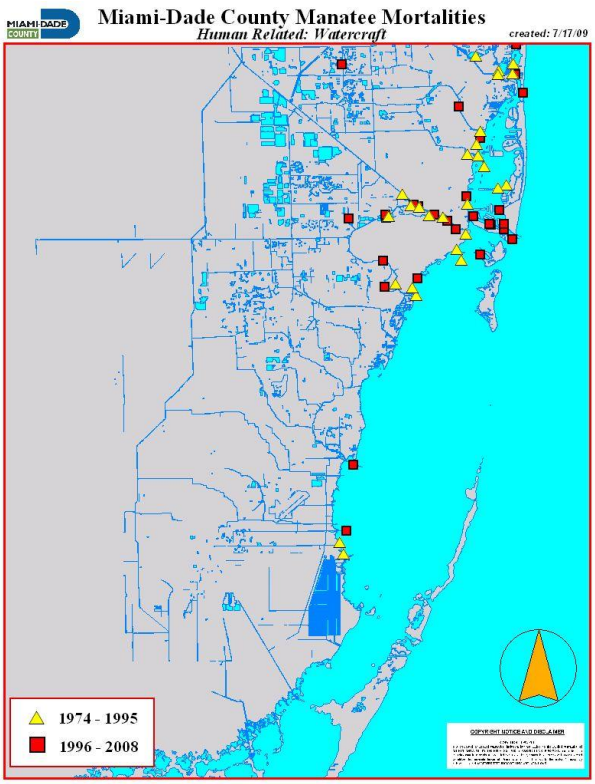


Figure 15. Location of carcasses killed by vessels

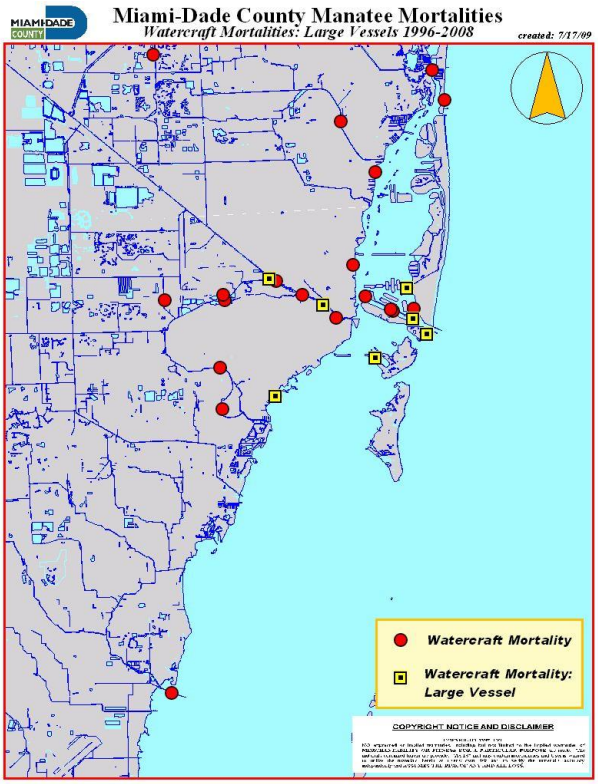


Figure 16. Large-vessel mortality 1996-2008.

Spatial analysis of vessel-related mortality indicates that more than 60% of all carcasses associated with this cause of death from 1995 to present were recovered within a 5-mile radius of the lower Miami River, as compared to 45% prior to 1995 (Figure 17; Table 1). The region with the second highest relative amount of manatee carcasses from vessel collisions is the area within 5 miles of Haulover Inlet; however, percentages improved from 41% prior to 1995 to approximately 18% after. Approximately 11% of manatee carcasses have been recovered within 5 miles of Coral Gables. Approximately 7% have been recovered within 5 miles of south Biscayne Bay canals. There are also some cases of vessel-related manatee death in freshwater lakes and portions of the canal network that are accessible to small boats, including the upper C-9 canal and lakes, Biscayne Canal, C-4 canal and Blue Lagoon.

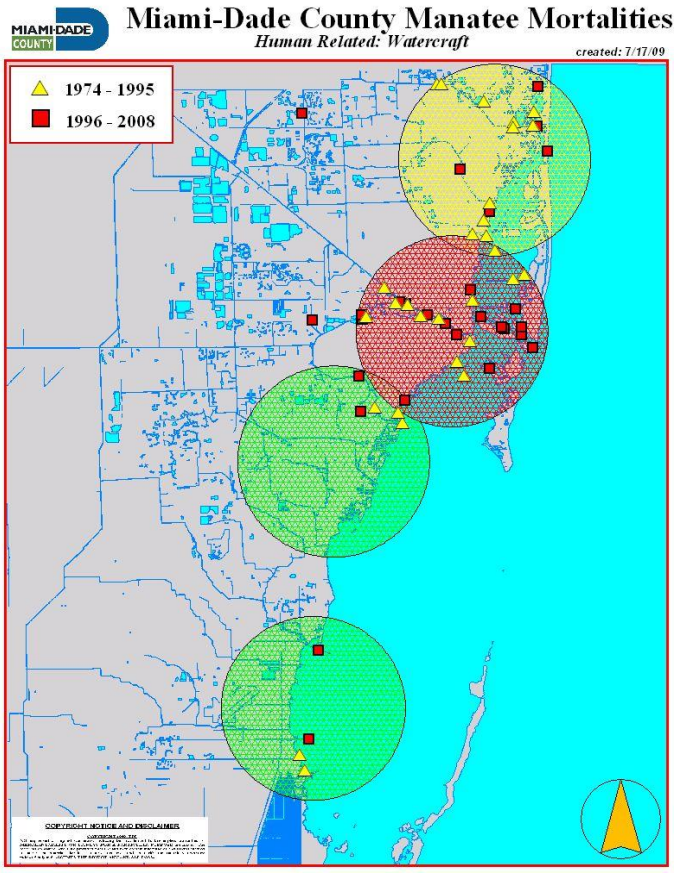


Figure 17. Relative distribution of carcasses of manatees Killed by vessel collisions.

Miami-Dade County Manatee Mortalitie		
Human Related: Watercraft		
Totals:		
1974 - 1995:	**29**	
1996 - 2008:	**28**	
	Total	% of Overall
Haulover Inlet		
1974 - 1995:	**12**	**41.4%**
1996 - 2008:	**5**	**17.9%**
Miami River/Port		
1974 - 1995:	**13**	**44.8%**
1996 - 2008:	**17**	**60.7%**
Coral Gables		
1974 - 1995:	**3**	**10.3%**
1996 - 2008:	**3**	**10.7%**
South Bay		
1974 - 1995:	**2**	**6.9%**
1996 - 2008:	**2**	**7.1%**

Table 1 - Distribution of Watercraft Deaths

A greater number of carcasses of manatees killed by vessel collision have been collected from the navigable tidal portions of Miami River and its tributaries, Tamiami Canal and Comfort Canal, than any other tidal canal or tributary system. From the period 1974 to 1995, five animals killed as a result of vessel collisions were recovered from the system, a rate of 0.2 carcasses per year. From the period 1996 to 2008, five animals killed as a result of vessel collisions were recovered in the system, a rate of 0.4 carcasses per year (Table 2). This represents a rate increase of 100%. This is a higher rate than either rate of increase over the comparable period for all vessel deaths countywide or for all causes of death countywide. The majority of animals exhibited evidence of acute trauma, indicating that they were unlikely to have moved a significant distance prior to death from their injury.

TABLE 2. Manatee carcasses killed by vessel collision recovered in Miami River and its tributaries.

Date	Location	Symptoms	Acute or chronic
June 2008	Miami River near 17th Ave	Broken ribs w healing, torn diaphragm, hernia	chronic
Nov 2007	Miami River near Flagler Bridge	Broken ribs with signs of healing; chronic infection	chronic
Sep 2007	Miami River 431 NW S River Dr	Massive internal injuries and hemorrhage (stomach, lungs, ribs, sternum, spine separation)	acute
Jan 2003	Tamiami Canal 160 m u/s of MR	Skull fractures, blood clots in stomach, airway and fracture site	acute
Feb 2001	Miami River w of 27 Ave	Massive internal injuries and hemorrhage (lung, kidney, ribs, muscle)	acute
Mar 1994	Miami River near 27 Ave	Massive internal injuries and hemorrhage (skull, ribs, lung, spine separation)	acute
Mar 1989	Miami River near 17 Ave	Large fresh prop wounds penetrate chest cavity; pregnant	acute
Oct 1988	Sighted at Miami River east of 23rd Ave; rescued from south fork of Miami River (Comfort Canal) near Allied Marine	Rescued alive, died months later at Seaquarium; multiple broken ribs, punctured lung, etc.	chronic
Aug 1987	Miami River at 36 St	Large prop severed animal into 3 pieces	acute
Feb 1978	Tamiami Canal near Bertram	Crushed skull, hemorrhage	acute

Flood Gate and Other Human Related

Manatees killed in flood control structures are generally recovered near canals. Several different human-related causes of death are grouped by FWC into a category called “human related other”. This category includes animals trapped in drainage structures, animals with physical trauma that cannot be attributed with certainty to a particular cause, entanglement, and poaching. The majority of these recovery sites are within canals, especially the upper Miami River, Tamiami Canal, and canals near Miami International Airport (Figure 18).

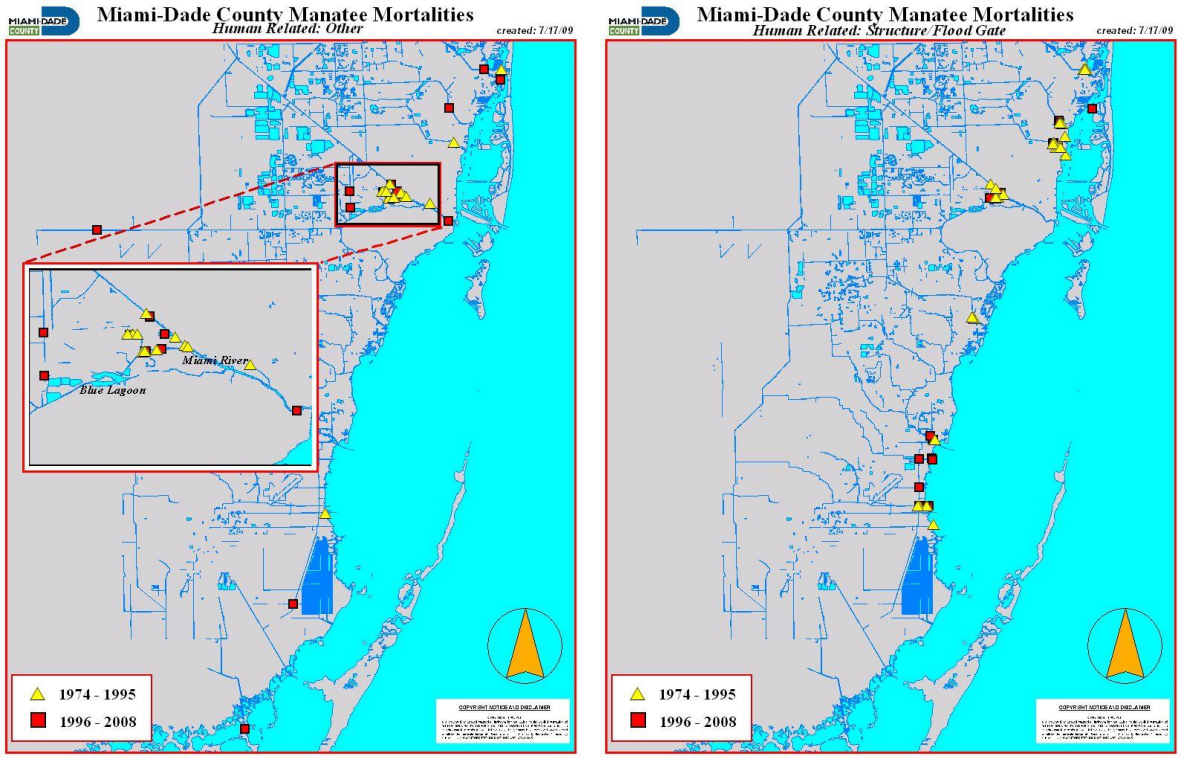


Figure 18. Location of carcasses of manatees killed by other human related causes, such as entanglement or poaching, and carcasses of manatees killed by flood gates.

Seagrass Habitat

Seagrass beds occur throughout Biscayne Bay. In north Biscayne Bay, some seagrass habitat was destroyed in the past by dredging for construction of navigation channels or as a source of fill for land development. However, even in these areas productive seagrass beds dominate most basins, particularly south of 79th Street Causeway, and nearshore areas (Figure 19). As noted above, manatees feed in many of these shallow seagrass beds, particularly in north Biscayne Bay and along the western shoreline near tributaries.

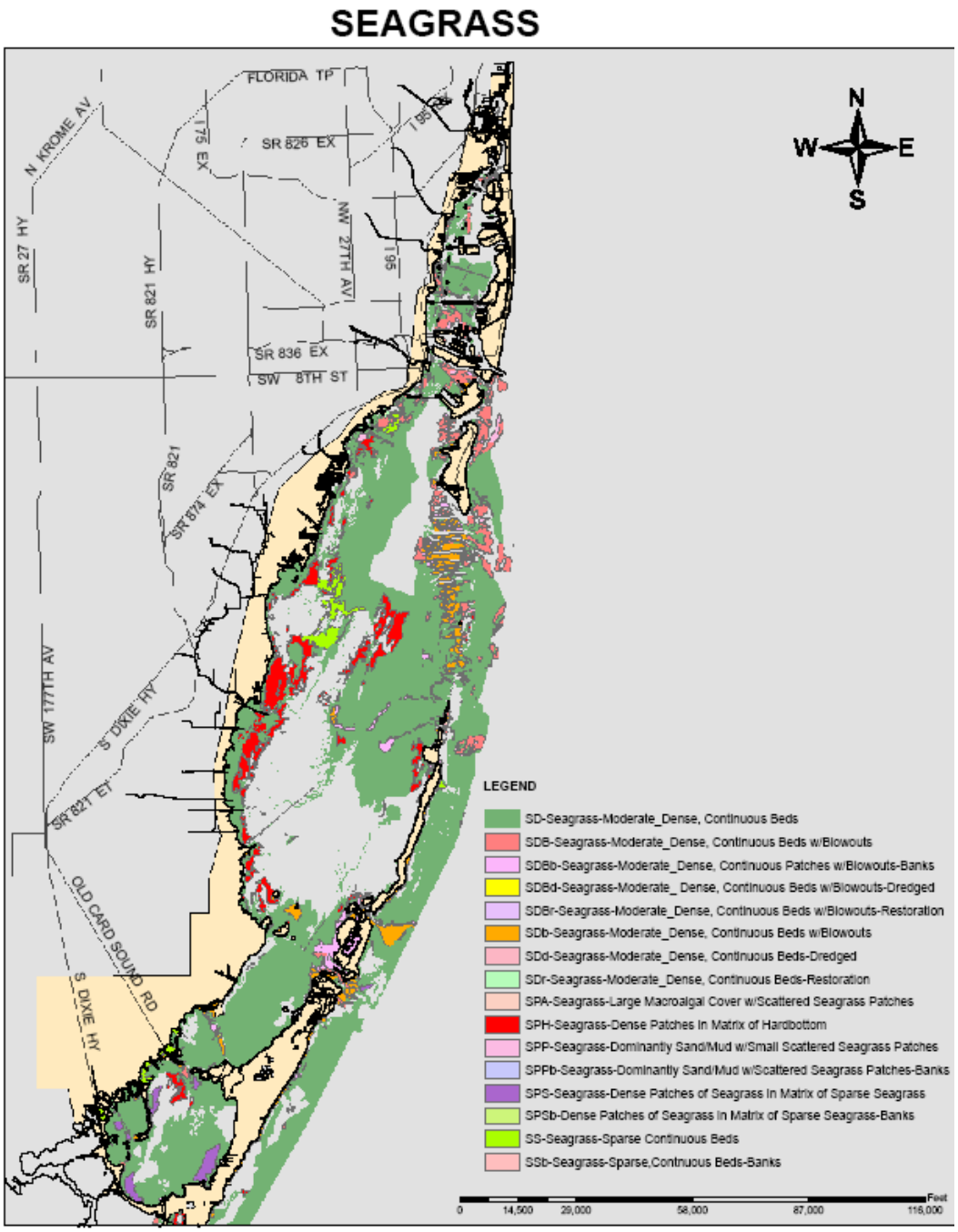


Figure 19. Seagrass distribution in Biscayne Bay and adjoining waters.

Marine Facility Inventory

Marinas and commercial and industrial marine facilities are concentrated along shorelines, canals, and rivers north of the Coral Gables Waterway. This is largely related to historic patterns of land use and development. South of Coral Gables, there are few private residential marinas, several large public marinas operated by Miami-Dade County, and two industrial facilities located in canals or basins. Most

of the remaining south Biscayne Bay shoreline consists of near pristine mangrove wetlands that constitute the landward boundary of Biscayne National Park (Figure 20).

Residential marinas with 10 or more slips, and other facilities where more than half the vessels are commercial, must obtain an annual operating permit from Miami-Dade County DERM. The operating permit primarily addresses best management practices for minimizing pollution; however, the operating permit files provide information that can be useful in creating an inventory of such facilities and the number of wet and dry slips requested for use by the applicant. In 2008, based upon available records in permit files, there were 219 facilities with 13,147 slips holding valid operating permits. Sixty-two, or 28%, of these facilities are located within the Miami River and its tributaries (Tamiami Canal, Comfort Canal, Wagner Creek). When the 1995 MPP was approved, there were 228 facilities countywide with 12,412 slips holding valid operating permits. Although the total number of facilities decreased over time, the number of slips reported at the permitted sites increased by 735. This is a consequence of expansion or consolidation of facilities at some locations. These figures do not include facilities that are or were operating without permits, or those smaller facilities that are not required to have permits.

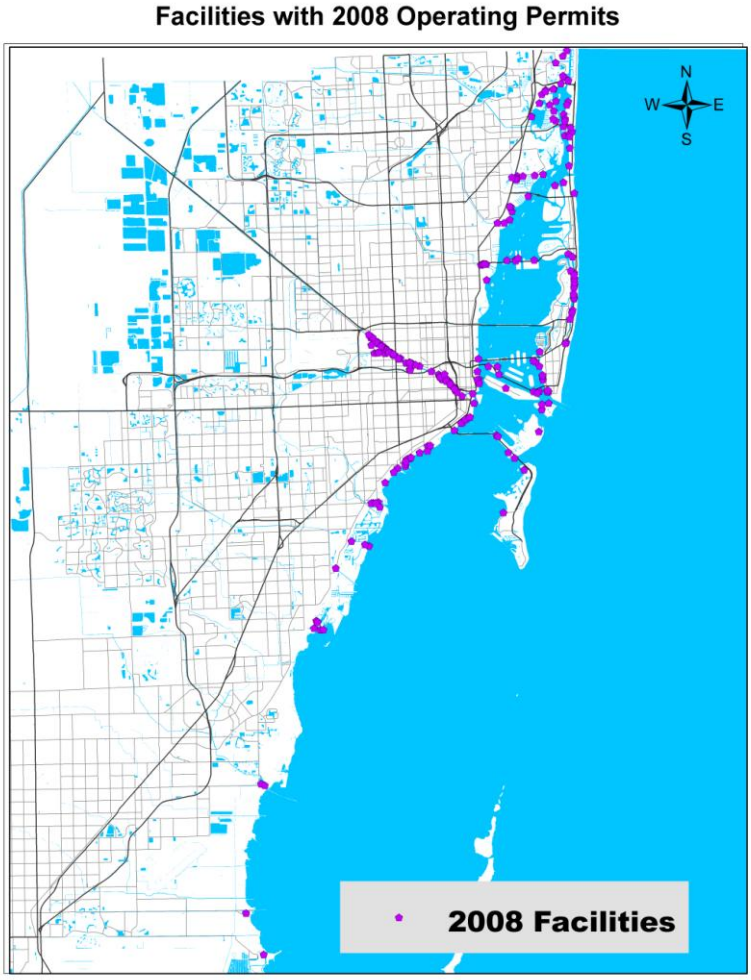


Figure 20. Marine facilities with current DERM operating permit in 2008.

The majority of sites that had some type of facility operating in 1995 continued to have a facility operating in 2008. A few facilities are currently operating without the required permit. Due to land

use changes, some large wet or dry marinas in north Miami-Dade and some commercial or industrial facilities in the Miami River are no longer in operation. However, some new facilities have also been established since 1995 (Figure 21, 22).

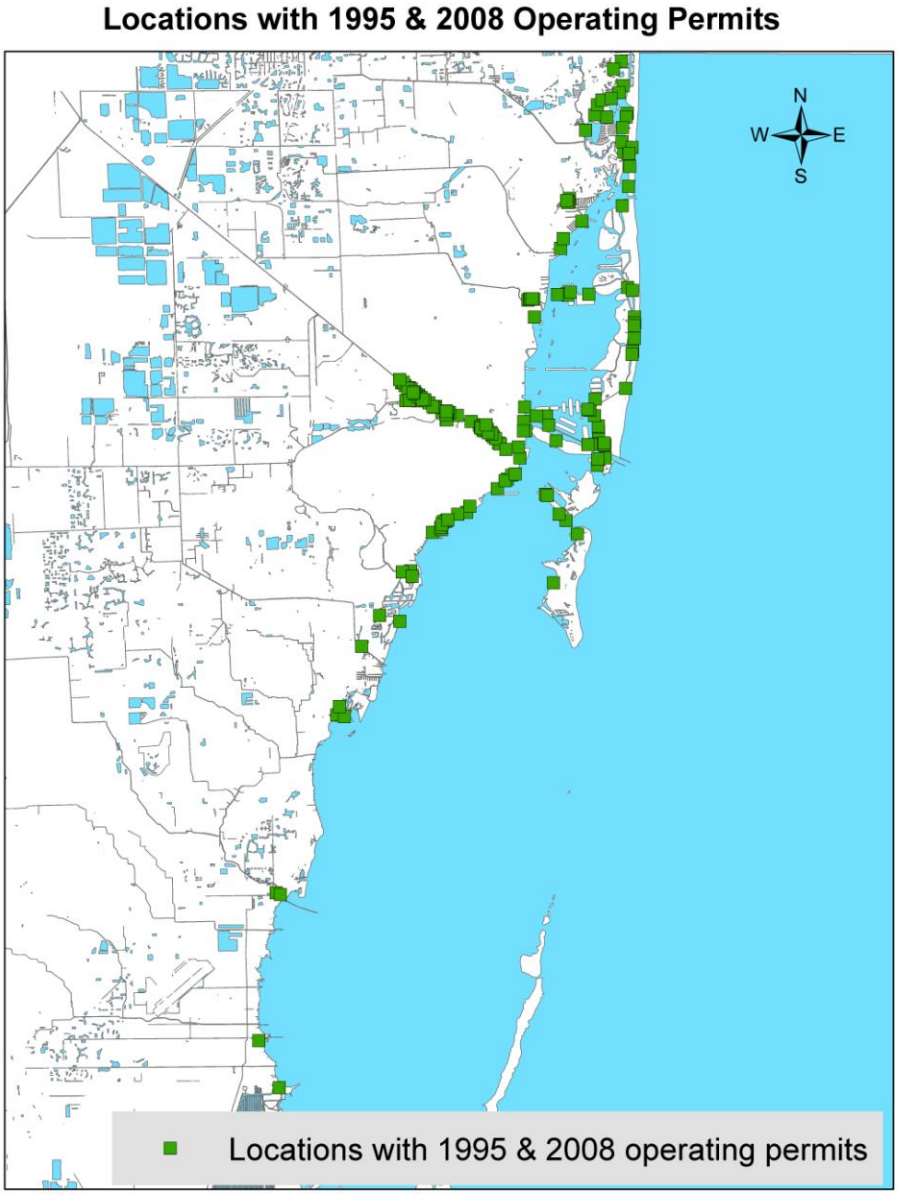


Figure 21. Locations where a facility with an operating permit was present in 1995 and where a facility is in operation in 2008.

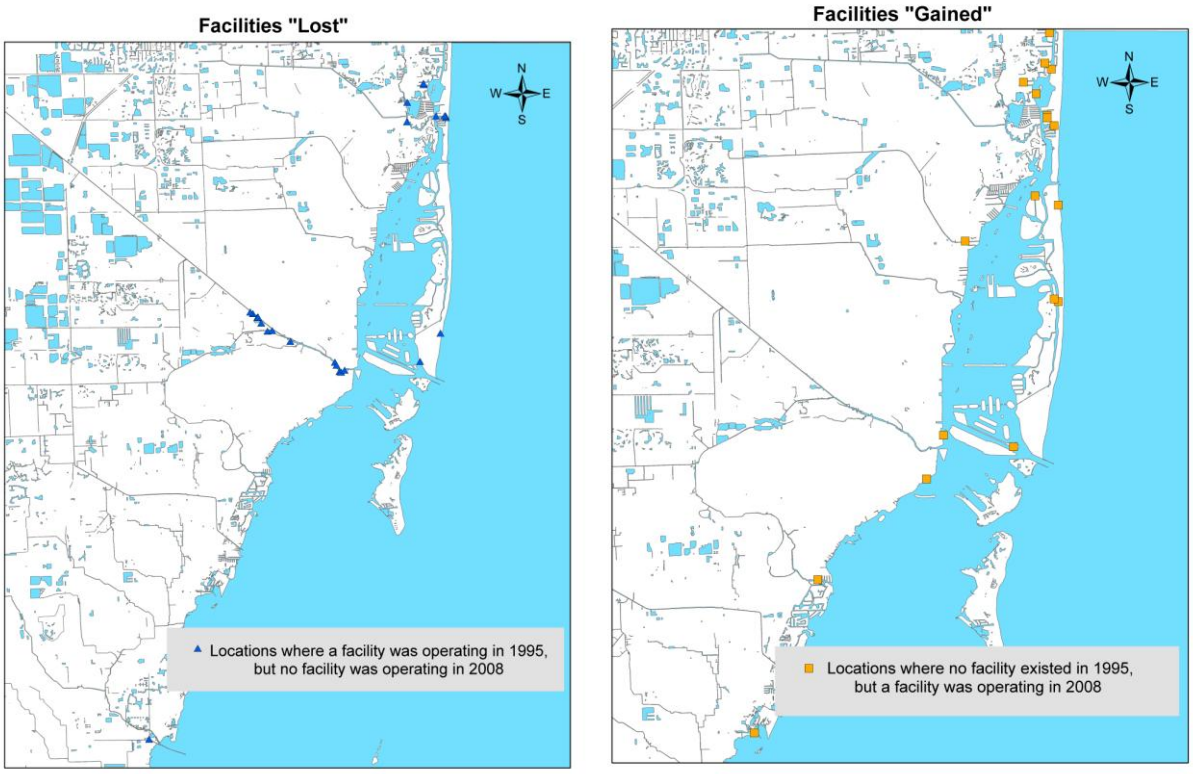


Figure 22. Changes in locations of facilities with operating permits from 1995 to 2008.

In the Miami River and its tributaries some sites that had commercial or industrial marine facilities in 1995 no longer have a marine facility of any type. Facilities with operating permits decreased from 76 in 1995 to 62 in 2008. However, the number of slips reported in the operating permits for the Miami River and its tributaries increased over the time period from 1,157 in 1995 to 1,210 in 2008. This appears to be a result of consolidation or expansion of facilities at some locations, and historically operating facilities obtaining the permit, which offset losses. A count of vessels visible on aerial photos of the Miami River and its tributaries also exhibits an increasing trend in number of vessels (Figure 23). New or expanded public marinas have been constructed or are undergoing development at Haulover and in the Dinner Key area, and new slips have been authorized at numerous multifamily or commercial sites throughout the county (figure 24).

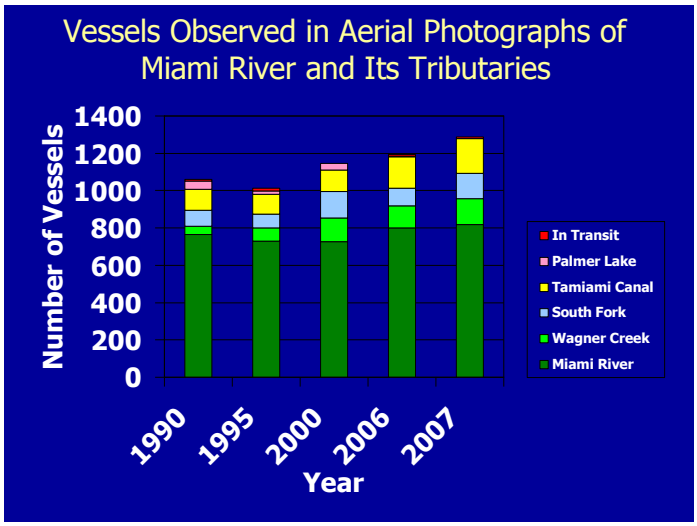


Figure 23. Numbers of vessels observed on aerial photos in the Miami River and its tributaries.

DERM has permitted construction of docks or shoreline improvements in tidal waters that allow 898 new berths available to powerboats at multi-slip facilities since 1995 (Figure 24). Rebuilding or repairs of facilities with 3,250 berths available to powerboats have been authorized. These figures do not include slips authorized for sailboats only, single family residential docks or general repairs to seawalls.

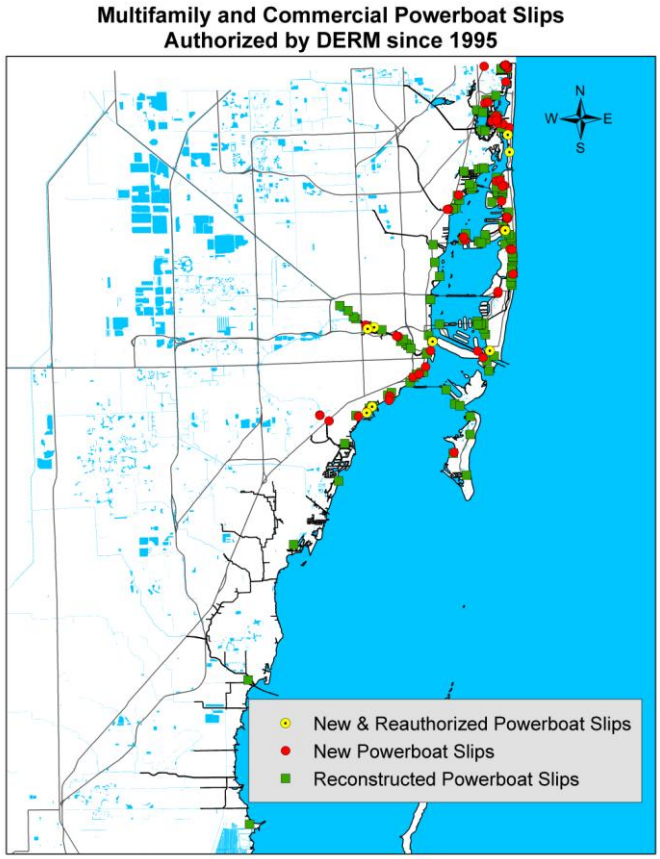


Figure 24. Locations where DERM has authorized new or reconstructed slips available to powerboats since 1995 (does not include slips for sailboats only, single family residences, or seawalls).

Public Ramps and County-Owned Public Facilities

Miami-Dade County had approximately 47,000 registered vessels in 1995, increasing steadily to approximately 58,000 by 2001, and remaining near that level with some variability to the present (Source: FWC Boating Accident Statistics annual reports). The majority of these vessels, approximately 75 to 80%, are 26' or less in length and are generally kept on trailers. They are launched at boat ramps.

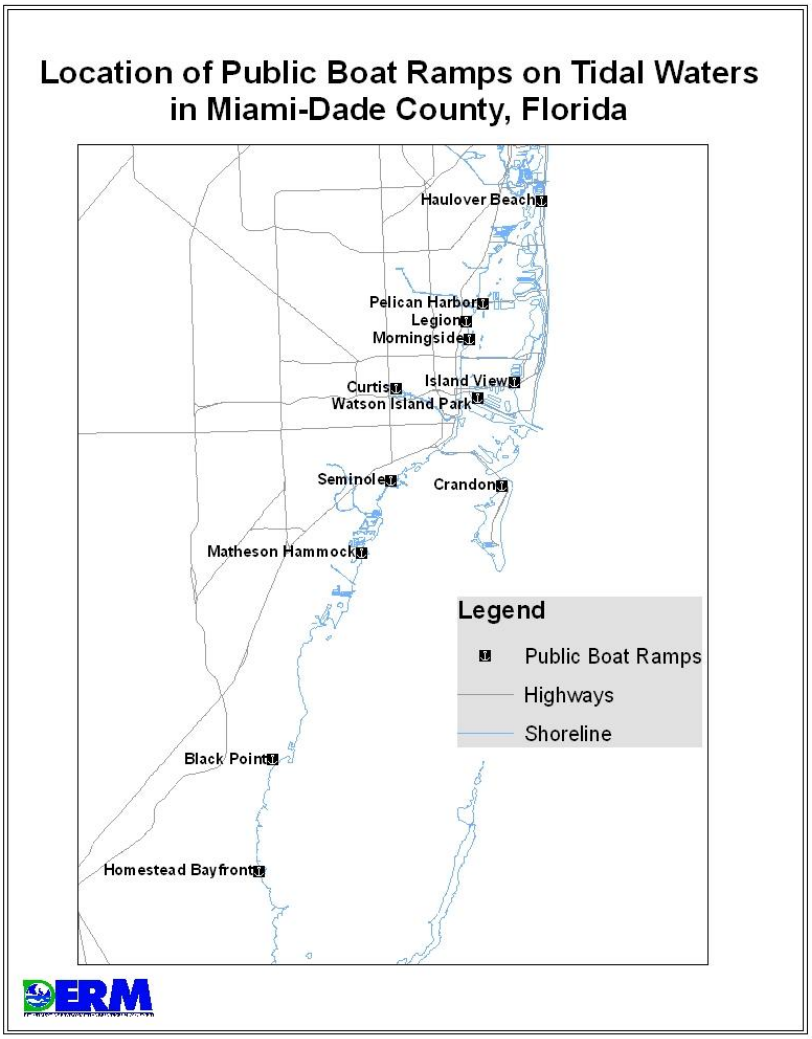


Figure 25. Locations of public boat ramps in tidal waters of Miami-Dade County.

Public ramps are operated primarily by Miami-Dade County Park and Recreation Department, and by the City of Miami. A small facility is operated by the City of Miami Beach. Since the 1995 MPP was approved, public ramps at Virginia Key and Dinner Key (Virrick Gym site) have been closed or restricted.

Table 3. Public Boat Ramps in Tidal Waters of Miami-Dade County, Florida and Number of Marked Boat Trailer Parking Spaces at Each Ramp

Ramp Name	# of Trailer Parking Spaces	Ramp Location
1. Haulover Beach Park* (county)	172	10800 Collins Avenue, Sunny Isles
2. Pelican Harbor (county)	49	1275 NE 79 Street, Miami
3. Legion Park (City of Miami)	17	6447 NE 7 Avenue, Miami
4. Morningside Park (City of Miami)	21	750 NE 55 Terrace, Miami
5. Island View Park (City of Miami Beach)	12	Venetian Cswy Miami Beach
6. Watson Island (City of Miami)	44	MacArthur Cswy, Miami Beach
7. Curtis Park (City of Miami)	5	1901 NW 24 Avenue, Miami River
8. Seminole (City of Miami)	43	Dinner Key Marina, Coconut Grove
9. Crandon Park* (County)	229	4000 Crandon Blvd, Key Biscayne
10. Matheson Hammock Park (County)	211	9610 Old Cutler Road, Coral Gables
11. Black Point Park (County)	229	24755 SW 87 Ave, Homestead
12. Homestead Bayfront Park (County)	207	9698 N. Canal Drive, Homestead

*Note: Haulover Beach Park and Crandon Park are under construction at or near the ramp sites.

Seasonal data collected by Miami-Dade County and its marina operators document that ramps produce the largest number of vessel trips per site. Dry storage racks or barns also generate a large number of trips per site, because of the relatively large number of vessel berths that can be stacked in a small area. County-operated ramp use is generally highest in summer, with a secondary peak in spring. Seasonal patterns are less clear at county dry storage ramps (Figure 26, 27).

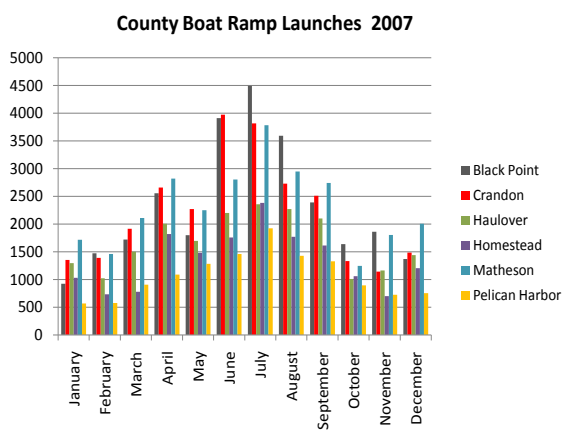


Figure 26. Launches by month at County ramps.

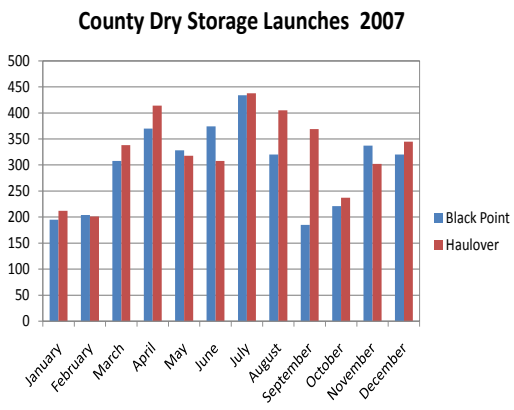


Figure 27. Launches by month at County dry storage.

Data were collected at Black Point to determine the rate of launches from the dry storage barn as compared to the rate of trips from the adjacent wet slip marina on three different dates (Table 4). Observations were made at both facilities on weekends during peak hours during the same time periods: July 20, 2008 from 8 am to 2 pm; November 15, 2008 from 8 am to 2 pm; and June 28, 2009 from 8:30 am to 12:30 pm. Data collection on the final date was suspended due to severe weather, including thunderstorms and lightning. The number of vessels launching or leaving each facility was compared to the number of leased berths in each facility. Overall rates of use, as expressed by the percent of vessels launching or departing the facility were similar at the boat barn and the wet slip marina, with highest rates of use observed during the 6 hour period on July 20, 2008.

Table 4 – Comparison of activities at Black Point Dry Storage Barn and Wet Slip Marina

	Boat Barn				**Wet Slips**			
DATE/TIME	**# berths leased**	**# boats launched**	**%**	**# boats returning to barn**	**# berths leased**	**# boats launched**	**%**	**# boats returning to marina**
07/20/2008 (Sun., 8:00 am to 2:00 pm)	240	29	12	14	178	27	15	3
11/15/2008 (Sat., 8:00 am to 2:00 pm)	230	20	9	3	171	10	6	3
06/28/2009 (Sun., 8:30 am - 12:30 pm)*	155	12	8	5	175	13	7	4
Total Boat "trips" counted		61		22		50		10

Highest frequency of launches occurred between approximately 9:30 am and noon. On July 20, 2008, during peak operation, an average of 1 vessel was launched from the dry storage barn every 5 – 6 minutes, and an average of 1 vessel departed the marina basin every 10 minutes. However, the total number of launchings was greater from the boat barn, due to its larger number of occupied berths. Lower numbers of vessel launches on June 28, 2009 were attributed to shortened observation period, threatening weather, and lower occupancy rates. It should be noted that a much higher number of vessels were recorded returning to the dry storage barn, as compared to the wet slip marina. Therefore, the dry storage barn generated a greater number of trips during the time periods than the wet slip marina.

100% of vessels launched or recovered at dry storage on observation dates were power boats (open motorboats, cabin motorboats, or performance design motorboats). During the July, November, and June observation periods, 7%, 23%, and 7% respectively of the vessels departing the marina basin were sailboats (with auxiliary power). The average length of vessels observed going to and from the dry storage barn is less than average length of vessels going to and from marina wet slips.

Boating Activity Study

Mote Marine Laboratory updated boating activity data by conducting a study to provide information on volumes and types of boats, seasonal patterns in boating activity, traffic routes, and speed or level of compliance with regulations. The study included 20 aerial surveys of coastal waters, including weekdays, weekends and a holiday over a one-year period. Four fixed-point ground-based sites were selected for intensive study of traffic pattern and compliance, with each site surveyed eight times. The following information is directly drawn from Mote Marine Laboratory's final report, "Recreational Boating Activity in Miami-Dade County", Jay Gorzelany, Principal Scientist, June 2009.

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. 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 (Figure 28 a and b).

Figure 28a. Composite view of vessel traffic data from all 20 aerial survey flights are combined. Green arrows indicate vessels underway. Red dots indicate stationary vessels.

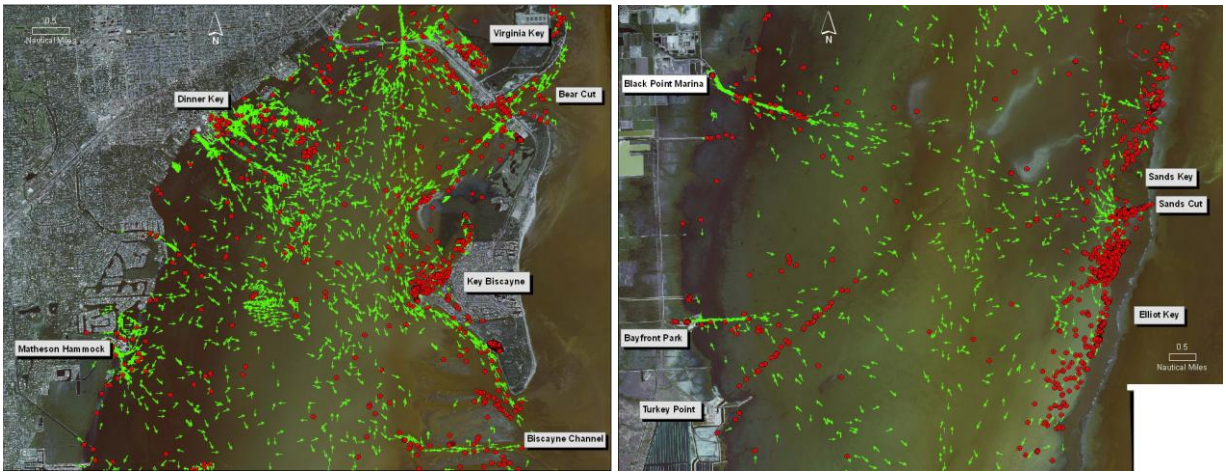


Figure 28b. Composite view of vessel traffic data from all 20 aerial survey flights are combined. Green arrows indicate vessels underway. Red dots indicate stationary vessels.

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 (Figure 29). Lower concentrations of vessel traffic were consistently observed throughout open water areas in lower Biscayne Bay. Though no clear seasonal pattern was observed, higher levels of recreational boat use were generally observed in the spring. 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.

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. 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.

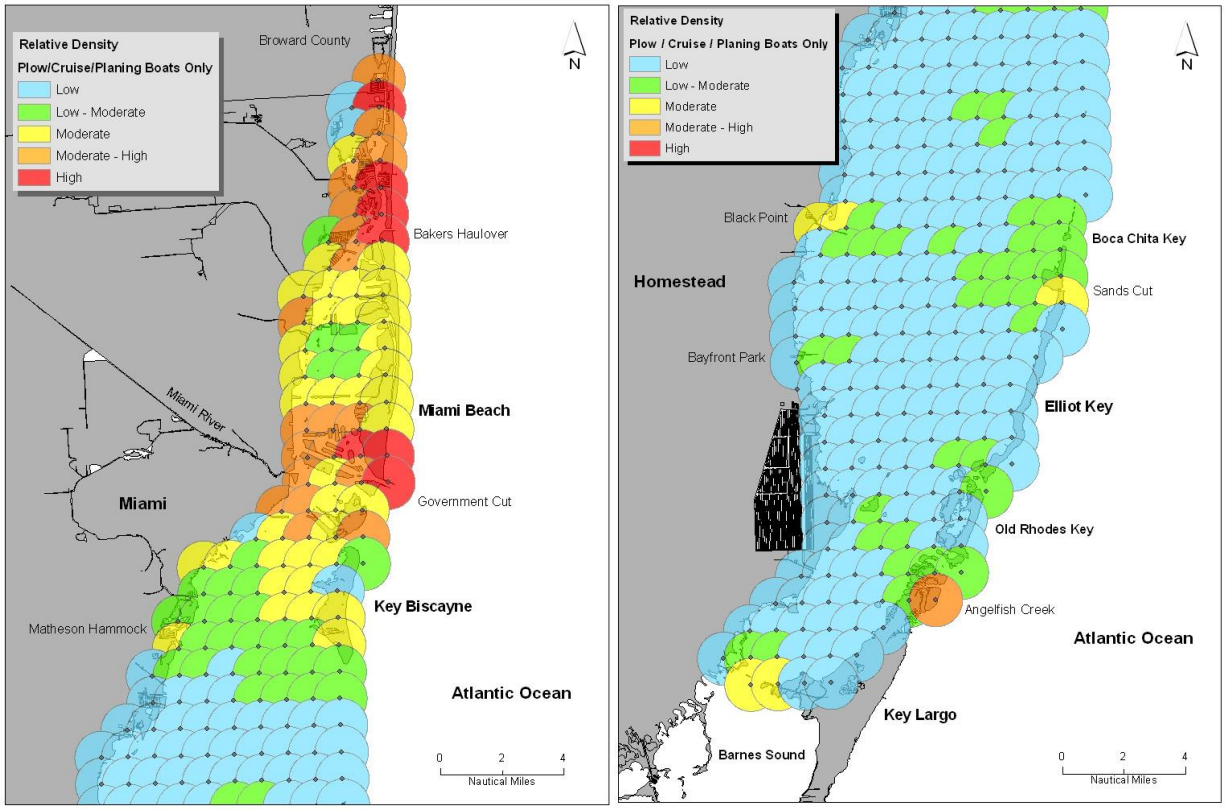


Figure 29. Spatial analysis results, expressed as areas of relative density, for all vessels traveling at plowing, cruising, or planing speed along the aerial survey route. Weekday and weekend surveys are combined.

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.

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 (Figure 30). Among vessel types, personal watercraft had the lowest levels of compliance and highest levels of blatant non-compliance (Figure 31). These trends were consistent with previous compliance studies conducted in other Florida counties.

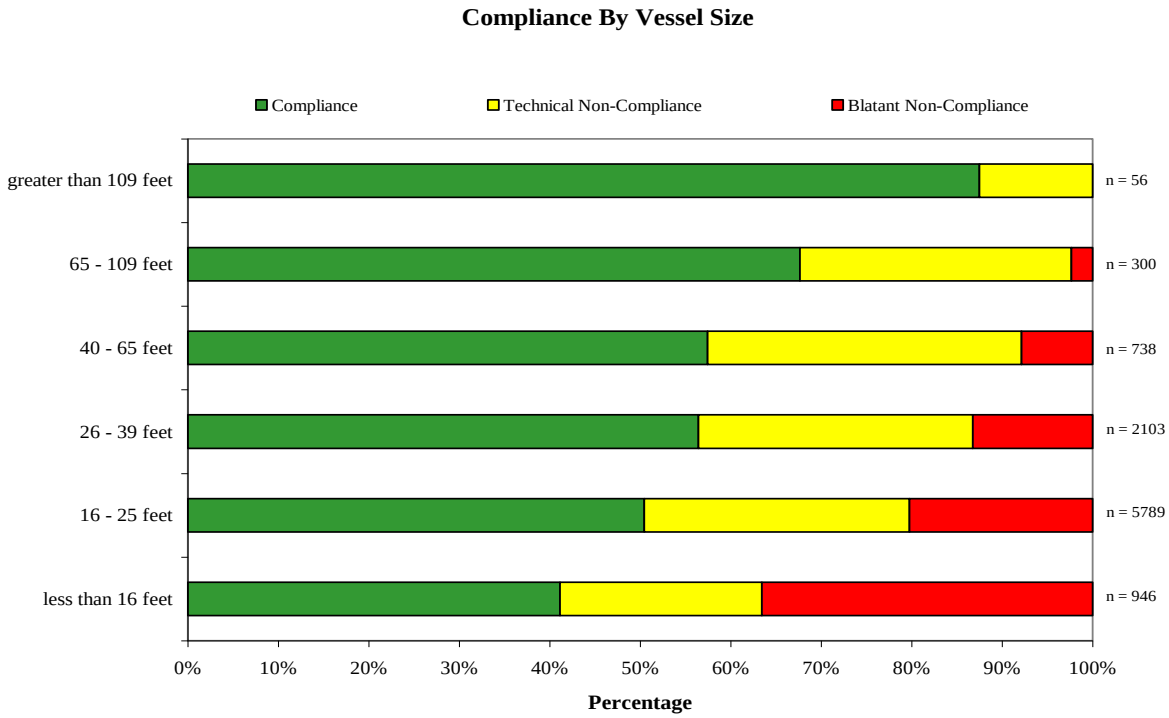


Figure 30. Comparison of boater compliance by vessel size category. All fixed point survey sites are combined.

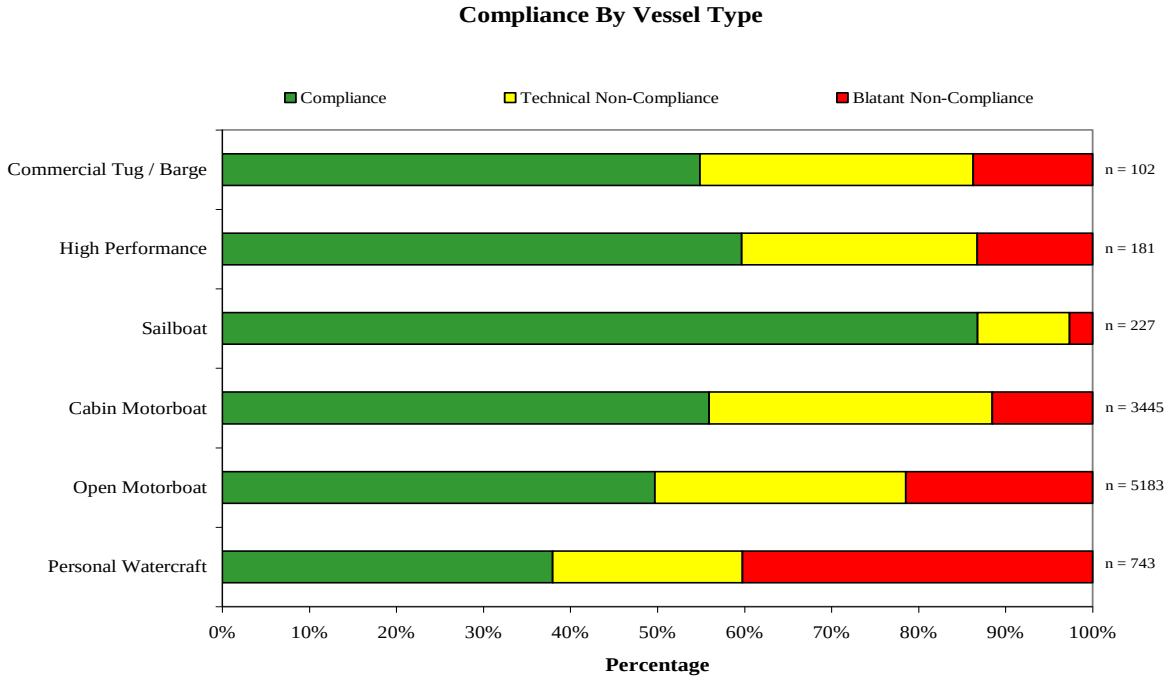


Figure 31. Comparison of boater compliance by vessel type. All fixed point survey sites are combined.

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 (Figure 32). Compared with previous studies, boater compliance at several fixed point locations in Miami-Dade County was relatively low.

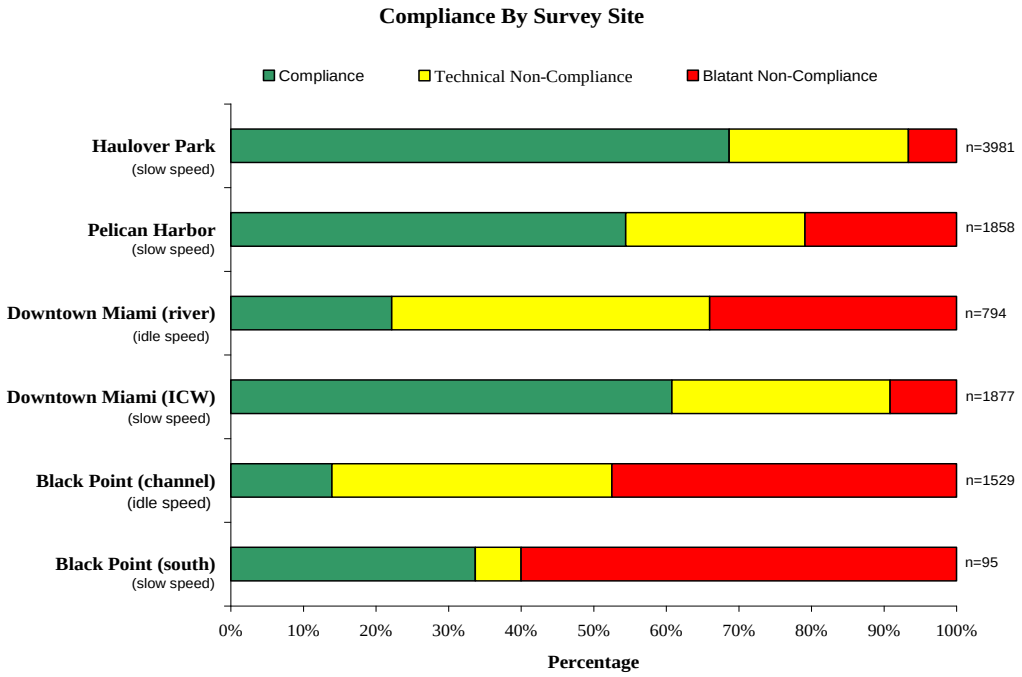


Figure 32. Observed levels of boater compliance, technical non-compliance, and blatant non-compliance at each fixed point survey site and associated regulatory zone.

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.

SUMMARY

- Manatees undergo a seasonal migration, and are approximately 5 times more abundant in Miami-Dade in winter months than in summer.
- Manatee densities and frequency of occurrence are greatest in tributaries and north Biscayne Bay. Manatees aggregate in winter in canals and rivers, particularly Little River, the Miami River and its tributaries, and the Coral Gables Waterway. They also occur in higher numbers in seagrass beds adjoining the major tributaries and near Virginia Key.
- Manatees move among tributaries and grass beds, particularly north of Rickenbacker Causeway, and may travel within or cross major navigation channels such as the Intracoastal Waterway and federal channels in the Port of Miami and Miami River.

- Vessel collision has become the leading known cause of manatee death in Miami-Dade, and the absolute number of manatees killed by vessels has also increased compared to the period before the 1995 MPP.
- Flood gate deaths have greatly decreased over the last 5-years as a result of improvements to flood gates implemented by the U.S. Army Corps of Engineers and South Florida Water Management District.
- The relatively greatest density of carcasses killed by vessel-collision is in a 5 mile radius of the downtown area, including the Miami River, its tributaries, and waters near the Port of Miami. This area also includes a number of carcasses with evidence of large vessel trauma.
- Manatee deaths occur in all seasons, and are affected by the number of manatees present as well as the level of human activities.
- Marine facilities with current operating permits are concentrated north of Coral Gables.
- Although there have been losses and gains in facilities since 1995, the total number of slips at facilities with current operating permits has increased. Losses of commercial and industrial facilities are associated with land use changes and redevelopment of upland parcels in the Aventura area and some sites on the Miami River.
- Number of vessels observed on the Miami River and number of slips at facilities with current operating permits has increased since 1995.
- DERM has authorized construction of more than 800 new slips at multi-slip facilities and reconstruction of more than 3,000 slips since 1995 (these figures do not include single family residential docks).
- The number of boat ramps has decreased since the 1995 MPP was approved. County boat ramp use generally peaks in spring and summer, and is much greater on weekends and holidays than on weekdays. County ramps alone generated more than 130,000 launches in 2007. County dry storage racks at two locations generated more than 7,000 launches.
- A comparison of use of boats in dry storage and wet slips at Black Point Marina demonstrated similar rates of use, averaging approximately 10% of vessels launched from each berthing area over 4 to 6 hours on weekend days. However, due to the size of the facility and occupancy, the dry storage facility generated a larger total number of trips than the wet slip marina. Vessels in dry storage racks are generally smaller than those in wet slips, and unlike wet slips included no sailboats.
- Boats travel to ocean inlets and major channels for offshore access, anchorages at Haulover, Key Biscayne and Elliott Key, and open water in south Biscayne Bay.
- In north Biscayne Bay, vessel traffic is densest within marked navigation channels.
- Vessel speed zones appear to be effective in reducing vessel speed. However, rate of compliance with posted vessel speed zones was poor compared to other counties where similar studies have occurred.
- Compliance rate generally increased with vessel size. Personal watercraft had the lowest rate of compliance and sailboats had the greatest rate of compliance. Commercial and recreational vessels compliance rates were similar.
- Poorest compliance occurred in Idle Speed Zones, where vessels traveling at Slow Speed are considered non-compliant.
- By site, poorest compliance occurred in the outer channel of Black Point Marina (14%), followed by the mouth of Miami River channel (22%). The site with the best rate of compliance was at Haulover (69%).

EVALUATION and SYNTHESIS

FWC's Boat Facility Siting Guide (August 2000) states that the main goal of boat facility siting components of MPP's will be to minimize the amount of interaction between manatees and boats. In evaluation of the required types of data on manatees, their habitat, and boating facilities and patterns, FWC directs that areas should be identified where boat use patterns show minimal overlap with manatee use patterns, and these may become preferred locations for future marina expansion. In areas where the manatee and boat patterns do converge, an assessment of overlap and the potential negative impacts of vessels on manatees and their habitat must be undertaken. FWC offers the following factors or criteria for consideration of marina and boat facilities:

- *Proximity to inlets and/or the ICW*
- *Existing water depths adequate for clearance beneath vessels*
- *Presence of seagrass beds*
- *Proximity to popular boating destinations*
- *Amount of manatee use, and*
- *Distances of boat/manatee use pattern overlap*
- *Expansion of existing facilities may be preferred over new facilities if environmentally sound*
- *There should be no impact to seagrass, and mitigation for seagrass destruction should not be allowed (as a means of justifying impacts)*
- *Areas with adequate depth and good flushing which require no new dredging are preferable*
- *Locations near inlets and popular destination are preferable*
- *Piling construction is preferred over dredge and fill techniques*
- *Marinas should not be sited in essential manatee habitats; and*
- *Marinas should not be situated in areas with high manatee mortality occurrence*

Using these factors or criteria, the following evaluation and synthesis can be made, based upon the manatee, habitat, and boating activity data.

- Manatees are most abundant and consistently observed in areas of north Biscayne Bay including seagrass beds, and in canals and rivers, particularly the Little River, Miami River and its tributaries and the Coral Gables Waterway. These are also locations of sensitive behavior, such as winter aggregation, feeding, or nursing of calves.
- The highest number of power vessels in use, the highest densities of powerboats relative to water area, and the highest number of boats traveling at high speed are located in the Downtown Miami area, the Intracoastal Waterway north and south of the Miami River, the Port of Miami including Government Cut, and the Intracoastal Waterway near Haulover Inlet.
- Waters in the vicinity of the Port of Miami, Miami River, and downtown are also the areas with the highest occurrence of manatee carcasses killed by vessel collisions, including large vessel impacts, and these are also the areas with highest density of currently operating marine facilities.
- Manatees and vessels north of Rickenbacker Causeway may be confined to narrower waterways or dredged channels, affording less opportunity to avoid an interaction.

Therefore, highest manatee and vessel use areas overlap significantly, and coincide with the general area of highest number of manatee deaths. The risk of manatee and vessel interaction, resulting in disturbance of sensitive behavior, injury, or death is greatest in tributaries, portions of the Intracoastal

Waterway in north Biscayne Bay, and in seagrass beds from Rickenbacker Causeway to 79th Street Causeway based simply on the concentration of both manatees and higher speed vessel traffic in these regions. Furthermore, vessels departing from north Biscayne Bay tributaries or western shorelines must travel several miles or more through the most essential manatee habitat to reach ocean inlets or other popular boating destinations. These are the least preferred sites for expansion pursuant to state manatee protection criteria, and limits or restrictions on facility types and number of berths is appropriate.

Conversely, in deeper open waters south of Rickenbacker, vessels are generally not restricted to channels, and manatees are generally associated with nearshore areas. Once vessels depart the shallow inshore waters, interaction with manatees is unlikely. Manatees may have been observed in relatively low density in locations near boating destinations, such as popular anchorages and ocean inlets However, vessels launching near these destinations would not be required to travel miles through the most densely used manatee habitats or tributaries. They are the most preferred locations for expansion generally pursuant to state manatee protection criteria provided that dredging and/or impacts to wetland or submerged aquatic vegetation would not be needed, and may require fewer or no limitations on facility types and number of berths.