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Final Report

Aerial Survey of Boater Use in Everglades National Park Marine Waters: Florida Bay and Ten Thousand Islands

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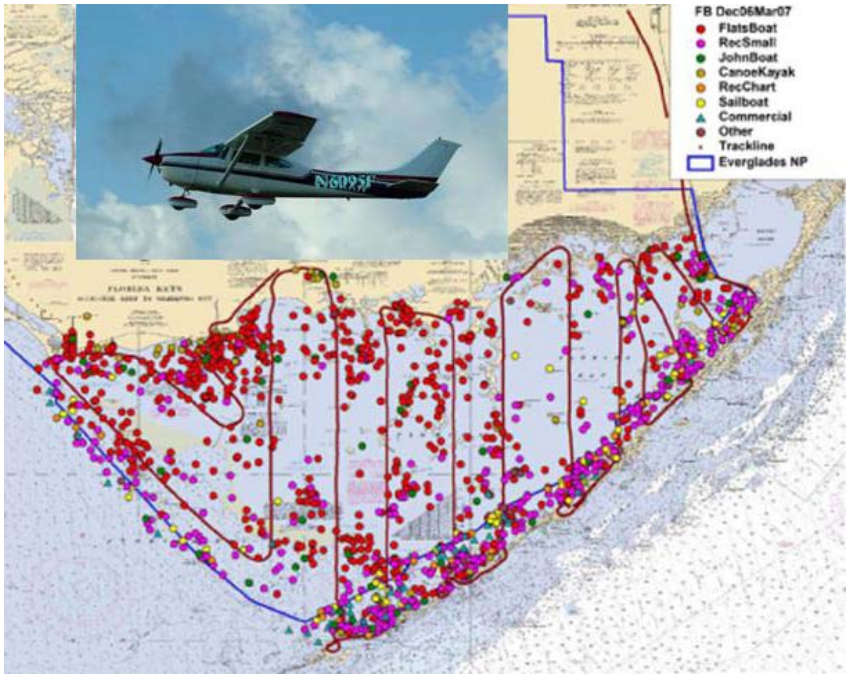

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December 2008

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Executive Summary

Over the past several decades the combination of rapidly growing regional human population, ever-growing recreational use, overfishing, and habitat alterations have placed significant stress on marine resources in the Florida Keys ecosystem including Everglades National Park (ENP), a 1.5 million acre sub-tropical wilderness situated at the southern tip of the Florida peninsula. The marine environment makes up nearly 1/3 of the Park acreage and includes Florida Bay and the Ten Thousand Islands/Cape Sable region. ENP is a unique marine environment, renown for its diverse natural resources, world-class fishing and boating opportunities, and spectacular scenic beauty. This ecosystem provides the foundation for multibillion-dollar fishing and tourism industries in south Florida.

Understanding the extent of boater uses in ENP waters is an important consideration for building sustainable resources in the General Management Plan and for subsequent planning efforts such as fisheries management, boating education, backcountry management, etc. The goal of this research was to establish a cost-effective method for estimating boater use of ENP on scales of weeks to seasons to years. The study had four main objectives: (1) to conduct an aerial census of vessels in Park waters; (2) to conduct a concurrent census of boat trailers at major public boat ramps in the vicinity of ENP; (3) to develop statistical models for predicting total boater use; (4) to determine changes in boating activity and patterns of visitor use of park marine waters in the past 20 – 30 years, by pooling and comparing data from past boat surveys/trailer counts (conducted intermittently between 1972 and 1984) with the results of this project.

- An aerial census of Park boater use was conducted between Fall 2006 and Fall 2007. We flew 83 missions. A mobile integrated GPS-GIS recording system, developed for the Biscayne NP aerial survey (Ault et al. 2008), was modified using pilot study data for Florida Bay vessel types and disposition categories. Eight vessel classes were identified and were characterized by activity type on the water.
- Photographs were taken of various principal access-point marinas during each overflight survey for obtaining trailer counts. Physical counts of trailers were taken at a limited number of marinas.
- From these data we developed mathematical functions to predict the number of vessels on ENP waters dependent on boat trailer counts at marinas for the 2006-2007 study period.
- We compared these results with historical studies of boater use in ENP conducted in the 1970s. We found that boater use had increased 2.5 times between the 1970s and 2006-2007.

Recommendations are provided that highlight potential uses of the spatial database in other Park management initiatives.

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1.0 Introduction

Situated at the southern tip of the Florida peninsula, Everglades National Park (ENP) is a 1.5 million acre sub-tropical wilderness, comprising extensive fresh- and marine-water resources (**Figure 1**). The marine environment makes up nearly 1/3 of the Park acreage and includes Florida Bay, that separates the mainland from the Upper Keys, and the Ten Thousand Islands/Cape Sable region, that runs nearly 80 miles along the park boundary and Gulf of Mexico. Park marine waters play a critical role in the function of natural processes in the Everglades and Florida Keys coral reef ecosystems.

Everglades NP and its marine resources are increasingly impacted by ever-growing recreational use and activity, and have also been impacted from manipulation of the natural hydrologic regime over the past century. ENP, along with neighboring Biscayne National Park and the Florida Keys National Marine Sanctuary, comprise a unique marine environment, renown for its diverse natural resources, world-class fishing and boating opportunities, and spectacular scenic beauty. This ecosystem provides the foundation for multibillion-dollar fishing and tourism industries in south Florida (Johns et al. 2001; Ault et al. 2005; Ault 2008).

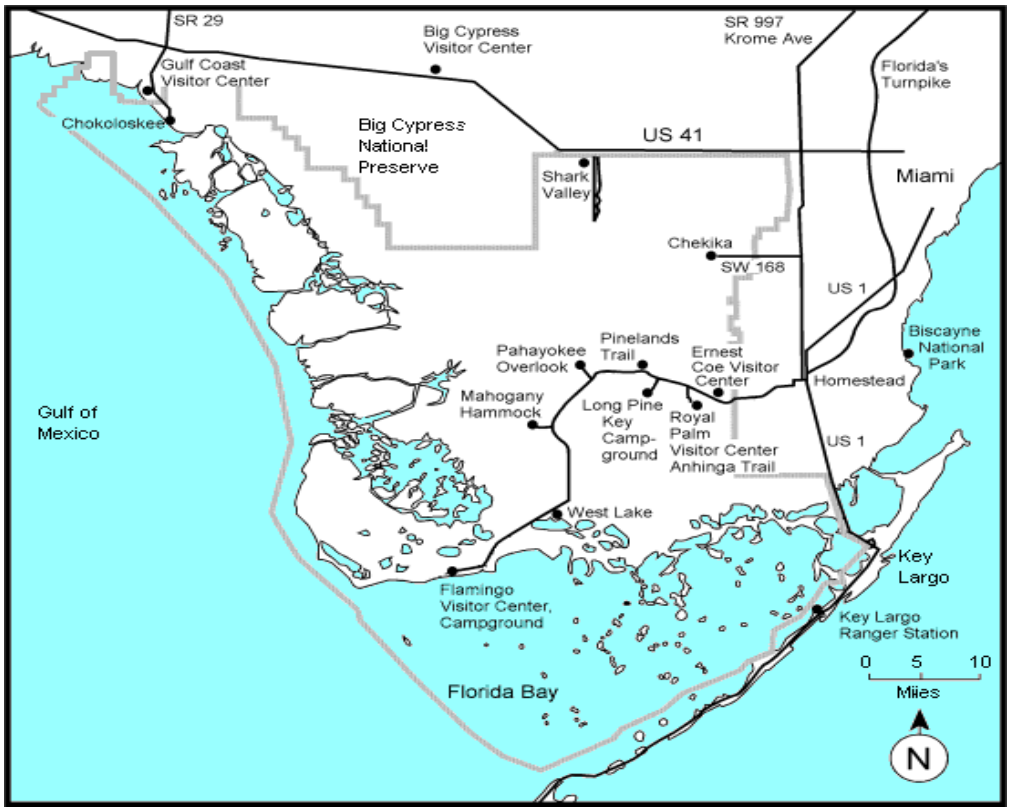


Figure 1. The gray boundary line delineates Everglades National Park.

Over the past several decades, however, the combination of rapidly growing human populations, increased levels of fishing activity, habitat alterations, and changes in regional water quality have placed significant stress on the marine resources in the Florida Keys ecosystem, including ENP (Ault et al. 1998, 2005). To address these important issues within ENP, the Park has

embarked upon the development of a comprehensive General Management Plan (GMP) to guide decision making regarding resource conservation and visitor use over the next 20 years. The GMP will replace the Park's 1979 master plan. The overall intent of the GMP is to set a clear direction and implement policies that fulfill the mission for the Park when it was established in 1947. Specific to the marine resources, the GMP will outline desired future conditions for managing current and anticipated future visitor use in a manner consistent with the requirements for protecting and conserving biological integrity, natural and cultural resources. Because of the challenges of boating in the extremely shallow waters of the park (average depth of 3 to 4 feet) and in the complex system of basins and banks in Florida Bay (**Figure 2**), current, well-supported knowledge about ENP boat use is essential.

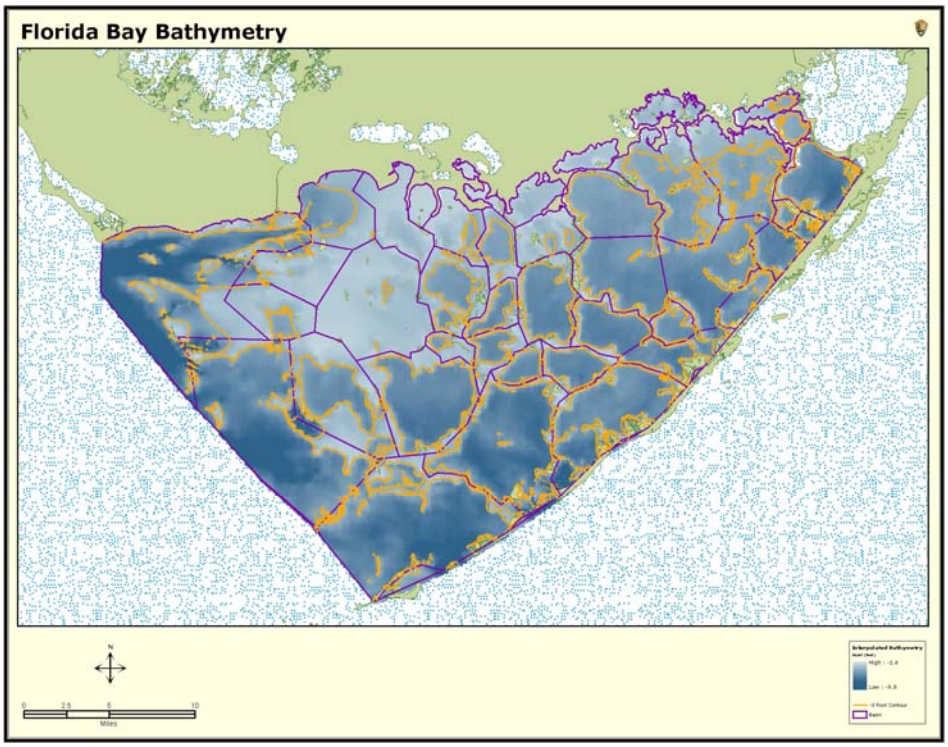


Figure 2. Light blue color represents a bathymetry of 3 feet or less.

Understanding the extent of boater uses in ENP waters is an important consideration for building sustainable resources in the GMP and for subsequent planning efforts such as fisheries management, boating education, back country management, etc. In the 1970s and 1980s, a statistical methodology for estimating boating use in ENP marine waters was developed by determining the relationship between direct counts of boat trailers at the Flamingo boat ramp in the Park and counts of boats on ENP waters estimated from aerial surveys (Tilmant 1989). At that time it was estimated that boating out of Flamingo accounted for between 50% and 60% of fishing boat uses in the park. More current annual fishing reports prepared by ENP estimate that more than 90% of boaters in the park participate in fishing activity. Activity is based on interviews of boaters by park staff at boat ramps at Flamingo and Chokoloskee.

The relationship between vessels and trailers was then used by Tilmant (1989) to predict total on-water boater use from relatively inexpensive trailer counts conducted on a daily, weekly, monthly, and annual basis. However, it has been more than two decades since the last aerial survey of boater use was conducted. Since this time a number of factors have changed which may have affected the underlying relationship between trailer counts and boater use:

1. substantial increases in the regional human population, particularly Miami-Dade, Collier, and Broward counties;
2. increased numbers of registered vessels (40-50% increase/decade);
3. significant increases in boating opportunities (from marinas, private docks) to enter the park from the Florida Keys (there are over 30 miles of permeable boundary in the Upper Keys bordering Florida Bay and the Park); and
4. large increases in the number of professional fishing guides (Incidental Business Permit holders in ENP) operating lucrative businesses in ENP (currently more than 330 IBPs).

There is a clear need to conduct a new study to update the statistical relationship between boat trailers at marinas and total boats in Park waters.

2.0 Goal and Objectives

2.1 Goal

The proposed goal of this research was to establish a cost-effective method for estimating boat use of ENP on a daily, weekly, seasonal or annual basis.

2.2 Objectives

There were three principal study objectives and three secondary objectives. The principal objectives were: (1) to conduct an aerial census of vessels in Park waters; (2) to conduct a concurrent census of boat trailers at major public boat ramps in the vicinity of ENP; and (3) to develop statistical models for predicting total boater use from the data obtained by objectives (1) and (2). The secondary objectives were: (4) to determine changes in boating activity in the past 20 – 30 years by comparing data and analysis results from past boat surveys/trailer counts (conducted intermittently between 1972 and 1984) with the results of this project; (5) to determine future protocols, likely future trends/issues, and suggested follow up work (such as how to simplify/automate future trailer counts) based on findings from this project; and, (6) to teach ENP project participants the methodology and techniques used in this project so that future follow up overflight and trailer count studies could be conducted by the Park.

2.3 Strategy

The survey design and assessment methods were adapted from a previous study conducted in Biscayne National Park (Ault et al. 2008). The study focused on two principal marine regions of ENP, Florida Bay and Ten-Thousand Islands/Chokoloskee (**Figure 1**). In our analysis of boater use, the Florida Bay region was further subdivided into two areas, within the Park boundary and outside the boundary, most notably the Intra-Coastal Waterway between the southern boundary of the Park and the upper Florida Keys. Because of the size and complexity of ENP marine water resources and the socio-economic variables (population, boat use, access points, recreational uses), the PIs and ENP staff working on the project concluded that undertaking the project in 2 phases was appropriate. Phase 1 involved conducting a pilot study (components outlined in 3.0 below) to determine how best to meet the project goal and objectives. This was completed in October 2006. Phase 2, begun in October 2006, consisted of 1-year of full-scale aerial surveys of vessels and trailers at marinas to

provide the data needed for Park managers and the GMP. This report documents our research activities and findings for the pilot study and for five seasons of full-scale surveys conducted from fall 2006 to fall 2007.

3.0 Pilot Study

The pilot study provided investigators with the background and knowledge necessary to design the full-scale study to efficiently yield the desired results for long-term park management and decision making in a cost-effective manner. During the pilot phase, the investigators and ENP personnel conducted a series of research activities to:

1. determine which marinas and access points to include in the trailer census;
2. determine the optimal time frame during daylight hours for conducting the vessel and trailer surveys;
3. determine optimal flight patterns and survey tracks for the aerial census of vessels;
4. determine scientific personnel requirements for aerial surveys;
5. modify the aerial survey onboard data recording system for ENP vessel types and uses; and,
6. develop a sampling plan for the full-scale vessel and trailer surveys.

At the outset of the pilot study, the investigators reviewed a variety of historical flight survey data provided by the Park and conducted interviews with individuals knowledgeable of boating and fishing activity in the Park. The information gained from these activities provided the basis for carrying out the various tasks of the pilot study listed above. Historical Park data included aerial surveys of vessels conducted during the period July 1972-May 1975, as well as maps of historical flight tracks. ENP and University of Miami (UM) project personnel jointly conducted interviews with knowledgeable stakeholders concerning historical, current, and future trends regarding boating and fishing (when, for what, where) in the Park. Interviewees included Park employees with marine water responsibilities, fishing guides, marine resource researchers, community leaders, and representatives of nearby parks and preserves with similar management challenges.

In the historical vessel-trailer surveys, trailers were counted only at the ENP Flamingo marina. The PIs and ENP project personnel both agreed that surveying additional marinas in both the Chokoloskee and Florida Keys regions might improve the statistical relationship between vessels and trailers in the current study. Park personnel and stakeholders familiar with the Chokoloskee region indicated that the marina at Outdoor Resorts would be the best choice to include in the trailer count survey. Selecting marinas in the Florida Keys region was substantially more challenging. An initial list of boat ramps in the Keys was compiled from various internet sources (i.e., state, county, recreational boating websites) and maps, along with descriptions of location, condition of the ramp, parking availability, and specific latitude-longitude coordinates in some cases (**Table 1**). Interviewees familiar with the Florida Keys region provided information on additional ramps/access points as well as suggestions for which marinas to target for trailer counts. A consensus of interviewees indicated that boaters launching from marinas south of Long Key on the Overseas Highway would not likely be traveling to ENP waters; consequently, effort was focused on boat ramps from Long Key north to Card Sound (**Table 1**, ramps 1 to 16).

For the full-scale aerial surveys, accuracy of vessel types, counts, and disposition categories was controlled in several ways: 1) only 3 different experienced observers served as the chief scientific observer on the flight surveys; 2) the spacing of survey track lines and the flight altitude and speed were experimented with during the pilot study flights to (a) provide a complete coverage of the survey domain, (b) to optimize the sighting of all vessels that might be present, and (c) to optimize discernment of the disposition category (e.g., fishing) of sighted vessels; and 3) the ENP

Table 1. List of boat ramps/access points in the Florida Keys.

	Name	Location Description	Waterway	Condition	LAT	LONG	Note
1	Card Sound Road	Card Sound Road has two boatramps. The first is a private ramp at Alabama Jack's and the second is just past the toll plaza before the bridge.	Bayside	Poor, shallow and very uneven	25.2896583	-80.3752416	There is a fee at Alabama Jack's, or you have to pay the bridge tolls to reach the second ramp.
2	Little Blackwater Sound Park	US1, MM-111, Little Blackwater Sound Park	Bayside	Poor, no dock	25.2129364	-80.4254741	Dangerously close to traffic on US1. Public ramp. Wouldn't leave trailer parked here.
3	Gilbert's Resort	MM 107.9, Located at Jewfish Creek	Bayside	Good, shallow ramp, forklift	25.1798333	-80.3900000	Boat trailer parking $10/day. Restaurant-Bar. Wet and dry storage. Plenty of trailer parking
4	Caribbean Club	MM-104, Private ramp, fee $10/day. Safer than Barnes Sound.	Bayside	Good, shallow	25.1450336	-80.3972572	Bar, trailer parking. Nightclub was made famous by John Huston's 1948 film "Key Largo." (305) 451-9970.
5	John Pennekamp State Park	MM-102, ramp $10/day, slips $26/day, very heavily used, excellent park.	Oceanside	Very good	25.1236500	-80.4072200	(305) 451-1202.
6	Key Largo Harbor	100 Ocean Drive, Key Largo	Oceanside	No ramp, only forklift	25.0766667	-80.4271667	$50 for a 30ft boat, can use Adams cut to go to bay, park trailer across the street
7	Harry Harris County Park	MM-92.5, Take Burton Dr. to end, park entrance is on Beach Rd.	Oceanside	Very Good, 2 ramps, parking for 20 trailers	25.0245600	-80.4944800	Park fees$10/trailer and $5/person (non county resident) weekends and holidays, 8:00 am to sundown, restrooms, picnic tables, playground, good security and sandy beach. 20 boats/trailers daily. It is under construction but ramp is open, no entrance fees. 305/852-7161 or 888/227-8136
8	Tavernier, Jo-Jean Way	MM-92, Tavernier, Jo-Jean Way.	Bayside, Tavernier creek	Small unpaved ramp	25.01247	-80.5175800	Dead end street, ends in a ramp. No parking
9	Fournders Park	MM 86 (Former Plantation Yacht Harbor)	Bayside	Big ramp, members only*, slips	24.9647400	-80.5682400	*Members only: free to locals, fee for others, ample pkg, excellent condition, Fuel station, restroom, ice, nice facilities, trailer parking
10	Smugglers Cove Marina	MM85.5, 85500 Overseas Highway, Islamorada	Bayside	Good, small ramp*	24.9528700	-80.5889700	Next to snake creek. New owner changed rules, *ramp closed to public (only registered guests), slips available for public use $2.00/ft
11	Holiday Isle Marina	MM84	Bayside	Big ramp for register guests*	24.9311667	-80.5951667	*During low season open to public for a fee $20. Flats boats in covered dry storage with info sign, no visible parking for trailers (on grass maybe)
12	Lorelei	MM 82	Bayside	Small ramp next to restaurant	24.9212200	-80.6328500	Trailer parking covered by trees, appears to be construction around it
13	La Siesta Marina	MM 79	Bayside	Nice ramp, well protected marina, fee $20	24.9071900	-80.6497500	Ice, restrooms, nice entry road. WILL CLOSE ON 09/2007
14	Indian Key Fill Boat Ramp	MM-79, Indian Key Fill Boat Ramp. Access for Lignumvitae and Indian Keys.	Bayside and Ocean via Hawk Channel	Poor, unpaved, shallow, no dock	24.8896658	-80.6778055	Limited parking for trailers.

Table 1 (continued).

	Name	Location Description	Waterway	Condition	LAT	LONG	Note
15	Fiesta Key KOA campground	Bayside	Bayside	Big ramp, small access canal, members only, slips	24.8431800	-80.7929900	Facilities, tackle store, restrooms, fuel pumps
16	Seabird Marina	Bayside on Long Key at MM 69.5	Bayside	Deep launch ramp, marina store, fee $15, slips	24.8377500	-80.7986800	305-664-2871, Ramp hours 7am-5pm
17	Marathon Boat Ramp	MM-53, Marathon Boat Ramp. Limited access, additional parking at Quey or across the street.	Bayside, Vaca Cut to Ocean.	Good, no dock	24.7332180	-81.0181136	Low overhead.
18	North on Aviation Blvd.	MM-51, North on Aviation Blvd. at west end of Airport. Go north and east to corner of Harbor Dr.	Bayside	Poor, short & narrow, sharp drop at end			Tiny park, very limited access and parking.
19	Behind Marathon Yacht Club	MM-49, North on 33 St., behind Marathon Yacht Club. Parking, dock, busy	Bayside	Good	24.7132517	-81.0951252	
20	Bahia Honda State Rec. Area	MM-37, Bahia Honda State Rec. Area. Park fee, restrooms, snackbar, beach, open 8:00 am to sunset.	Oceanside and Bayside	Very Good 2 Ramps			
21	Little Duck Key	MM-39, Little Duck Key. Good access & parking, dock, shallow at low tide.	Bayside	Good	24.6820522	-81.2294503	
22	Spanish Harbor Wayside Park	MM-34, Spanish Harbor Wayside Park, on West Summerland Key	Bayside	Good/Poor Short ramp, shallow at low tide, no dock.	24.6499945	-81.3179469	
23	Big Pine Key	MM-30, Big Pine Key, North on Key Deer Blvd, east on Big Pine St., north on Koehn Ave., ramp is straight off the end of the road. No real parking or security	Bayside	Poor, Very shallow at low tide, no dock			
24	Little Torch Key	MM-28, Little Torch Key, North on old SR 4A. Parking across street.	Oceanside & Bayside	Good			
25	Shark Key	MM-11, Shark Key. Very tight maneuvering, limited parking.	Oceanside	Poor, no dock	24.6012373	-81.6474830	
26	Stock Island	MM-6, Stock Island. Tight maneuvering, limited parking.	Oceanside	Poor, no dock	24.5751286	-81.7323214	
27	Key West Roosevelt Blvd	Key West, Roosevelt Blvd., west end of Smather's Beach	Oceanside	Poor/Unusable. Ramp in very poor condition.	24.5508116	-81.7762936	Emergency use only. Launch from busy A1A right on a 90 degree curve.
28	Key West Garrison Bight	Key West, A1A, MM-2.5, Garrison Bight. $5 for ramp, $6 all day.	Gulf of Mexico	Very Good, double wide, dock.			
29	Key West, North end of Simonton St.	Key West, North end of Simonton St. $1/hr meters (bring quarters), restrooms, small beach.	Gulf of Mexico	Good, single ramp, dock, sunrise to sunset			

marine waters were divided into 2 separate flight domains, with only 1 domain surveyed on a given flight, to keep flight times in the range of 2-3 hours which minimized both pilot and observer fatigue.

UM personnel conducted a driving tour of the candidate boat ramps to update information on ramp condition, parking, etc., as well as to obtain precise latitude and longitude coordinates using a handheld GPS. Based on the site visits and suggestions from knowledgeable stakeholders, seven marinas were selected for conducting trailer counts (**Table 2**). These marinas had boat ramps that were in good condition, were readily accessible to the public, had adequate parking for vehicles with trailers, and were likely launching points for trips to ENP waters. ENP personnel and the PIs subsequently determined that the most reliable, cost-effective method for obtaining trailer counts at these marinas would be via aerial photographs taken during the vessel aerial surveys.

Table 2. The seven marinas in the Florida Keys selected for trailer count surveys.

Name	Location	Waterway	LAT	LONG
Gilbert's Resort	Mile Marker 107.9	Bayside	25.1798333	-80.3900000
Caribbean Club	Mile Marker 104	Bayside	25.1450336	-80.3972572
Harry Harris County Park	Mile Marker 92.5	Oceanside	25.0245600	-80.4944800
Founders Park (Former Plantation Yacht Harbor)	Mile Marker 86	Bayside	24.9647400	-80.5682400
Lorelei	Mile Marker 82	Bayside	24.9212200	-80.6328500
La Siesta Marina	Mile Marker 79	Bayside	24.9071900	-80.6497500
Seabird Marina	Mile Marker 69.5	Bayside	24.8377500	-80.7986800

Selection of the survey time period within a sampling day was based on two conditions: (1) the time period corresponding to peak levels of vessels in Park waters and trailers at marinas; and, (2) the time period most conducive for visual observation of vessels from an airplane. Interviewees suggested that peak vessel use would occur between 1000h and 1300h. Previous experience in Biscayne NP (Ault et al. 2008) demonstrated that optimal sighting of vessels from an airplane occurred during the midday period of 1000h to 1400h. The target time frame was thus set for 1000h to 1300h, with extension to 1400h if necessary.

The domain for aerial surveys encompassed ENP waters extending to the land-sea interface of the easternmost, southernmost, and westernmost boundaries of ENP, including the Intra-Coastal Waterway (ICW) between the Park and Upper Keys, and Gulf of Mexico waters bordering the Park. Using historical flight tracks as an initial guide, four test flights were conducted, two in the Florida Bay region and two in the Ten Thousand Islands region. The test flights experimented with several different arrangements of survey tracks and flight patterns, seeking to optimize observations of vessels and efficiently use flight time. **Figure 3** shows the optimal survey tracks determined for each region.

In Florida Bay, an altitude between 500 and 800 ft was most conducive for vessel sightings whereas in Ten Thousand Islands the optimal altitude was between 800 and 1000 ft. In Florida Bay tracklines were 3 miles apart (1.5 miles either side of the airplane) which enabled all vessels to be counted. In the Ten Thousand Islands flight tracks first hugged the coast and vessels were also counted in the rivers and creeks. The southern track followed the bays and main rivers which optimized sightings. These tracks also eliminated the possibility of repeated sightings of the same vessel.

The required duration for Florida Bay surveys was approximately 3 h, and the duration for

Ten Thousand Islands was approximately 2 h. It was decided to divide the survey domain into two regions, Florida Bay (FB) and Ten Thousand Islands (TTI), and to survey each region on separate flights. This would enable each region to be surveyed within the optimal time frame of 1000h to 1300h and also to avoid the need to make a refueling stop.

Based on the test flights, it was determined that two scientific observers in addition to the pilot would be required for each aerial survey, one person to run the laptop-GPS recording system and one person to identify the type and disposition of sighted vessels. Each observer utilized binoculars to aid in vessel sightings and classification.

A mobile integrated GPS-GIS recording system, developed for the Biscayne NP aerial survey (Ault et al. 2008), was modified using pilot study data for Florida Bay vessel types, disposition categories, etc. This recording system comprises a laptop computer, trackball mouse, and GPS unit mounted on a lap desk, and was used to collect real-time in-flight data on vessel usage including position (latitude and longitude), time of sighting, vessel number and characterization (e.g., larger deep-draft motor boats, flats boats $\leq 23'$, canoes/kayaks, sailboats, etc.), and disposition (e.g., in transit, anchored/moored, fishing, snorkeling, etc.). Vessel information was recorded using ArcGIS software. The vessel-recording software routine was modified to provide 'pick-lists' of typical vessel types (**Table 3**) and vessel disposition categories (**Table 4**) for ENP waters. Note that although commercial fishing was banned inside ENP waters in 1985, the flight survey domain included waters outside of Park boundaries where commercial fishing is allowed.

The sampling plan for full-scale vessel-trailer surveys was finalized after analysis of data obtained during the pilot study. A total of 82 surveys were initially allocated among seasons, the two survey regions, and weekdays and weekends as shown in **Table 5**.

Figure 3. (a) Optimal survey track line (brown dotted line) for the Florida Bay region, beginning at the eastern edge of Florida Bay; marinas for conducting trailer counts in the Florida Keys are denoted by red stars. **(b)** Optimal survey track line for the Ten Thousand Islands region, proceeding NW along the Gulf of Mexico coast and then SW through the backcountry waterways.

(a)

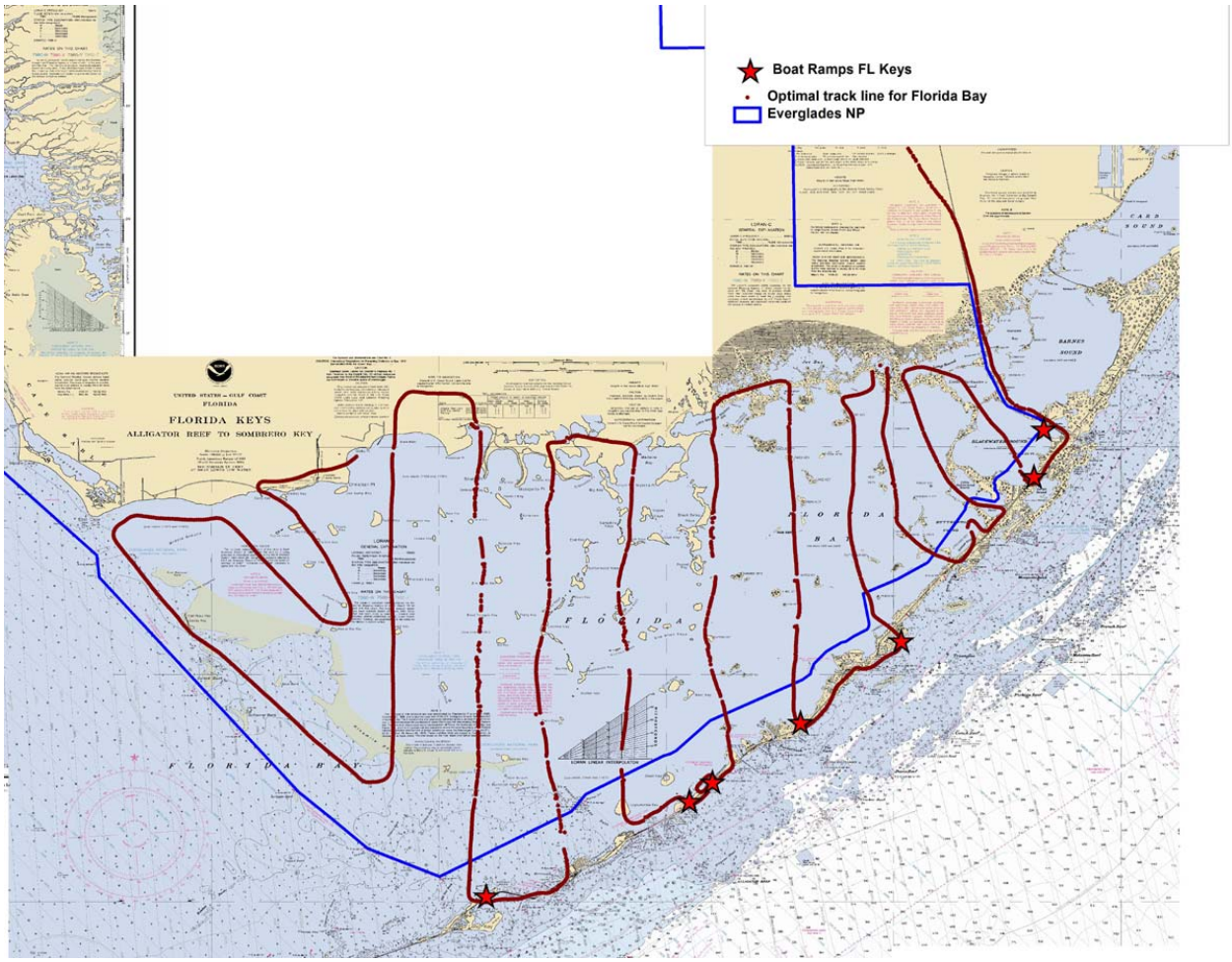


Figure 3 (continued).

(b)

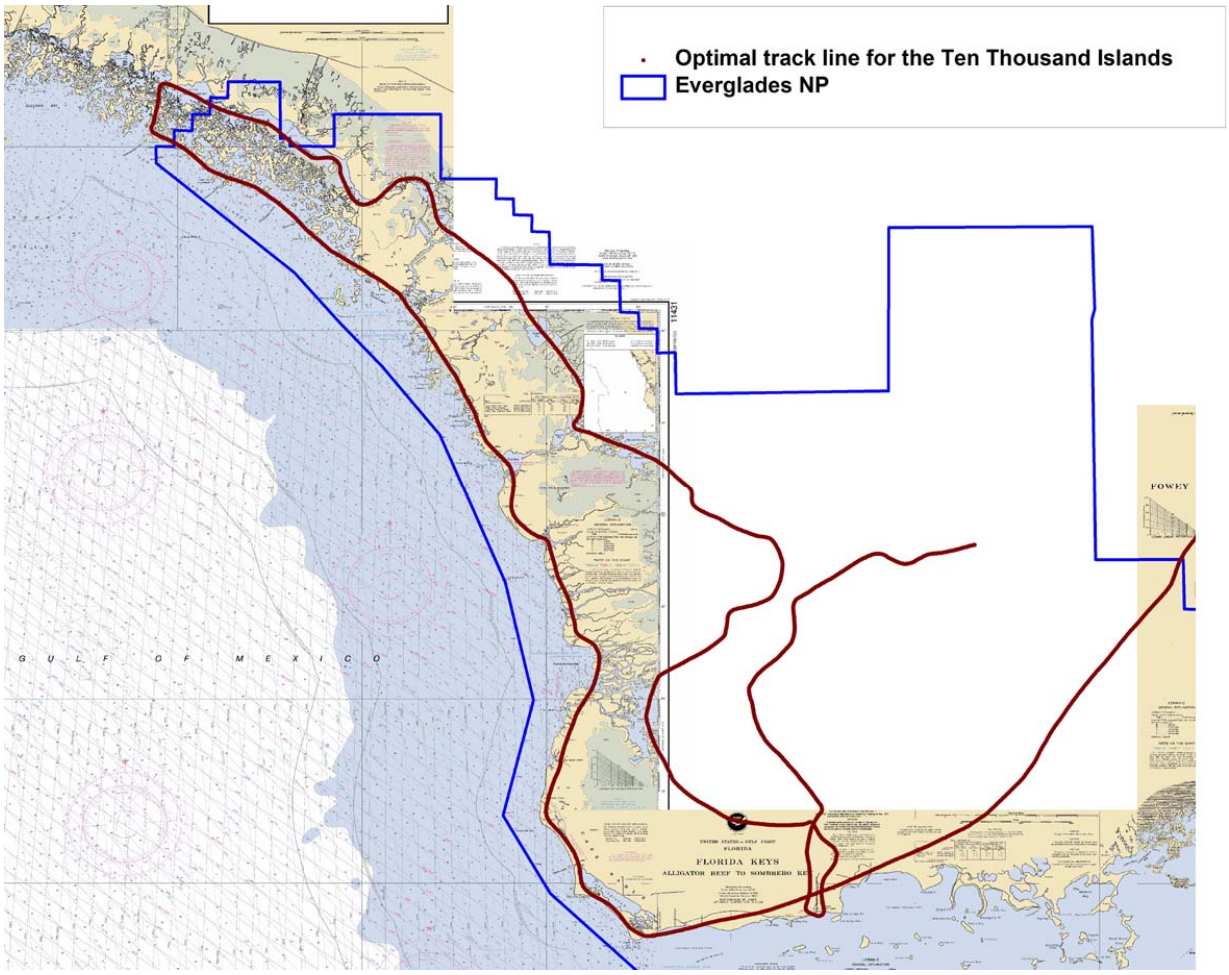


Table 3. Vessel categories for ENP aerial survey.

Vessel Type	Description
FlatsBoat	Recreational motorboats smaller than 23ft long, manufactured for optimal shallow water navigation and outfitted with a platform for sight fishing.
CanoeKayak	Canoes or kayaks.
JohnBoat	Recreational skiff, motorboats smaller than 14ft long.
RecSmall	Recreational motorboats smaller than 23ft long, usually outfitted with a center console.
RecChart	Recreational motorboats larger than 23ft long.
Sailboat	Recreational sail boats.
Commercial	Commercial fishing vessels typically outfitted for capturing crustaceans or sponges.
Other	Barges/cargo vessels, research/law enforcement vessels, house boats, personal watercraft, etc.

Table 4. Vessel disposition categories for ENP aerial survey.

Disposition Category	Description
Fishing	Vessels with persons engaged in: recreational hook-and-line fishing; commercial sponging; crabbing or lobstering with traps.
Cruising	Motorboats, sailboats, etc., in transit.
Diving	Vessels with persons engaged in snorkeling or scuba diving.
Party	Vessels anchored, moored, or secured to a boat dock or similar structure; persons aboard engaged in activities other than fishing or diving.
Other	Vessels engaged in patrolling (e.g., Coast Guard, Park rangers), scientific research; derelict vessels; vessels under tow.

Table 5. Number of vessel-trailer surveys initially allocated by season, region (Florida Bay or Ten Thousand Islands), and day of week category (weekday or weekend/holiday).

Season	Region	Weekday	Weekend/Holiday	Total
Fall 2006	FB	5	5	10
Fall 2006	TTI	3	3	6
Winter 2007	FB	8	8	16
Winter 2007	TTI	5	5	10
Spring 2007	FB	4	4	8
Spring 2007	TTI	3	3	6
Summer 2007	FB	8	8	16
Summer 2007	TTI	5	5	10
Total		**41**	**41**	**82**

4.0 Aerial Census of Vessels

4.1 Fall 2006 Season

A total of 16 vessel-trailer surveys were conducted from October to December 2006 (**Table 6)**, with 9 surveys occurring on weekend/holiday dates, and 7 surveys on midweek dates. For a given weekly time during the survey period, specific survey days were randomly selected within the two day of week categories, weekday or weekend/holiday, for each region. Days with extreme low-tide conditions during the survey time frame were avoided. Some of the randomly-selected dates were altered during the season because of flight cancellations due to scheduling conflicts, aircraft maintenance issues, and unsafe weather conditions. Scientific personnel for the fall 2006 aerial census of vessels were drawn from the University of Miami's Rosenstiel School of Marine and Atmospheric Science (UM-RSMAS) and the NOAA Fisheries Southeast Fisheries Science Center (SEFSC). The survey database was constructed and maintained by UM-RSMAS personnel.

Example aerial vessel census maps are shown in **Figure 4** for the Florida Bay region and in **Figure 5** for the Ten Thousand Islands region, illustrating differences in boater use of Park waters among a typical low-use day (**Figures 4a** and **5a**) and typical high-use day (**Figures 4b** and **5b)**. The complete set of daily flight maps for fall 2006 is given in **Appendix A**. Summary flight maps (all surveys combined) for fall 2006 are given in **Figure 6** for Florida Bay and in **Figure 7** for Ten Thousand Islands.

Table 6. Fall 2006 season sampling dates. Location codes: FB, Florida Bay; TTI, Ten Thousand Islands. Day of week category codes: MW, midweek; WH, weekend/holiday.

Survey ID#	Location	Year	Month	Day	Day of Week	Day of Week Category
001	FB	2006	OCT	17	TUE	MW
002	FB	2006	OCT	27	FRI	MW
003	TTI	2006	OCT	28	SAT	WH
004	FB	2006	OCT	29	SUN	WH
005	TTI	2006	OCT	31	TUE	MW
006	FB	2006	NOV	5	SUN	WH
007	FB	2006	NOV	10	FRI	WH
008	FB	2006	NOV	11	SAT	WH
009	FB	2006	NOV	12	SUN	WH
010	FB	2006	NOV	15	WED	MW
011	FB	2006	NOV	18	SAT	WH
012	TTI	2006	NOV	19	SUN	WH
013	FB	2006	NOV	26	SUN	WH
014	TTI	2006	NOV	28	TUE	MW
015	FB	2006	NOV	29	WED	MW
016	TTI	2006	DEC	4	MON	MW

Figure 4. Example aerial vessel census maps of the Florida Bay region illustrating **(a)** a typical low-use day (November 26, 2006) and **(b)** a typical high-use day (November 11, 2006). The flight track is denoted by the brown dotted line; vessel types at a given location are denoted by the colored dots.
(a)

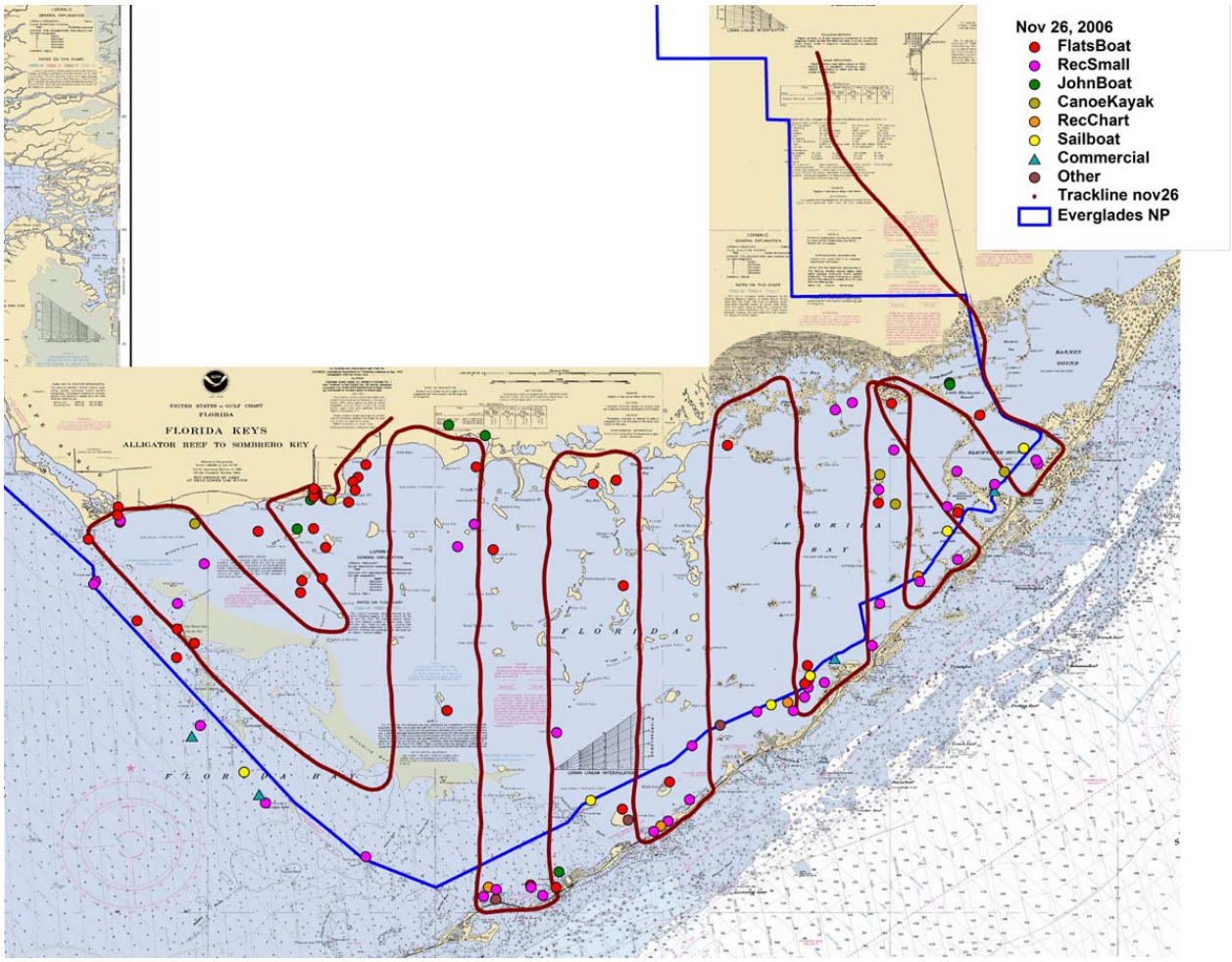


Figure 4 (continued).

(b)

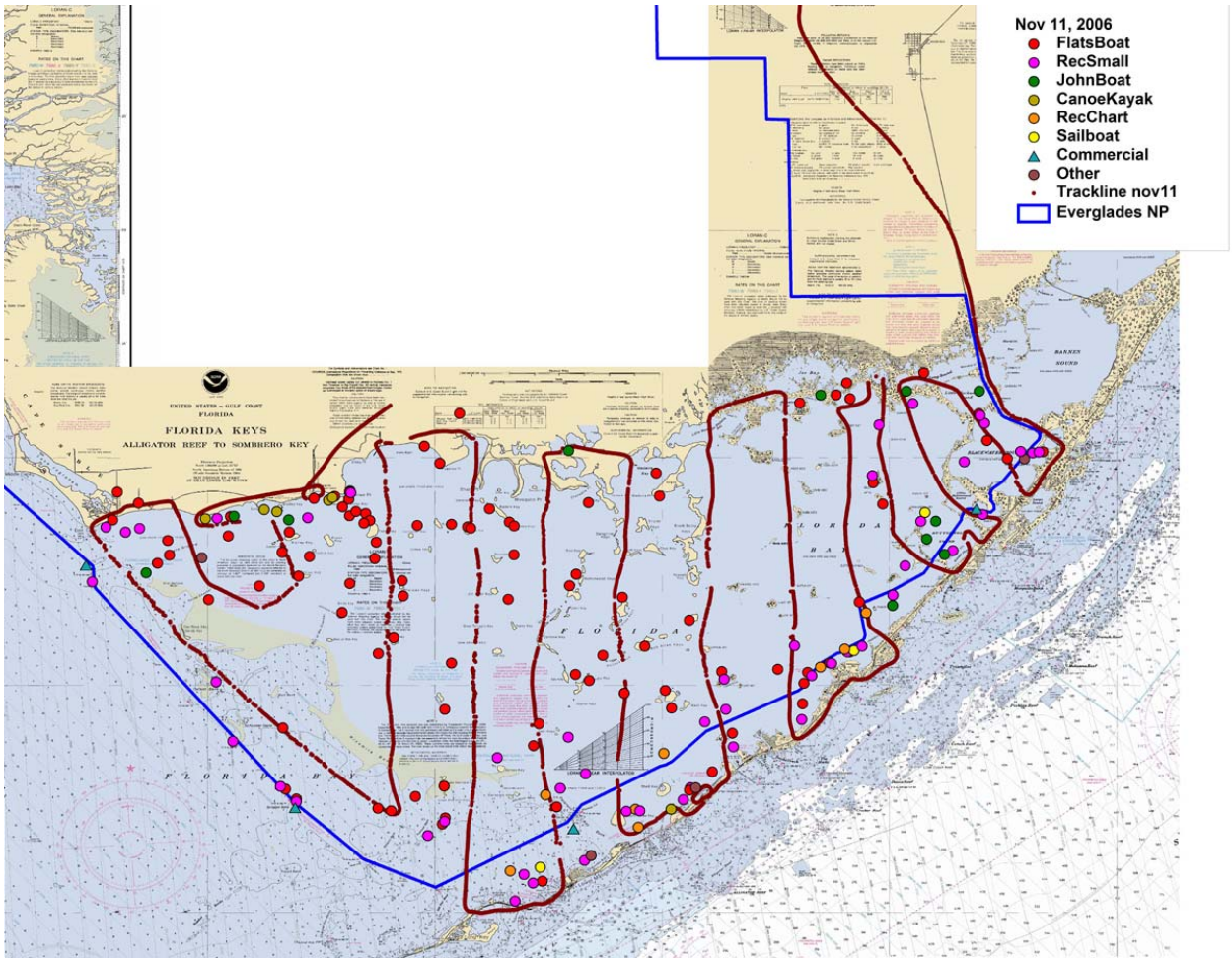


Figure 5. Example aerial vessel census maps of the Ten Thousand Islands region illustrating **(a)** a typical low-use day (December 4, 2006) and **(b)** a typical high-use day (November 19, 2006). The flight track is denoted by the brown dotted line; vessel types at a given location are denoted by the colored dots.

(a)

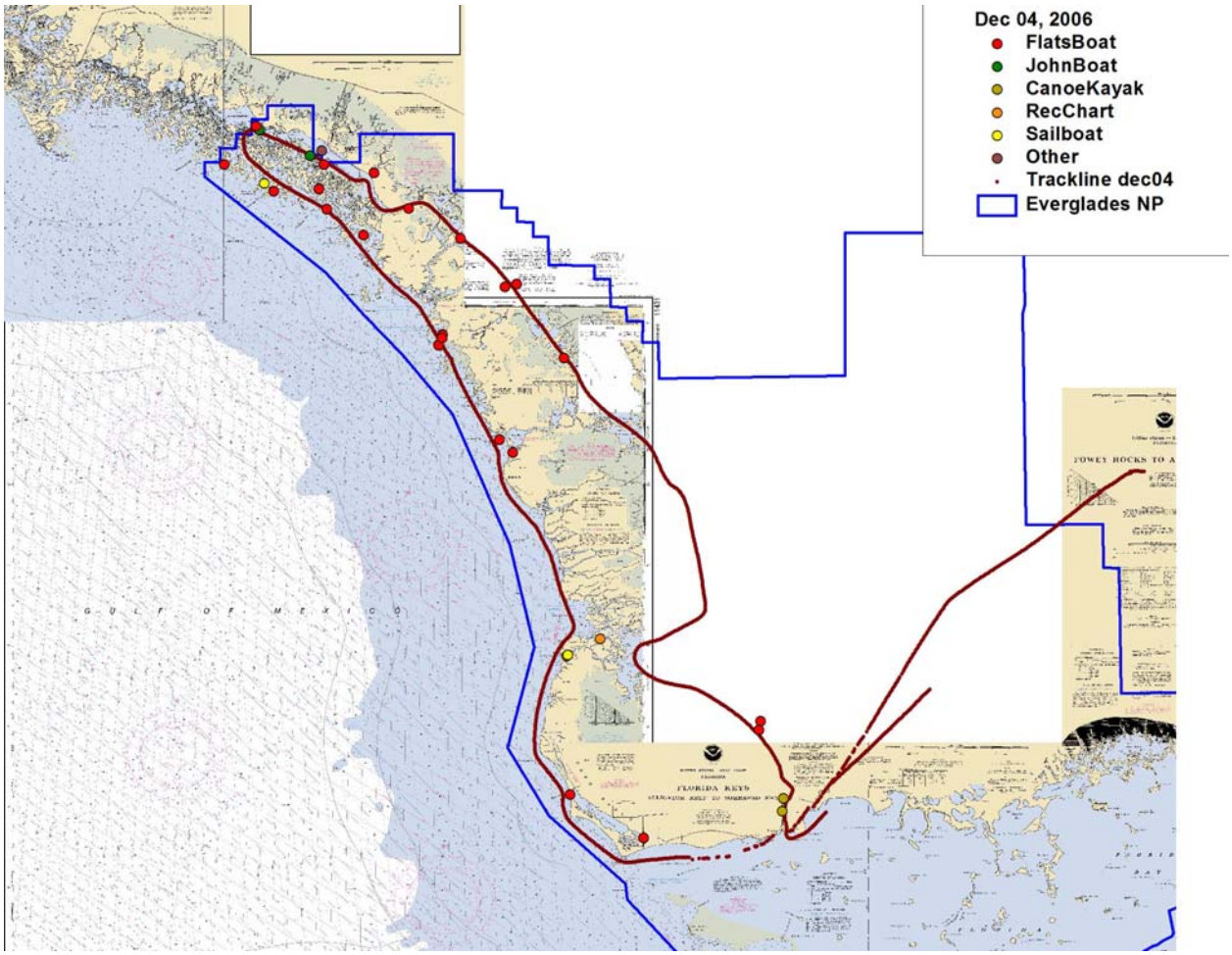


Figure 5 (continued).

(b)

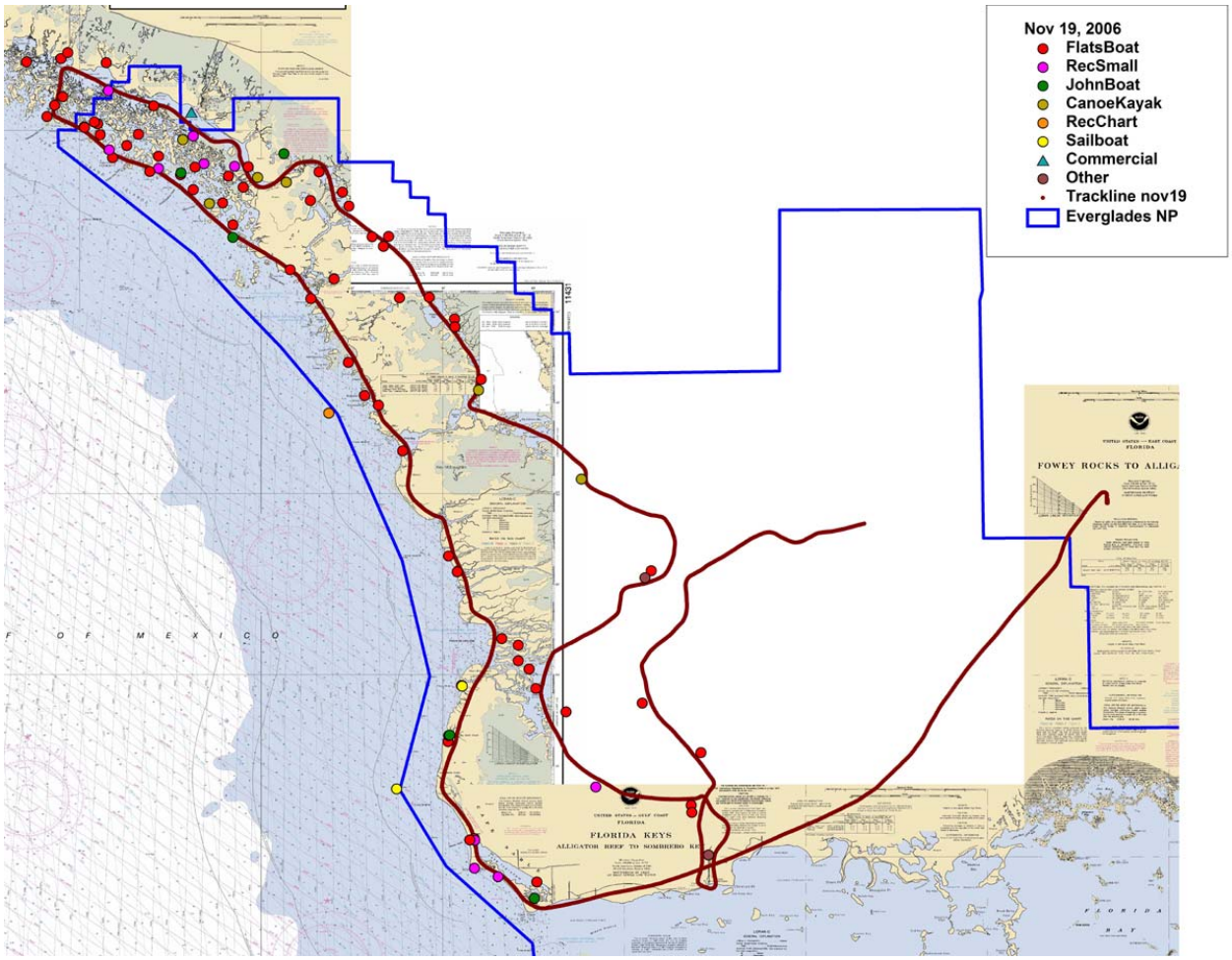


Figure 6. Seasonal summary flight map for fall season 2006 (October to December 2006) aerial surveys for the Florida Bay region.

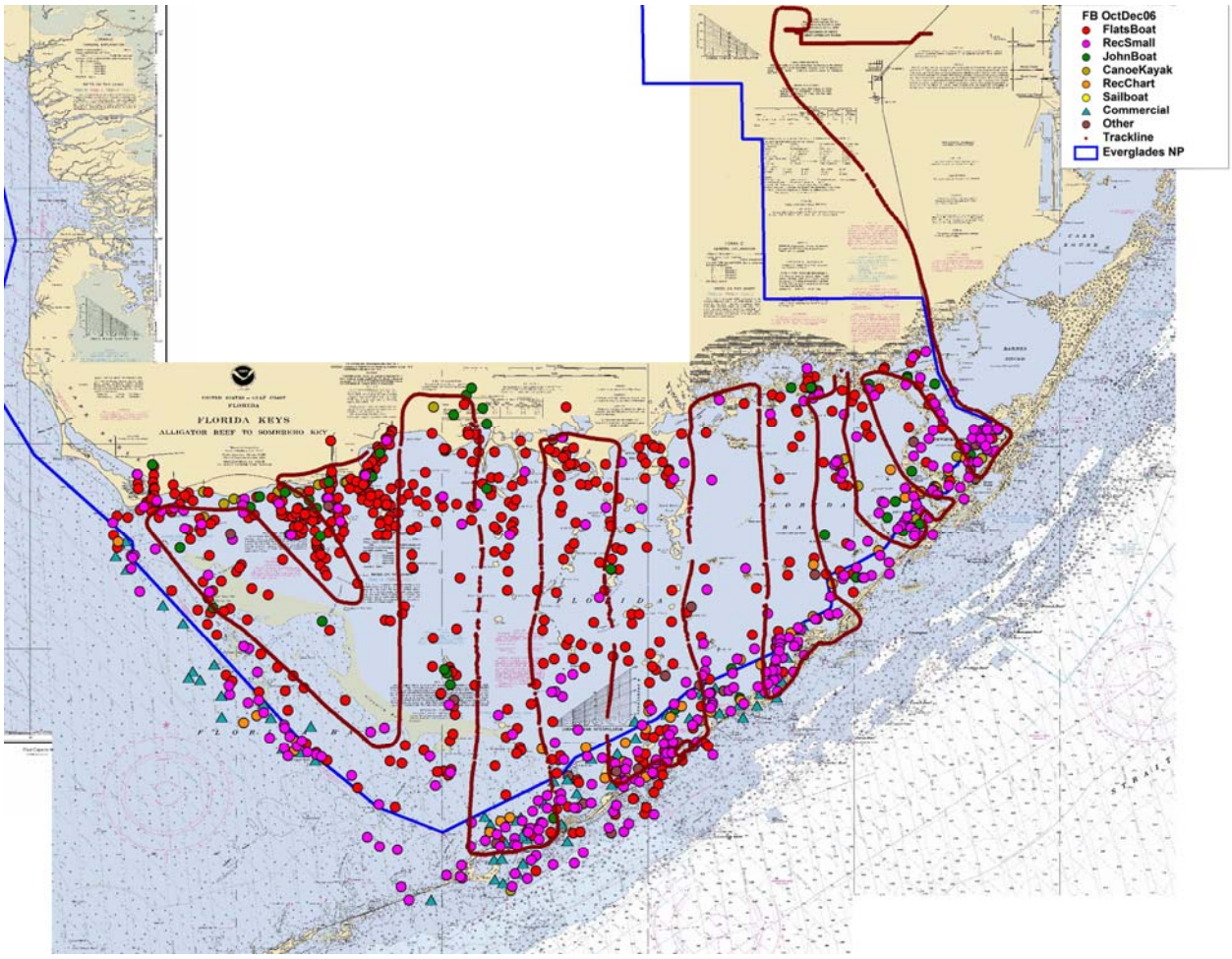
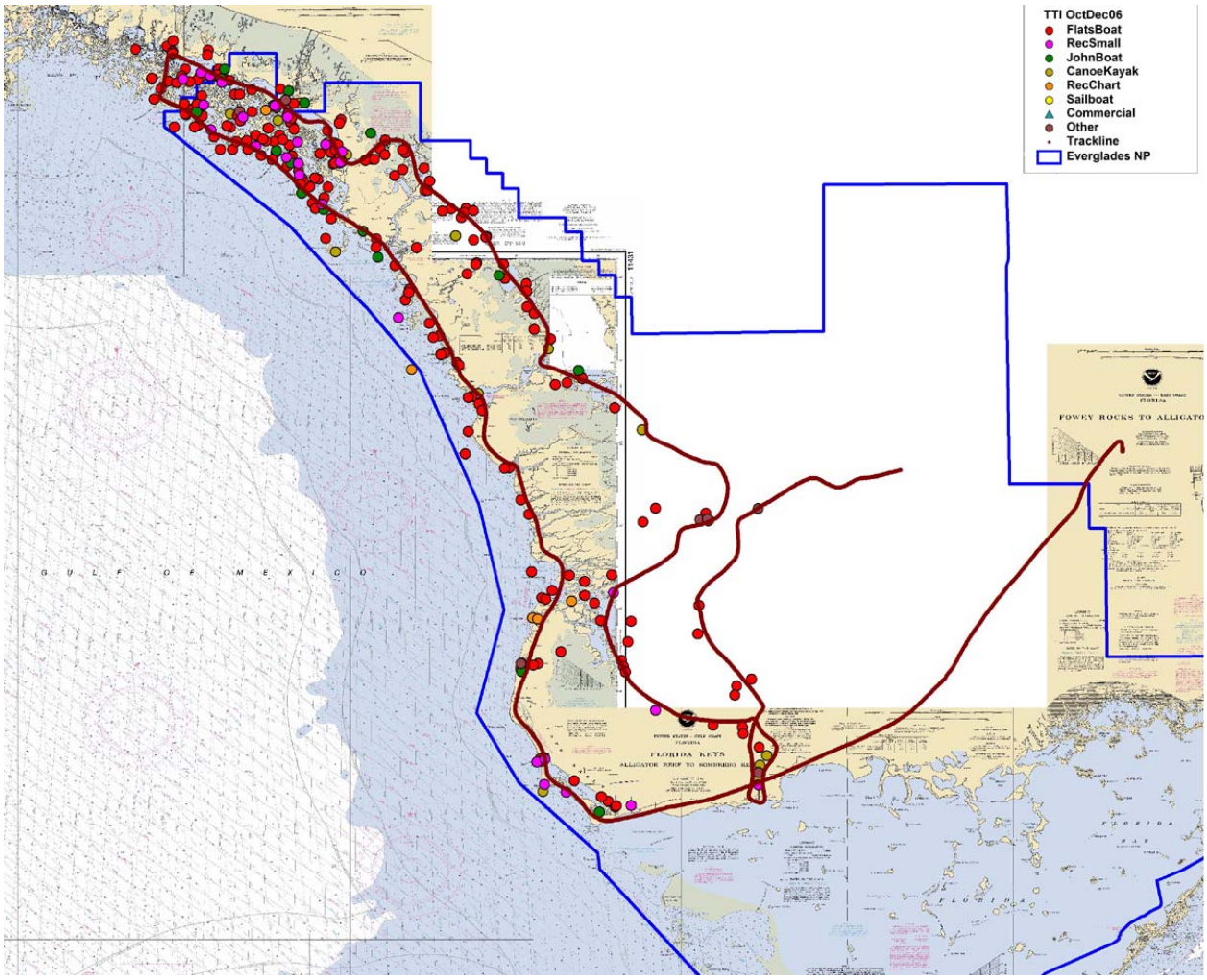


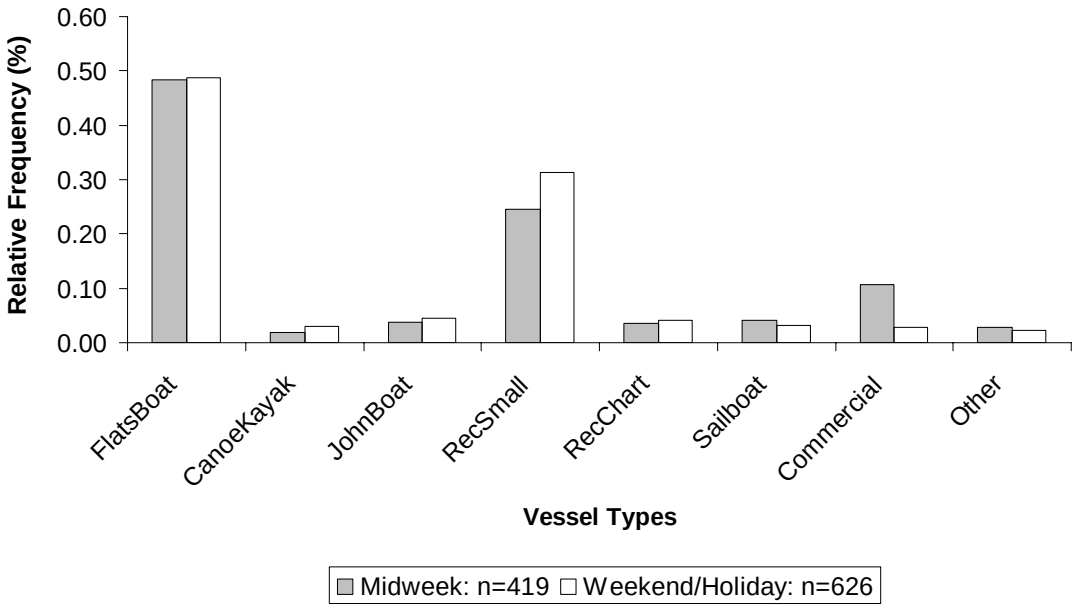
Figure 7. Seasonal summary flight map for fall season 2006 (October to December 2006) aerial surveys for the Ten Thousand Islands region.



In Florida Bay, flatsboats and small recreational motorboats (less than 23 ft in length) accounted for the majority of vessels irrespective of day of the week (**Figure 8a**). Commercial fishing vessels, observed along the southern and western Park boundaries, were more prevalent during weekdays compared to weekends. In the Ten Thousand Islands region, flatsboats were the dominant vessel type observed, followed by small recreational motorboats, johnboats, and canoes/kayaks (**Figure 8b**). In terms of disposition, vessels were mostly engaged in fishing or in transit in both regions irrespective of day of the week (**Figure 9**).

Figure 8. Relative composition of vessel types (see Table 3 for description) by day of week category for (a) Florida Bay and (b) Ten Thousand Islands regions for the fall season 2006 aerial surveys.

(a) Florida Bay



(b) Ten Thousand Islands

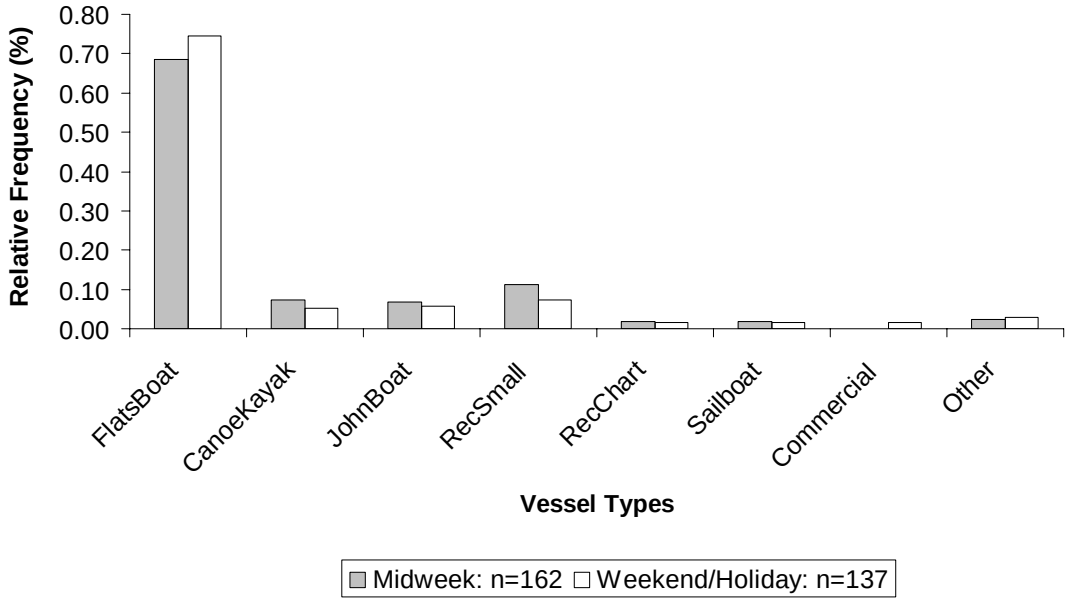
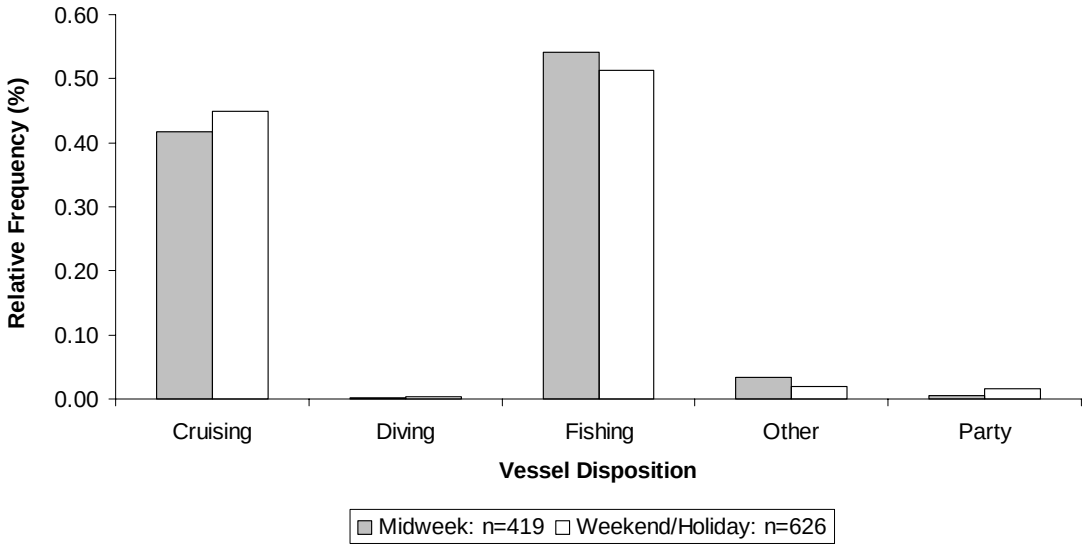
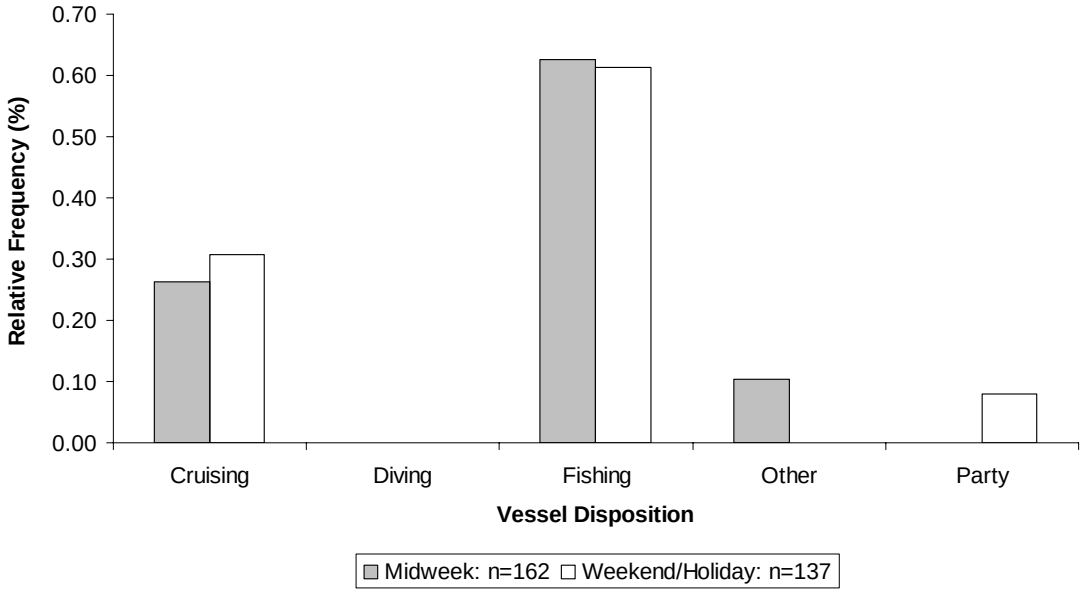


Figure 9. Relative frequency of vessel disposition categories (see Table 4 for description) by day of the week for (a) Florida Bay and (b) Ten Thousand Islands regions for the fall season 2006 aerial surveys.

(a) Florida Bay



(b) Ten Thousand Islands



4.2 Winter Season 2007

A total of 24 vessel-trailer surveys were conducted from December 15, 2006, through March 2007 (**Table 7)**, with 15 surveys on weekend/holiday dates and 9 surveys on midweek dates. The allocation strategy was altered for the winter season. After evaluating the flight data from the Fall 2006 season and consulting with Park scientists, it was decided to disregard the lunar tidal phase in the allocation of specific flight days. Tidal conditions are more a function of wind conditions rather than lunar period in the marine waters of ENP (both Florida Bay and Ten Thousand Islands). Also, attempting to avoid predicted low-tide periods resulted in surveys being conducted very close in time to one another during fall 2006. Therefore, during winter 2007 specific survey days were randomly selected within the two day of week categories, weekday or weekend/holiday, for each region without regard to lunar tidal phase. An attempt was also made to spread out survey days in time within each region to sample over the full range of environmental and boating conditions that likely influence the number of vessels in Park waters. Evaluation of fall 2006 data also showed that the largest variation in vessel numbers occurred on weekends and holidays; consequently, more flights were allocated to weekend/holiday days to control for this variation. Some of the randomly-selected dates were altered during the season because of flight cancellations due to scheduling conflicts, aircraft maintenance issues, and unsafe weather conditions. During winter 2007 and all subsequent flight seasons, scientific personnel from the University of Miami's Rosenstiel School of Marine and Atmospheric Science (UM-RSMAS) and the NOAA Fisheries Southeast Fisheries Science Center (SEFSC) performed the duties of recording vessel data on the laptop-GIS system, while personnel from Everglades NP and other institutions assisted with observing vessel types, locations, and dispositions.

The complete set of daily flight maps for winter 2007 is given in **Appendix B**. Summary flight maps for winter season 2007 aerial surveys are shown in **Figure 10** for the Florida Bay region and in **Figure 11** for the Ten Thousand Islands region.

Table 7. Winter season 2007 sampling dates. Location codes: FB, Florida Bay; TTI, Ten Thousand Islands. Day of week category codes: MW, midweek; WH, weekend/holiday.

Survey ID#	Location	Year	Month	Day	Day of Week	Day of Week Category
017	FB	2006	DEC	19	TUE	MW
018	TTI	2006	DEC	23	SAT	WH
019	FB	2007	JAN	6	SAT	WH
020	FB	2007	JAN	14	SUN	WH
021	FB	2007	JAN	16	TUE	MW
022	FB	2007	JAN	18	THU	MW
023	FB	2007	JAN	20	SAT	WH
024	TTI	2007	JAN	21	SUN	WH
025	FB	2007	JAN	25	THU	MW
026	FB	2007	JAN	28	SUN	WH
027	TTI	2007	FEB	1	THU	MW
028	TTI	2007	FEB	8	THU	MW
029	FB	2007	FEB	10	SAT	WH
030	TTI	2007	FEB	11	SUN	WH
031	TTI	2007	FEB	17	SAT	WH
032	FB	2007	FEB	19	MON	WH
033	TTI	2007	FEB	20	TUE	MW
034	TTI	2007	FEB	25	SUN	WH
035	TTI	2007	FEB	27	TUE	MW
036	FB	2007	MAR	1	THU	MW
037	FB	2007	MAR	3	SAT	WH
038	TTI	2007	MAR	10	SAT	WH
039	FB	2007	MAR	11	SUN	WH
040	FB	2007	MAR	17	SAT	WH

Figure 10. Seasonal summary flight map for winter season 2007 (December 2006 to March 2007) aerial surveys for the Florida Bay region.

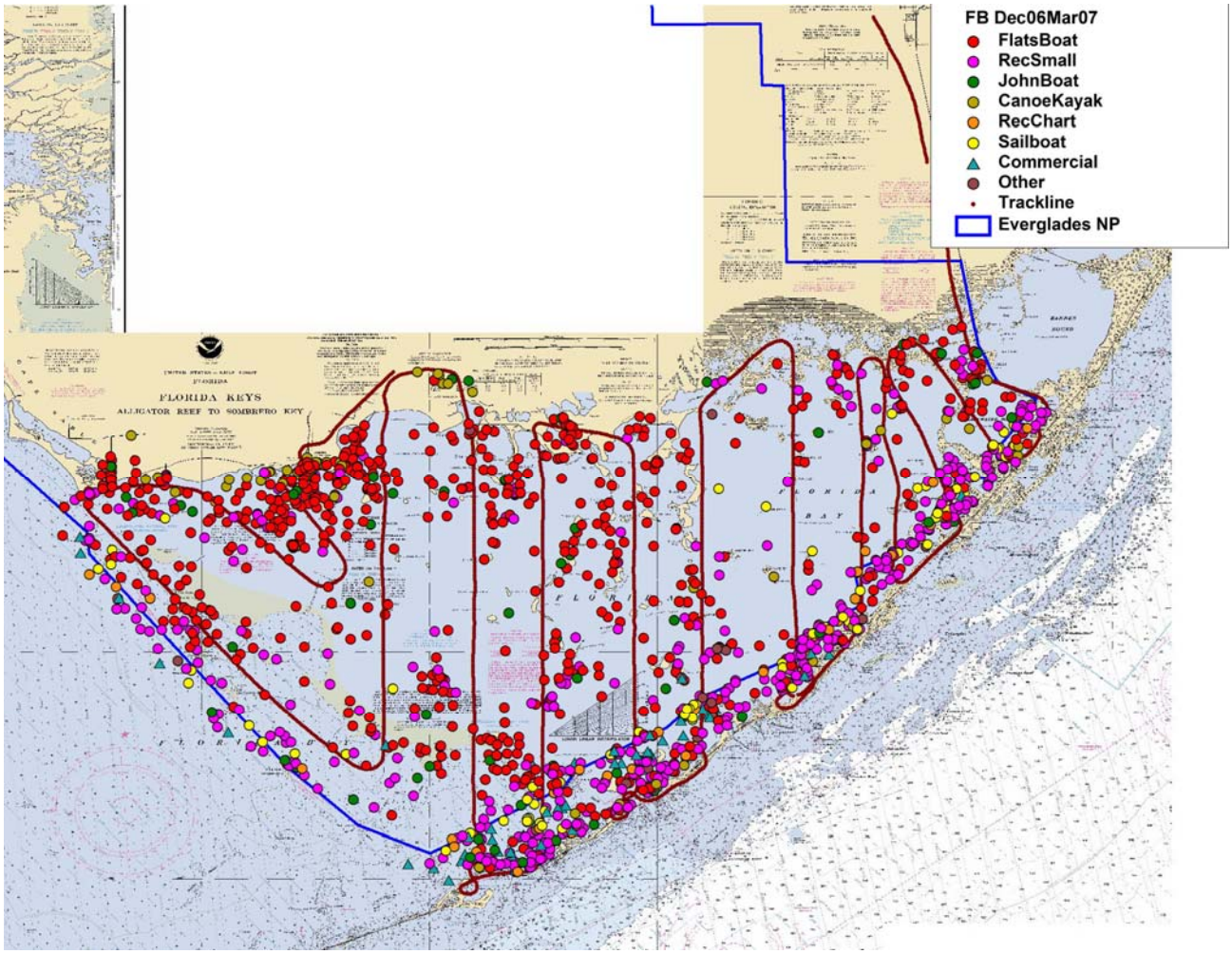
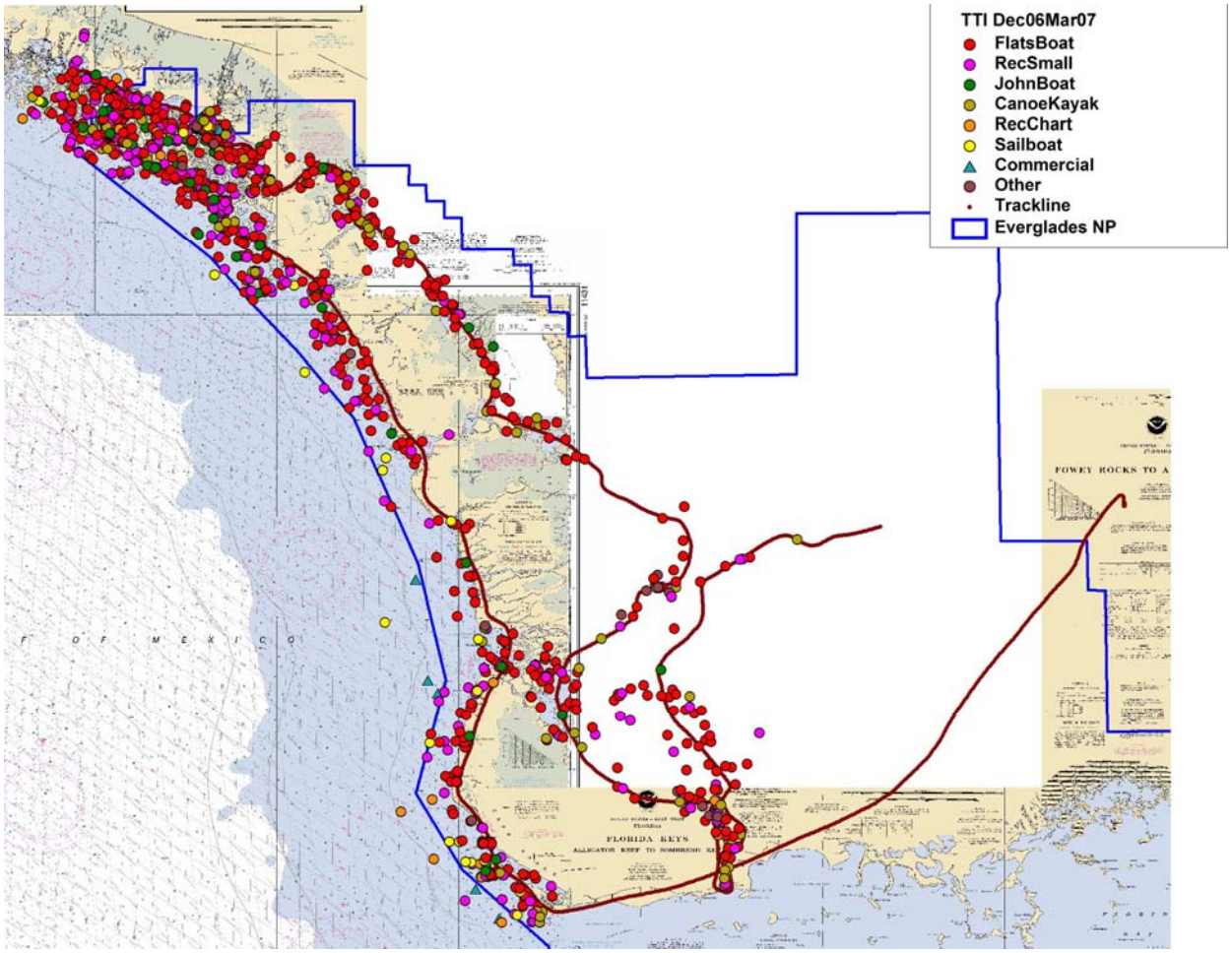


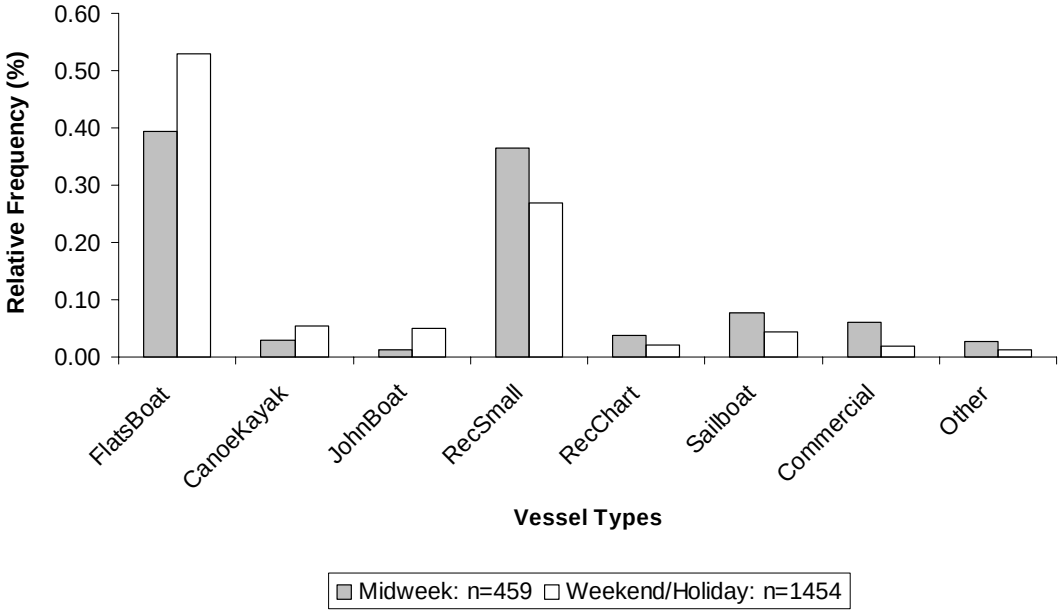
Figure 11. Seasonal summary flight map for winter 2007 (December 2006 to March 2007) aerial surveys for the Ten Thousand Islands region.



In Florida Bay, flats boats and small recreational motorboats (less than 23 ft in length) accounted for the majority of vessels irrespective of day of the week (**Figure12a**). Commercial fishing vessels, observed along the southern and western Park boundaries, were more prevalent during weekdays compared to weekends. In the Ten Thousand Islands region, flatsboats were the dominant vessel type observed, followed by small recreational motorboats, canoes/kayaks, and johnboats (**Figure 12b**). In terms of disposition, vessels were mostly engaged in fishing or in transit in both regions irrespective of day of the week (**Figure 13**).

Figure 12. Relative composition of vessel types (see Table 3 for description) by day of week category for **(a)** Florida Bay and **(b)** Ten Thousand Islands regions for the winter season 2007 aerial surveys.

(a) Florida Bay



(b) Ten Thousand Islands

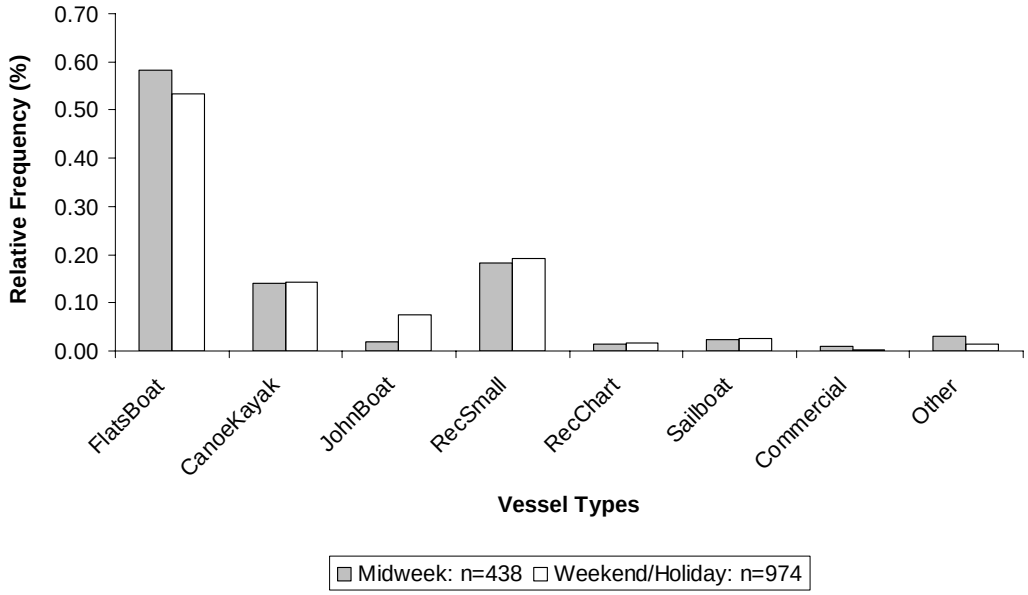
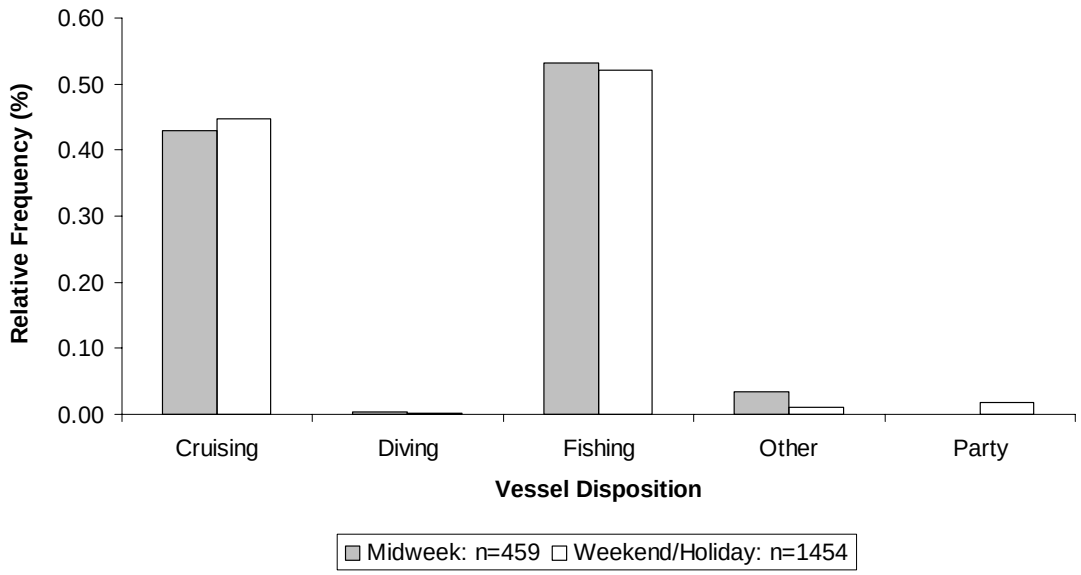
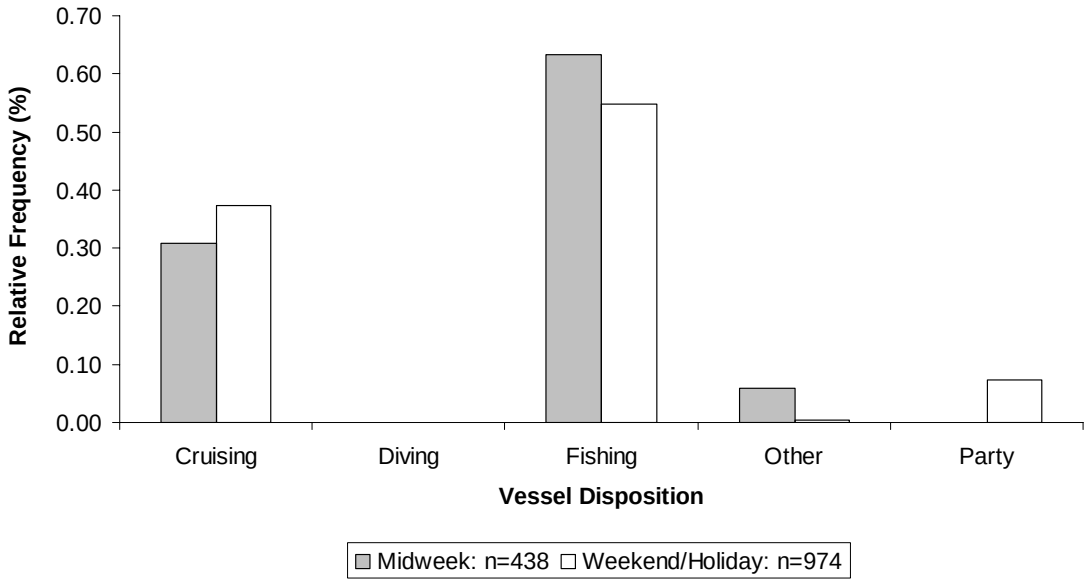


Figure 13. Relative frequency of vessel disposition categories (see Table 4 for description) by day of the week for (a) Florida Bay and (b) Ten Thousand Islands regions for the winter season 2007 aerial surveys.

(a) Florida Bay



(b) Ten Thousand Islands



4.3 Spring Season 2007

A total of 16 vessel-trailer surveys were conducted from April to May 2007 (**Table 8)**, with 10 surveys on weekend/holiday dates and 6 surveys on midweek dates.

Table 8. Spring season 2007 sampling dates. Location codes: FB, Florida Bay; TTI, Ten Thousand Islands. Day of week category codes: MW, midweek; WH, weekend/holiday.

Survey ID#	Location	Year	Month	Day	Day of Week	Day of Week Category
041	FB	2007	APR	14	SAT	WH
042	TTI	2007	APR	15	SUN	WH
043	FB	2007	APR	17	TUE	MW
044	TTI	2007	APR	19	THU	MW
045	TTI	2007	APR	21	SAT	WH
046	FB	2007	APR	22	SUN	WH
047	FB	2007	APR	24	TUE	MW
048	TTI	2007	APR	26	THU	MW
049	FB	2007	APR	29	SUN	WH
050	FB	2007	MAY	5	SAT	WH
051	TTI	2007	MAY	6	SUN	WH
052	TTI	2007	MAY	8	TUE	MW
053	FB	2007	MAY	10	THU	MW
054	TTI	2007	MAY	12	SAT	WH
055	FB	2007	MAY	13	SUN	WH
056	TTI	2007	MAY	19	SAT	WH

The allocation strategy during spring 2007 was further refined from that of the winter 2007 season. Initially (**Table 5**), more flights were allocated to Florida Bay compared to Ten Thousand Islands because of its larger size and perceived complexity due to the larger range of vessel access points. However, evaluation of the fall 2006 and winter 2007 vessel data suggested that the Ten Thousand Islands region was just as complex and variable with respect to vessel numbers on any given day as compared to Florida Bay. Therefore, surveys were evenly divided among the two regions during spring 2007 and subsequent flight seasons.

The complete set of daily flight maps for spring 2007 is given in **Appendix C**. Summary flight maps for spring season 2007 aerial surveys are shown in **Figure 14** for the Florida Bay region and in **Figure 15** for the Ten Thousand Islands region.

Figure 14. Seasonal summary flight map for spring season 2007(April to May 2007) aerial surveys for the Florida Bay region.

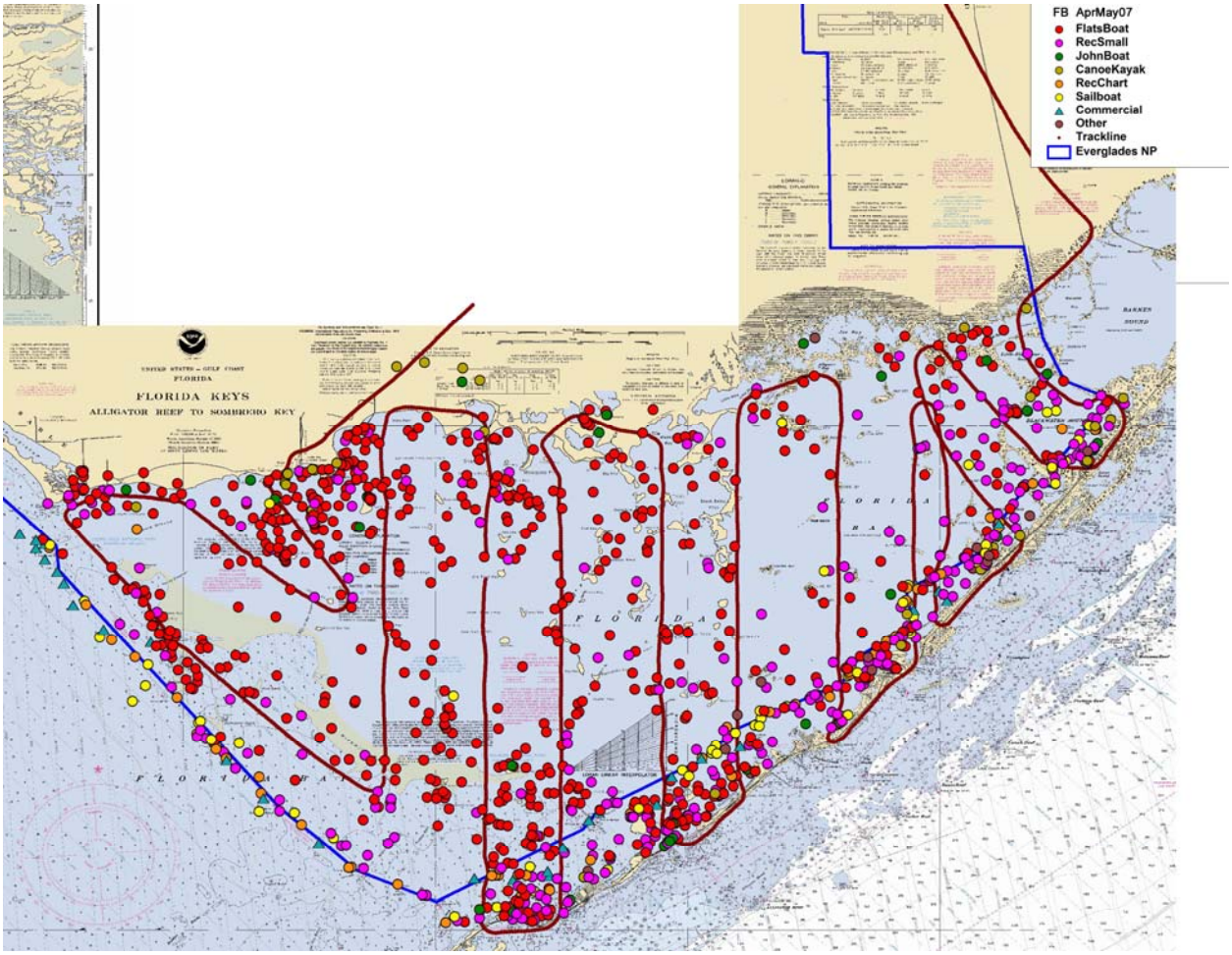
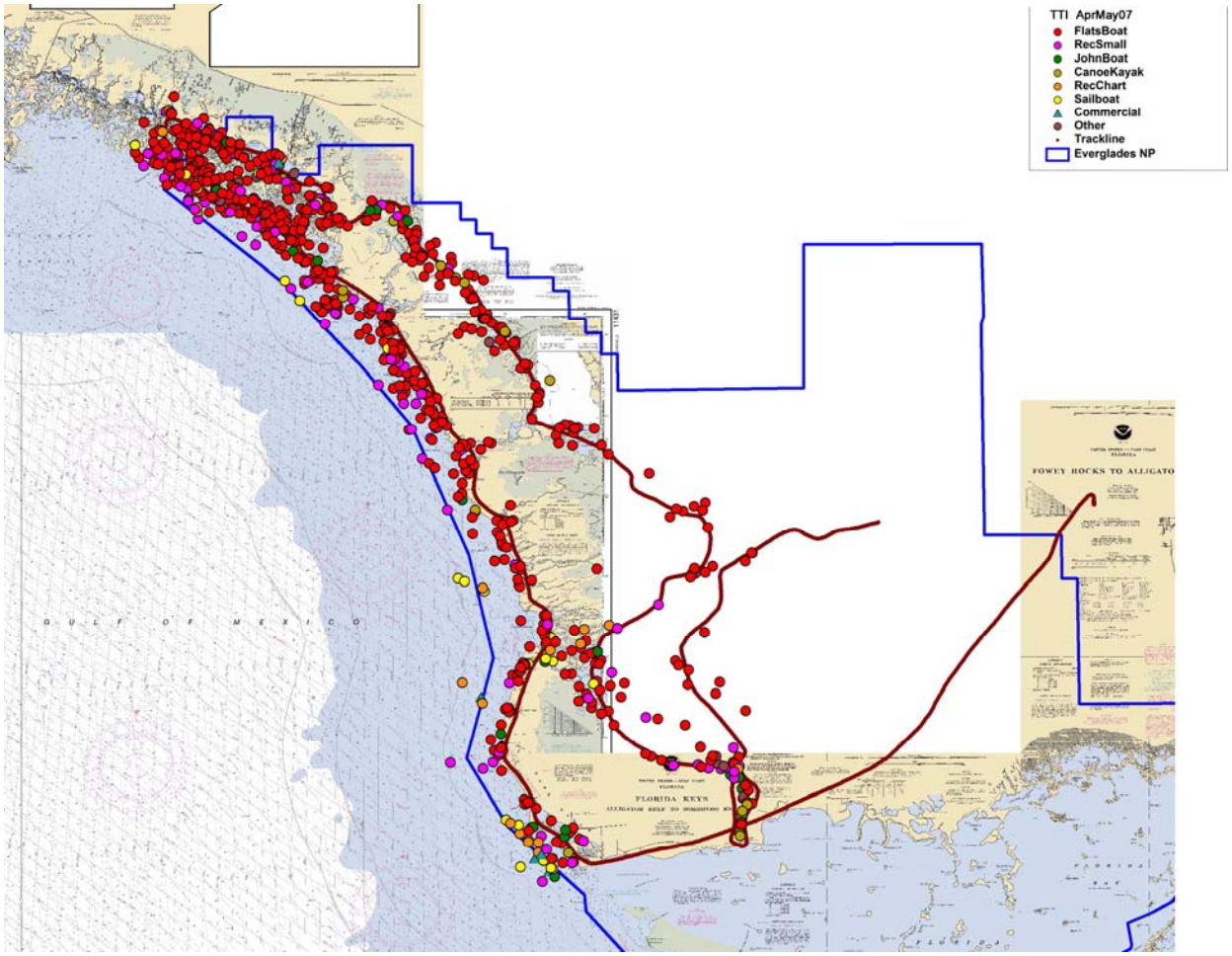


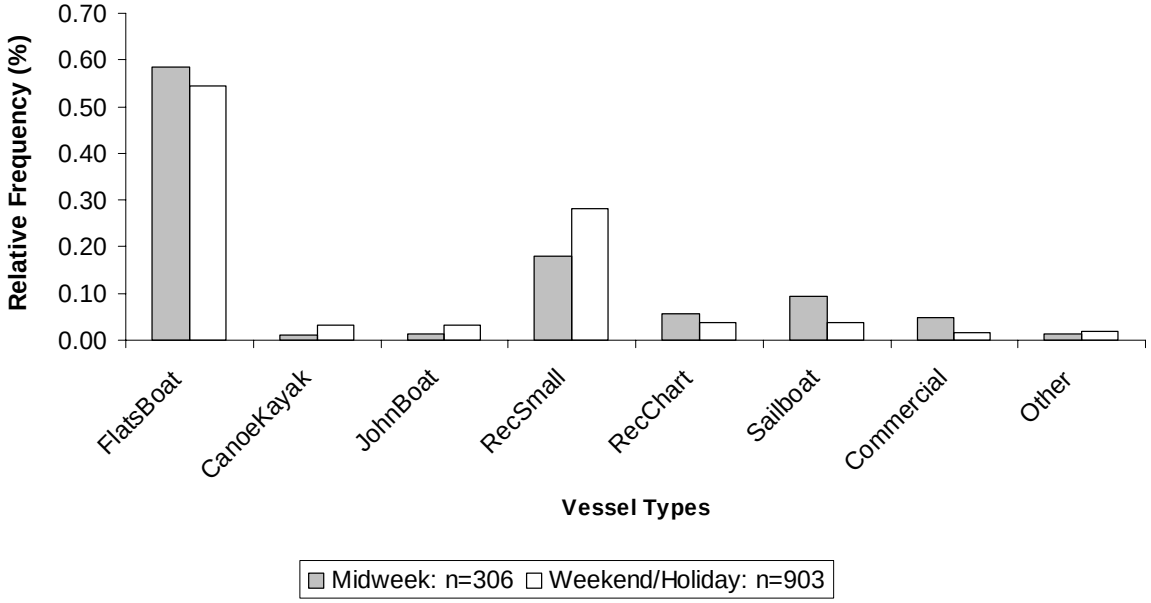
Figure 15. Seasonal summary flight map for spring 2007 (April to May 2007) aerial surveys for the Ten Thousand Islands region.



In Florida Bay, flatsboats and small recreational motorboats (less than 23 ft in length) accounted for the majority of vessels irrespective of day of the week (**Figure 16a**). Commercial fishing vessels, observed along the southern and western Park boundaries, were more prevalent during weekdays compared to weekends. In the Ten Thousand Islands region, flatsboats were the dominant vessel type observed, followed by small recreational motorboats, canoes/kayaks, and johnboats (**Figure 16b**). In terms of disposition, vessels were mostly engaged in fishing or in transit in both regions irrespective of day of the week (**Figure 17**).

Figure 16. Relative composition of vessel types (see Table 3 for description) by day of week category for **(a)** Florida Bay and **(b)** Ten Thousand Islands regions for the spring season 2007 aerial surveys.

(a) Florida Bay



(b) Ten Thousand Islands

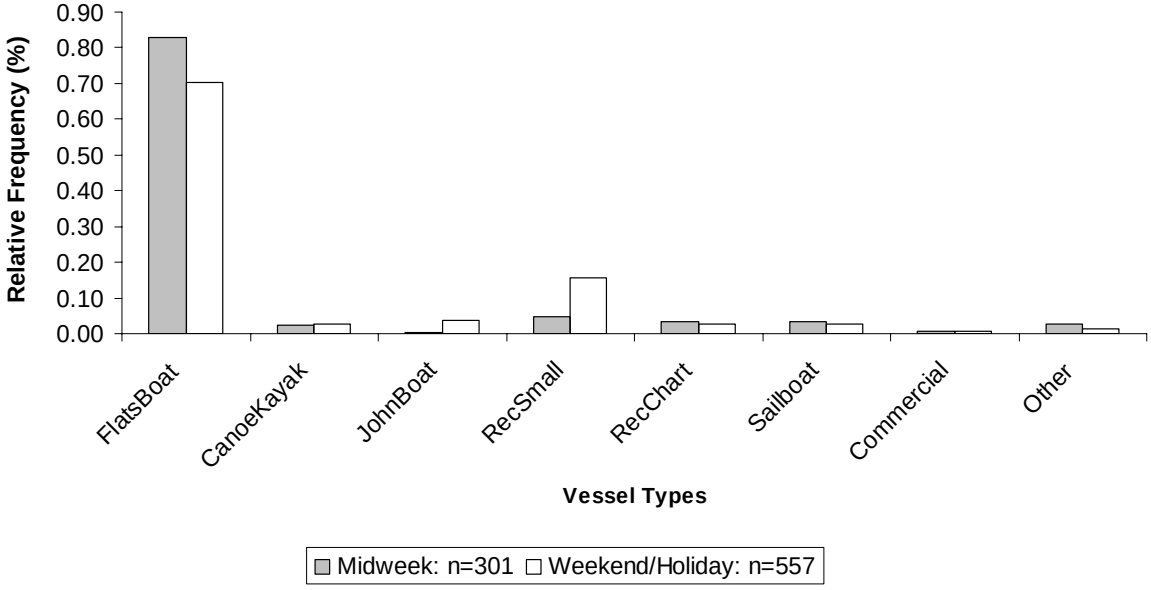
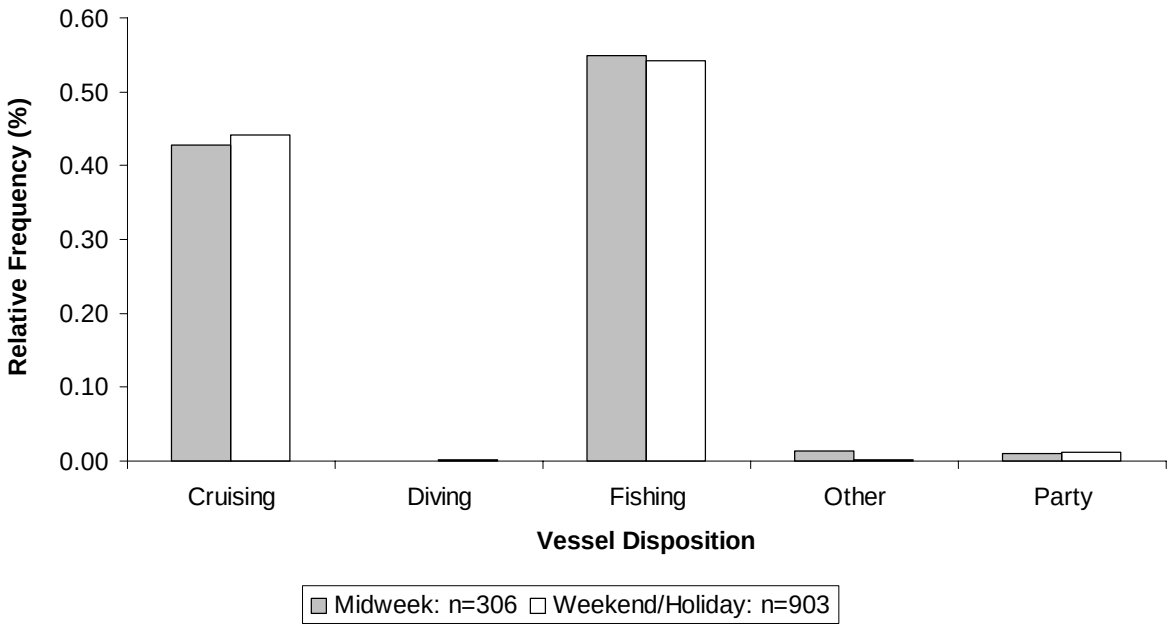
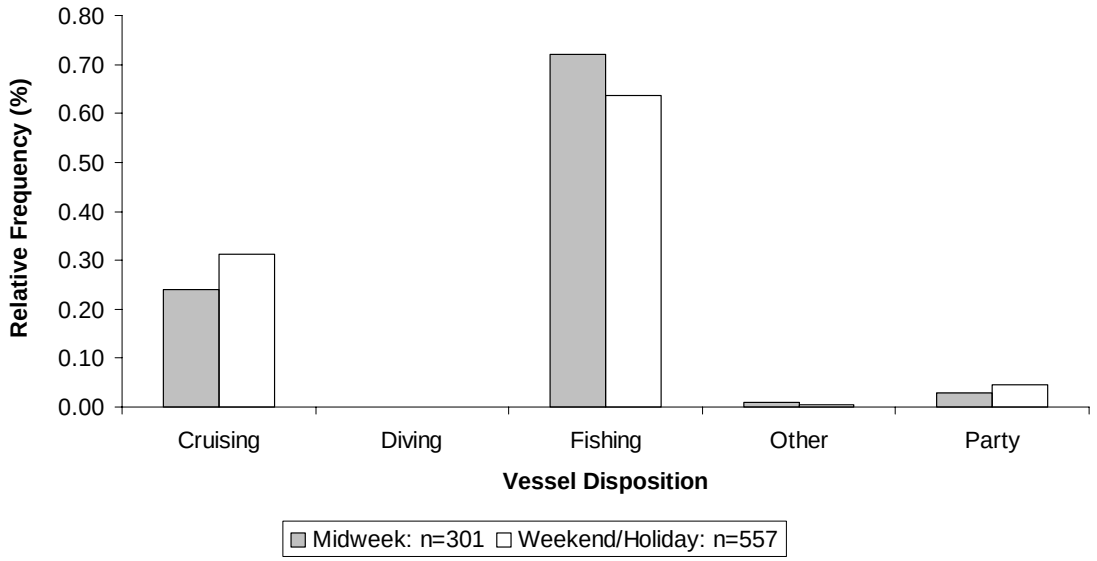


Figure 17. Relative frequency of vessel disposition categories (see Table 4 for description) by day of the week for (a) Florida Bay and (b) Ten Thousand Islands regions for the spring season 2007 aerial surveys.

(a) Florida Bay



(b) Ten Thousand Islands



4.4 Summer Season 2007

A total of 25 vessel-trailer surveys were conducted from June to September 2007 (**Table 9)**, with 15 surveys on weekend/holiday dates and 10 surveys on midweek dates. The complete set of daily flight maps for summer 2007 is given in **Appendix D**. Summary flight maps for summer season 2007 aerial surveys are shown in **Figure 18** for the Florida Bay region and in **Figure 19** for the Ten Thousand Islands region

Table 9. Summer season 2007 sampling dates. Location codes: FB, Florida Bay; TTI, Ten Thousand Islands. Day of week category codes: MW, midweek; WH, weekend/holiday.

Survey ID#	Location	Year	Month	Day	Day of Week	Day of Week Category
057	FB	2007	JUN	10	SUN	WH
058	FB	2007	JUN	17	SUN	WH
059	TTI	2007	JUN	19	TUE	MW
060	TTI	2007	JUN	24	SUN	WH
061	FB	2007	JUN	26	TUE	MW
062	TTI	2007	JUL	1	SUN	WH
063	TTI	2007	JUL	4	WED	WH
064	TTI	2007	JUL	7	SAT	WH
065	FB	2007	JUL	9	MON	MW
066	TTI	2007	JUL	15	SUN	WH
067	FB	2007	JUL	16	MON	MW
068	FB	2007	JUL	21	SAT	WH
069	FB	2007	JUL	24	TUE	MW
070	FB	2007	JUL	28	SAT	WH
071	TTI	2007	AUG	3	FRI	MW
072	FB	2007	AUG	4	SAT	WH
073	FB	2007	AUG	11	SAT	WH
074	TTI	2007	AUG	12	SUN	WH
075	TTI	2007	AUG	15	WED	MW
076	TTI	2007	AUG	18	SAT	WH
077	TTI	2007	AUG	20	MON	MW
078	FB	2007	AUG	23	THU	MW
079	TTI	2007	AUG	26	SUN	WH
080	TTI	2007	AUG	30	THU	MW
081	FB	2007	SEP	3	MON	WH

Figure 18. Seasonal summary flight map for summer season 2007 aerial surveys for the Florida Bay region.

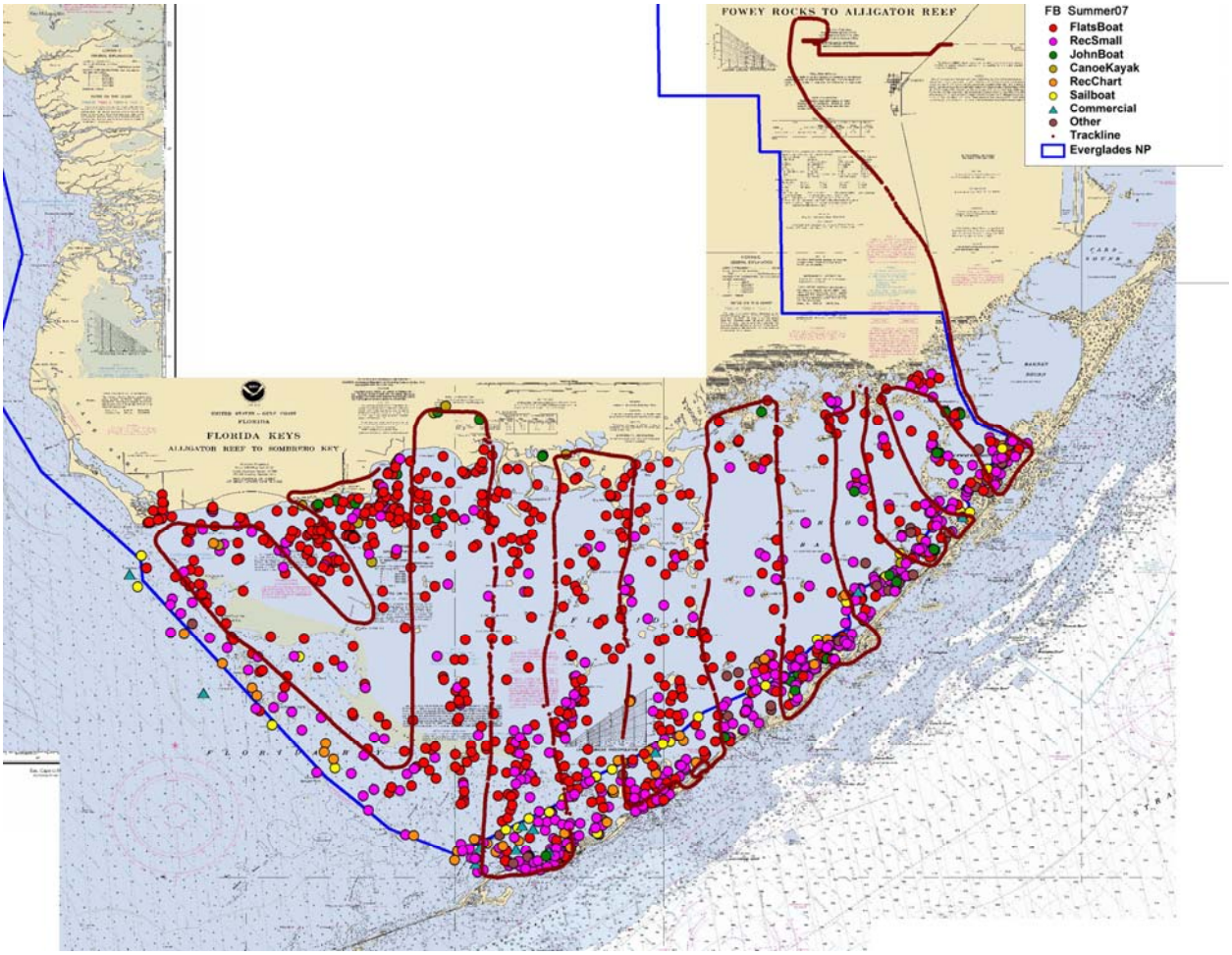
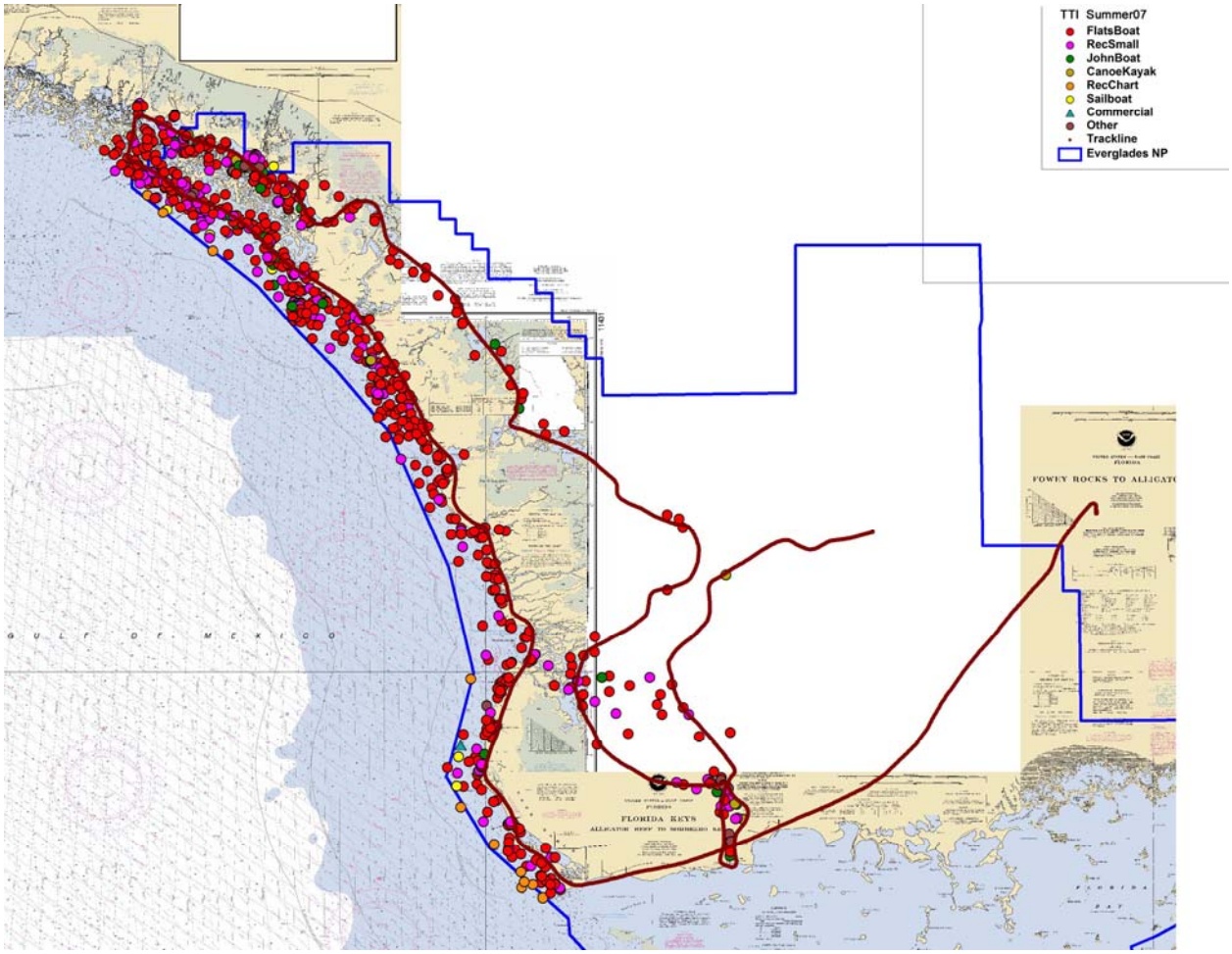


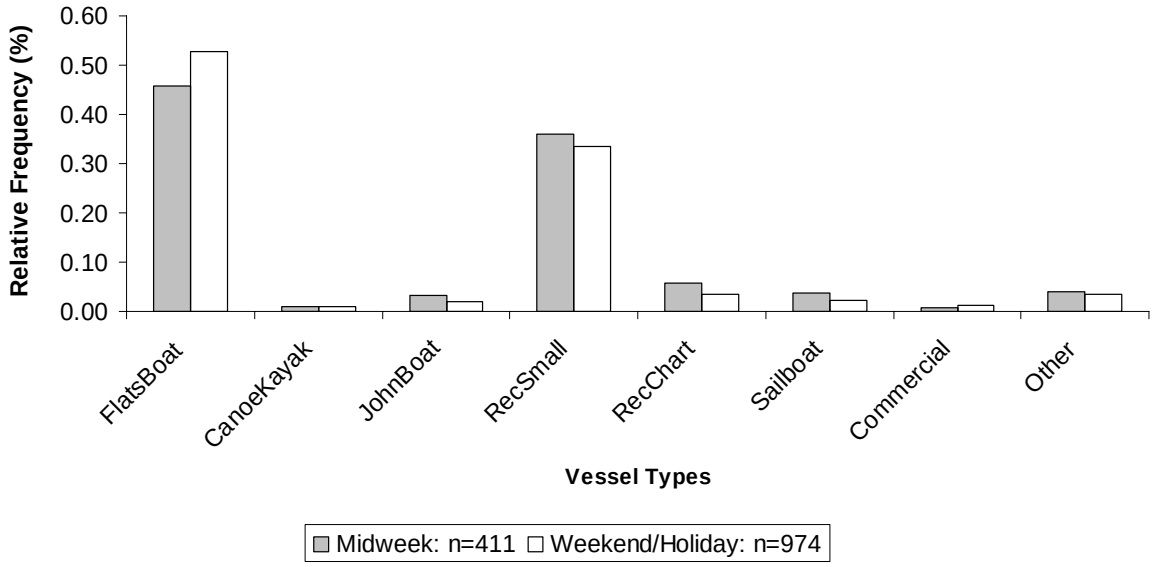
Figure 19. Seasonal summary flight map for summer 2007 aerial surveys for the Ten Thousand Islands region.



In Florida Bay, flatsboats and small recreational motorboats (less than 23 ft in length) accounted for the majority of vessels irrespective of day of the week (**Figure 20a**). In the Ten Thousand Islands region, flatsboats were the dominant vessel type observed, followed by small recreational motorboats, johnboats, and canoes/kayaks (**Figure 20b**). In terms of disposition, vessels were mostly engaged in fishing or in transit in both regions irrespective of day of the week (**Figure 21**).

Figure 20. Relative composition of vessel types (see Table 3 for description) by day of week category for **(a)** Florida Bay and **(b)** Ten Thousand Islands regions for the summer season 2007 aerial surveys.

(a) Florida Bay



(b) Ten Thousand Islands

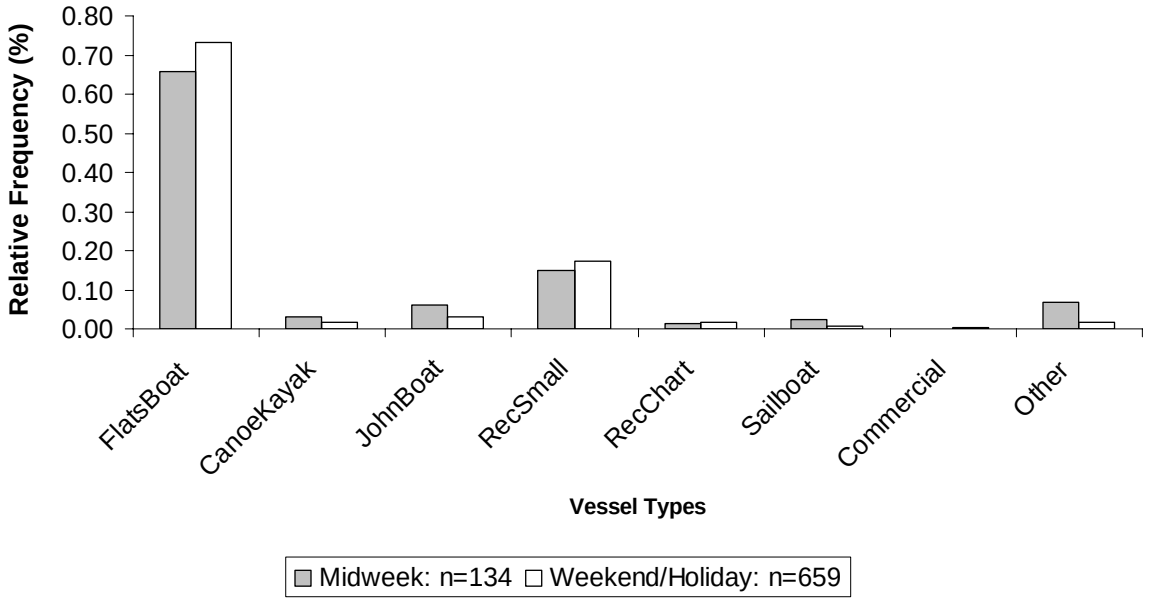
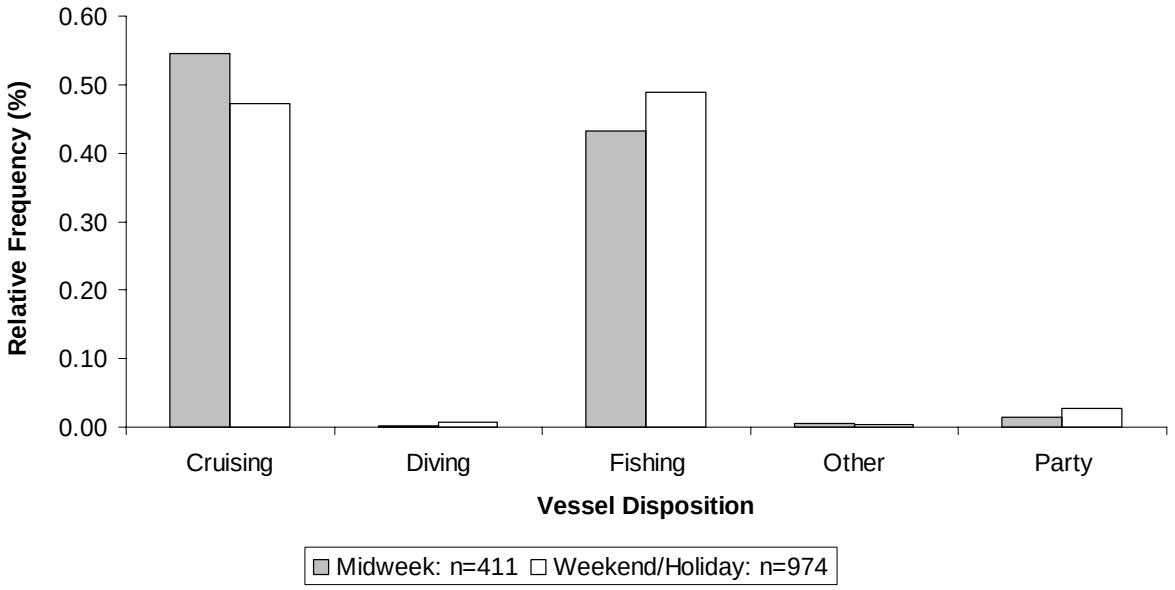
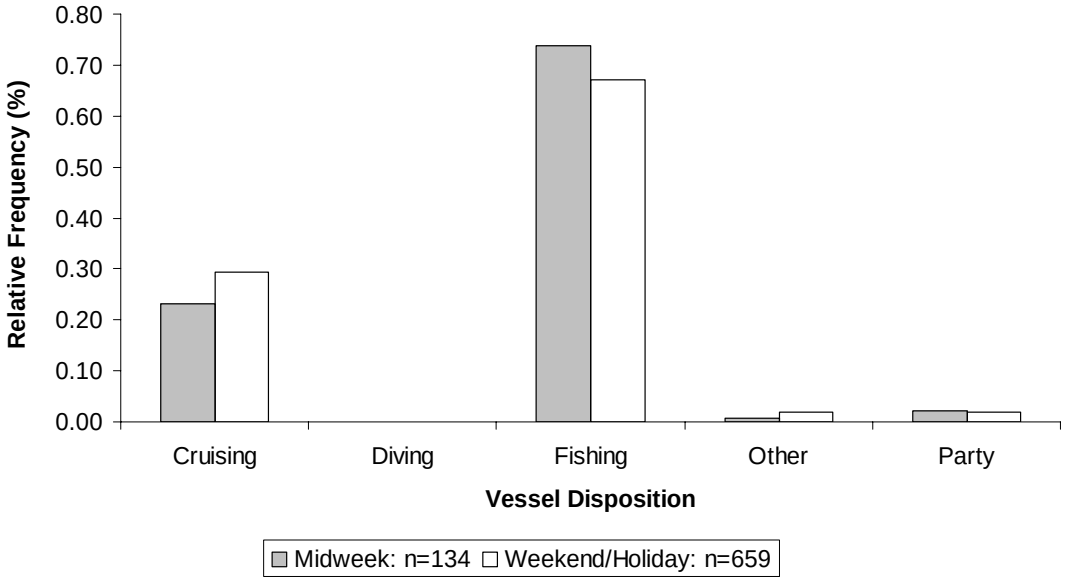


Figure 21. Relative frequency of vessel disposition categories (see Table 4 for description) by day of the week for (a) Florida Bay and (b) Ten Thousand Islands regions for the summer season 2007 aerial surveys.

(a) Florida Bay



(b) Ten Thousand Islands



4.5 Fall Season 2007

Four additional vessel-trailer surveys were conducted from October to November 2007 (**Table 10)** to make up for several flights that were cancelled in prior seasons, particularly on weekends/holidays, due to weather, scheduling problems, etc. All 4 surveys for fall 2007 were conducted on weekend/holiday dates.

Table 10. Fall season 2007 sampling dates. Location codes: FB, Florida Bay; TTI, Ten Thousand Islands. Day of week category codes: MW, midweek; WH, weekend/holiday.

Survey ID#	Location	Year	Month	Day	Day of Week	Day of Week Category
082	TTI	2007	OCT	27	SAT	WH
083	TTI	2007	NOV	3	SAT	WH
084	FB	2007	NOV	4	SUN	WH
085	FB	2007	NOV	17	SAT	WH

The complete set of daily flight maps for fall 2007 is given in **Appendix E**. Seasonal summary flight maps for fall season 2007 aerial surveys are shown in **Figure 22** for the Florida Bay region and in **Figure 23** for the Ten Thousand Islands region.

Figure 22. Seasonal summary flight map for fall season 2007 aerial surveys for the Florida Bay region.

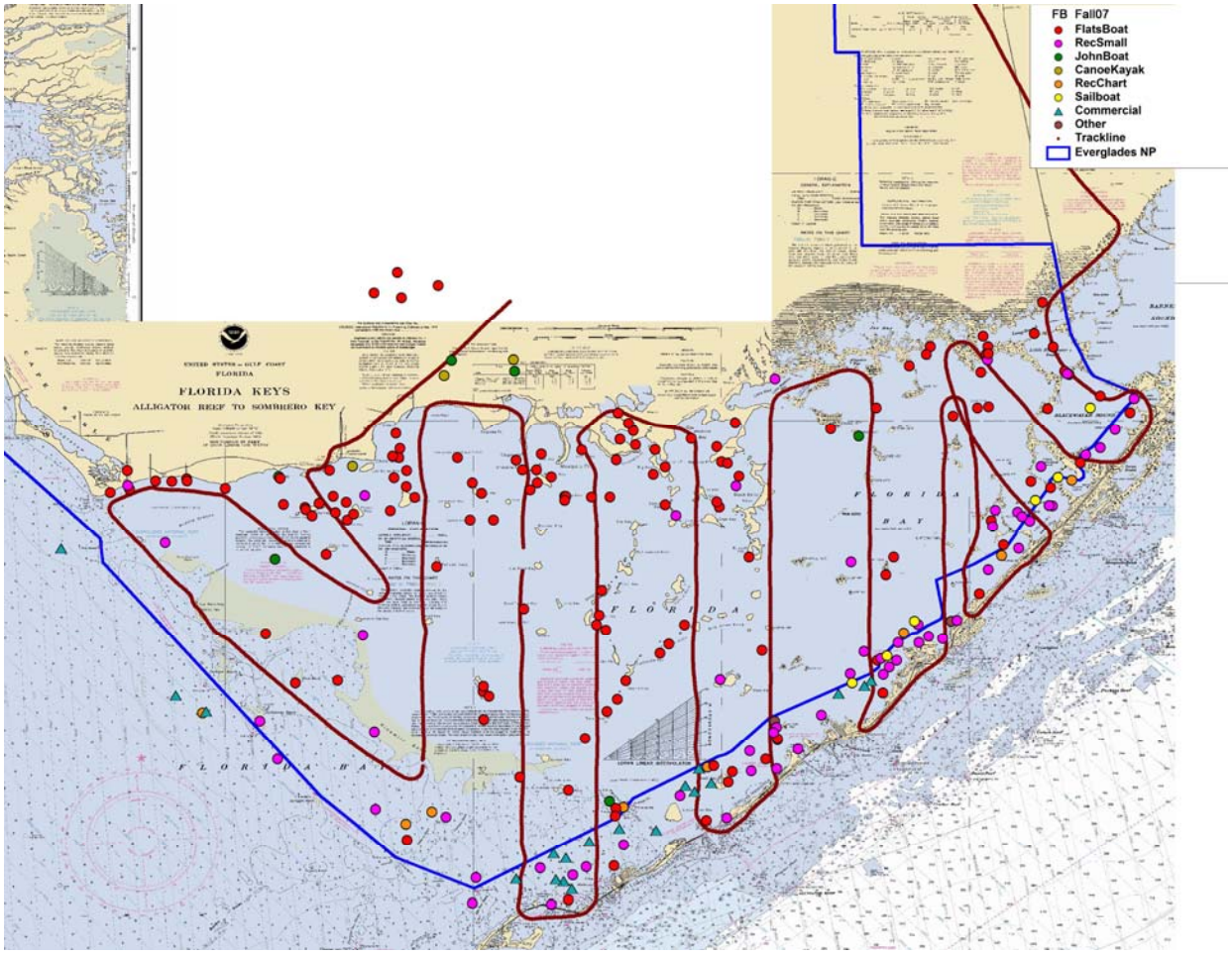
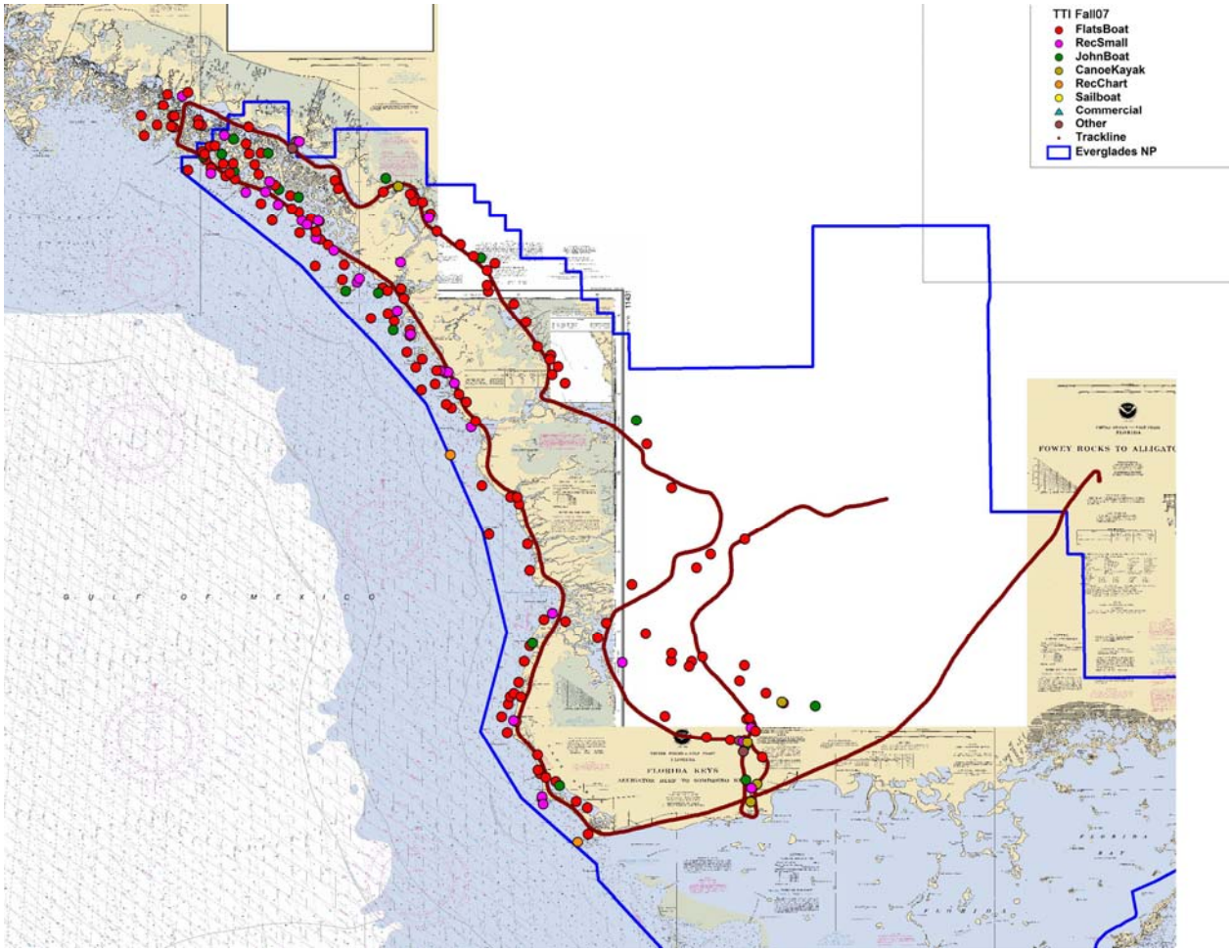


Figure 23. Seasonal summary flight map for summer 2007 aerial surveys for the Ten Thousand Islands region.



4.6 Seasons-Combined Results

A total of 85 flight surveys were conducted from fall 2006 to fall 2007, distributed between the Florida Bay and Ten Thousand Islands regions, among seasons, and between weekdays and weekends/holidays (**Table 11**).

Table 11. Number of flight surveys conducted from fall 2006 to fall 2007 by location, season, and day of week category.

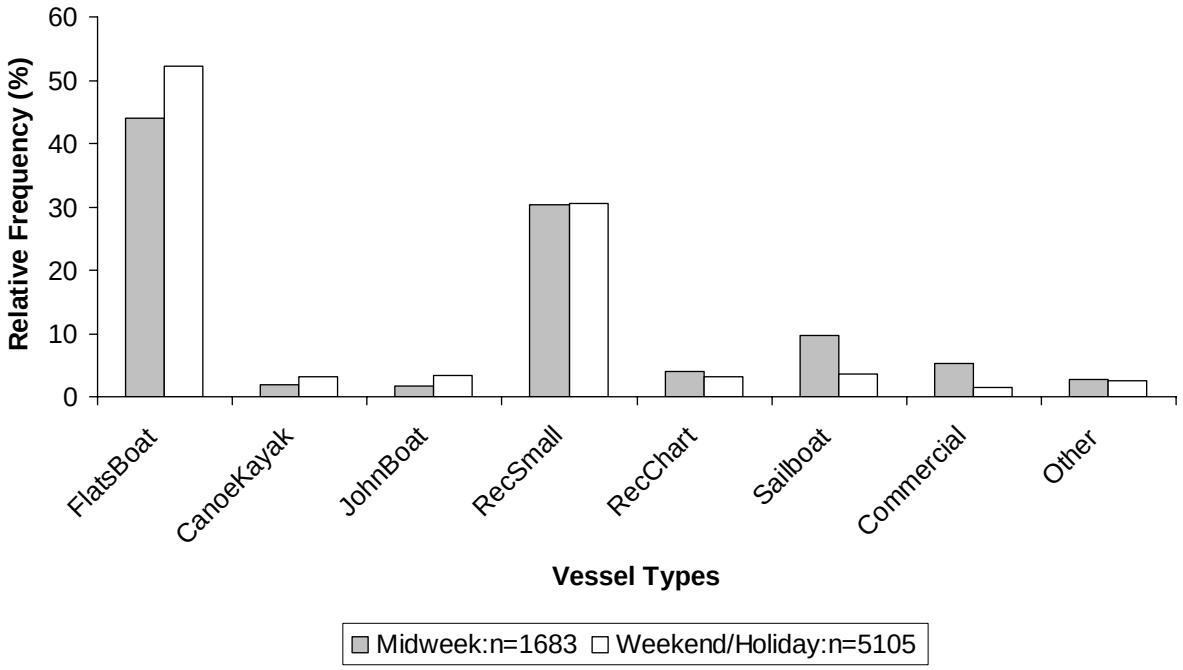
		Number of Flight Surveys		
Location	**Season**	**Weekday**	**Weekend/Holiday**	**Total**
FB	Fall 2006	4	7	11
FB	Winter 2007	5	9	14
FB	Spring 2007	3	5	8
FB	Summer 2007	5	7	12
FB	Fall 2007	0	2	2
	FB Total	**17**	**30**	**47**
TTI	Fall 2006	3	2	5
TTI	Winter 2007	4	6	10
TTI	Spring 2007	3	5	8
TTI	Summer 2007	5	8	13
TTI	Fall 2007	0	2	2
	TTI Total	**15**	**23**	**38**
All	**Total**	**32**	**53**	**85**

As was observed in each season, flatsboats and small recreational motorboats (less than 23 ft in length) accounted for the majority of vessels irrespective of day of the week in both Florida Bay and Ten Thousand Islands (**Figure 24**), and most vessels were either engaged in fishing or in transit when observed (**Figure 25**). The principal vessel types engaged in fishing were flatsboats, small recreational motorboats, johnboats, and commercial fishing vessels (**Tables 12** and **13**).

Seasons-combined summary flight maps are shown in **Figure 26** for the Florida Bay region and in **Figure 27** for the Ten Thousand Islands region. Small motorboats (<23 ft) were distributed throughout the flight domains for Florida Bay (**Figure 26a**) and Ten Thousand Islands (**Figure 27a**). In contrast, large motorboats (>23 ft) were mostly observed along Park boundaries in the two regions (**Figures 26b** and **27b**).

Figure 24. Relative composition of vessel types (see Table 3 for description) by day of week category for (a) Florida Bay and (b) Ten Thousand Islands regions for 2006-2007 aerial surveys (all seasons combined).

(a) Florida Bay



(b) Ten Thousand Islands

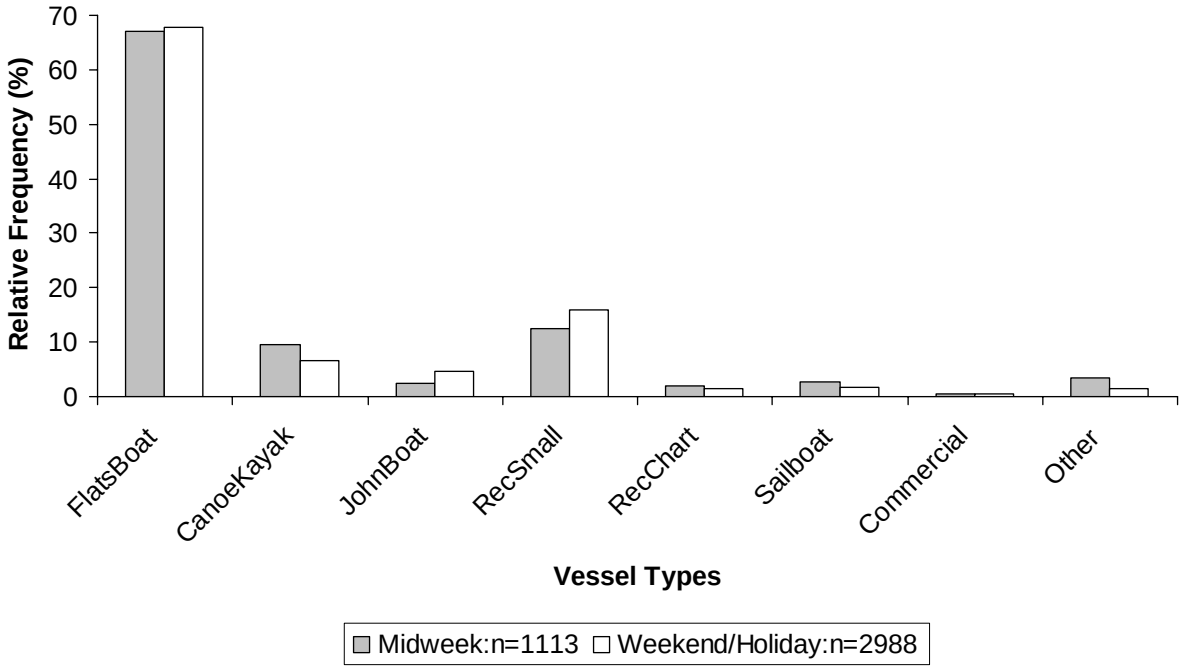
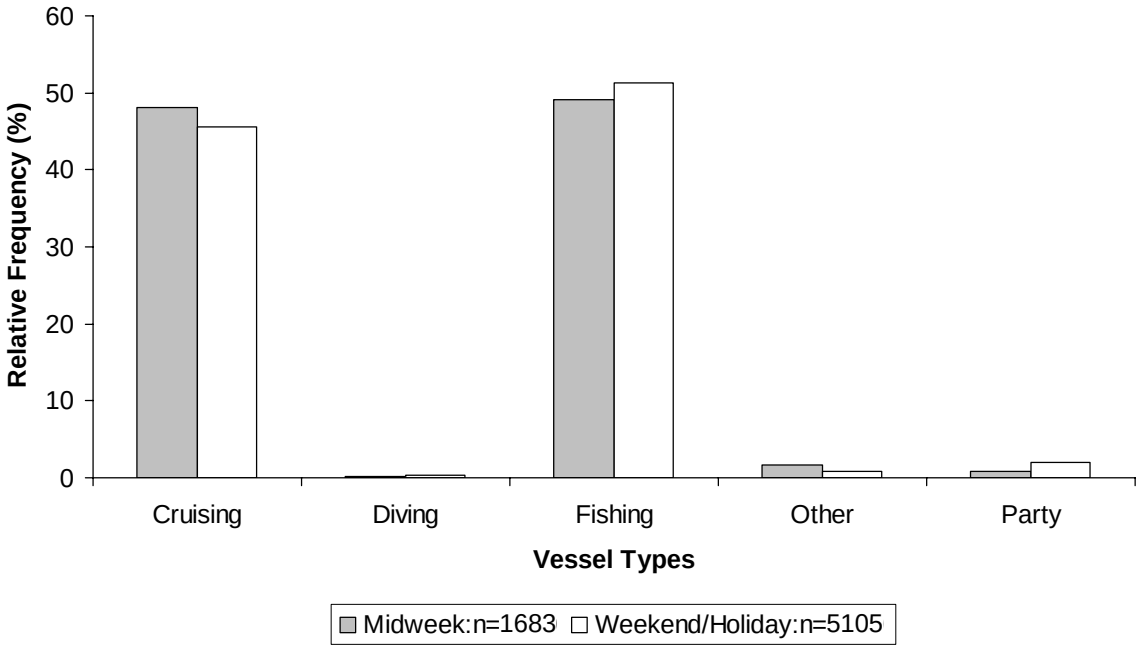


Figure 25. Relative frequency of vessel disposition categories (see Table 4 for description) by day of the week for (a) Florida Bay and (b) Ten Thousand Islands regions for 2006-2007 aerial surveys (all seasons combined).

(a) Florida Bay



(b) Ten Thousand Islands

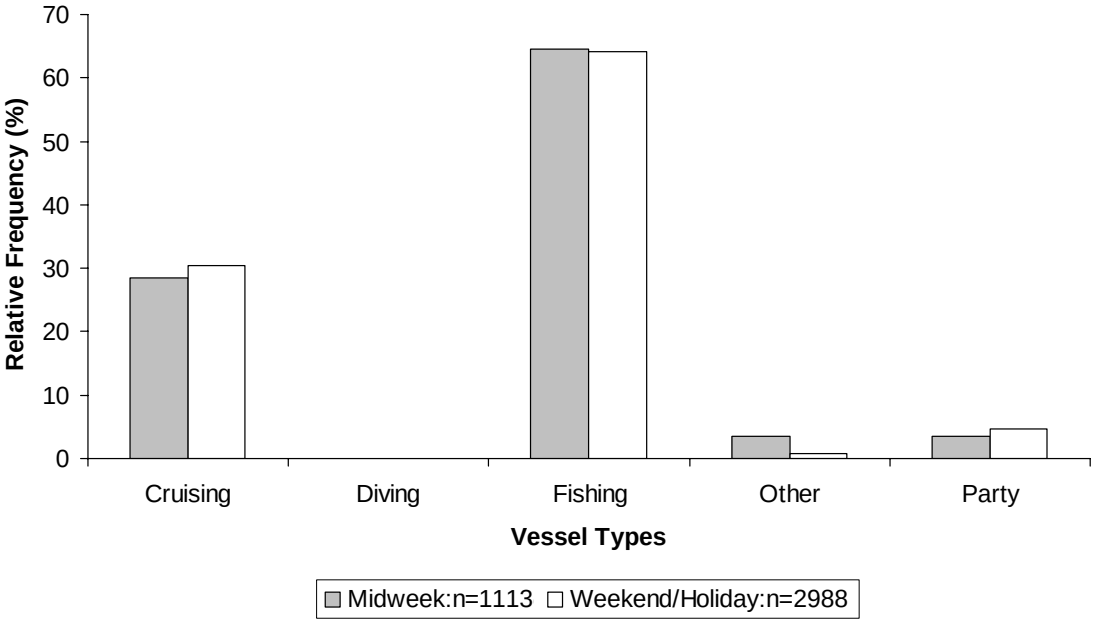


Table 12. Percent disposition by vessel type and day of the week in (a) Florida Bay and (b) Ten Thousand Islands for 2006-2007 aerial surveys (all seasons combined).

(a) Florida Bay

Vessel Type	Day of Week	Number of Vessels	Disposition Category (%)				
			Cruising	Diving	Fishing	Other	Party
FlatsBoat	Midweek	741	31.6	0.0	68.2	0.3	0.0
	Weekend/Holiday	2660	27.4	0.1	72.1	0.1	0.4
Canoe/Kayak	Midweek	33	93.9	0.0	6.1	0.0	0.0
	Weekend/Holiday	166	78.9	0.0	4.8	6.6	9.6
JohnBoat	Midweek	30	26.7	0.0	70.0	0.0	3.3
	Weekend/Holiday	169	23.1	1.2	73.4	1.8	0.6
RecSmall	Midweek	511	54.6	0.4	42.3	2.2	0.6
	Weekend/Holiday	1554	61.5	0.7	34.0	1.2	2.6
RecChart	Midweek	68	83.8	0.0	8.8	1.5	5.9
	Weekend/Holiday	156	91.0	0.0	2.6	0.0	6.4
Sailboat	Midweek	163	91.4	1.2	3.7	1.8	1.8
	Weekend/Holiday	188	91.5	0.0	2.1	0.0	6.4
Commercial	Midweek	90	23.3	0.0	75.6	0.0	1.1
	Weekend/Holiday	78	38.5	0.0	55.1	2.6	3.8
Other	Midweek	47	66.0	0.0	4.3	25.5	4.3
	Weekend/Holiday	134	86.6	0.0	2.2	4.5	6.7

(b) Ten Thousand Islands

Vessel Type	Day of Week	Number of Vessels	Disposition Category (%)				
			Cruising	Diving	Fishing	Other	Party
FlatsBoat	Midweek	747	18.6	0.0	80.1	0.5	0.8
	Weekend/Holiday	2024	20.8	0.0	77.0	0.6	1.6
Canoe/Kayak	Midweek	106	60.4	0.0	14.2	17.0	8.5
	Weekend/Holiday	195	81.0	0.0	3.6	3.1	12.3
JohnBoat	Midweek	28	10.7	0.0	82.1	3.6	3.6
	Weekend/Holiday	141	19.9	0.0	73.8	0.0	6.4
RecSmall	Midweek	138	40.6	0.0	54.3	0.7	4.3
	Weekend/Holiday	476	41.4	0.0	50.2	0.8	7.6
RecChart	Midweek	21	47.6	0.0	14.3	0.0	38.1
	Weekend/Holiday	47	74.5	0.0	6.4	0.0	19.1
Sailboat	Midweek	30	66.7	0.0	3.3	0.0	30.0
	Weekend/Holiday	52	50.0	0.0	3.8	0.0	46.2
Commercial	Midweek	6	33.3	0.0	66.7	0.0	0.0
	Weekend/Holiday	12	75.0	0.0	25.0	0.0	0.0
Other	Midweek	37	62.2	0.0	0.0	37.8	0.0
	Weekend/Holiday	41	75.6	0.0	2.4	7.3	14.6

Table 13. Percent vessel composition by disposition category and day of the week in (a) Florida Bay and (b) Ten Thousand Islands for 2006-2007 aerial surveys (all seasons combined). Day of week codes: MW, midweek; WH, weekend/holiday.

(a) Florida Bay

			Vessel Type (%)							
Disposition	**Day of Week**	**Number of Vessels**	**FlatsBoat**	**Canoe/Kayak**	**JohnBoat**	**RecSmall**	**RecChart**	**Sailboat**	**Commercial**	**Other**
Cruising	MW	810	28.9	3.8	1.0	34.4	7.0	18.4	2.6	3.8
	WH	2315	31.5	5.7	1.7	41.3	6.1	7.4	1.3	5.0
Diving	MW	4	0.0	0.0	0.0	50.0	0.0	50.0	0.0	0.0
	WH	15	13.3	0.0	13.3	73.3	0.0	0.0	0.0	0.0
Fishing	MW	826	61.1	0.2	2.5	26.2	0.7	0.7	8.2	0.2
	WH	2632	72.8	0.3	4.7	20.1	0.2	0.2	1.6	0.1
Other	MW	29	6.9	0.0	0.0	37.9	3.4	10.3	0.0	41.4
	WH	42	4.8	26.2	7.1	42.9	0.0	0.0	4.8	14.3
Party	MW	14	0.0	0.0	7.1	21.4	28.6	21.4	7.1	14.3
	WH	101	9.9	15.8	1.0	39.6	9.9	11.9	3.0	8.9

(b) Ten Thousand Islands

			Vessel Type (%)							
Disposition	**Day of Week**	**Number of Vessels**	**FlatsBoat**	**Canoe/Kayak**	**JohnBoat**	**RecSmall**	**RecChart**	**Sailboat**	**Commercial**	**Other**
Cruising	MW	317	43.8	20.2	0.9	17.7	3.2	6.3	0.6	7.3
	WH	906	46.6	17.4	3.1	21.7	3.9	2.9	1.0	3.4
Diving	MW	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	WH	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fishing	MW	719	83.2	2.1	3.2	10.4	0.4	0.1	0.6	0.0
	WH	1917	81.3	0.4	5.4	12.5	0.2	0.1	0.2	0.1
Other	MW	38	10.5	47.4	2.6	2.6	0.0	0.0	0.0	36.8
	WH	25	48.0	24.0	0.0	16.0	0.0	0.0	0.0	12.0
Party	MW	39	15.4	23.1	2.6	15.4	20.5	23.1	0.0	0.0
	WH	140	22.9	17.1	6.4	25.7	6.4	17.1	0.0	4.3

Figure 26. Summary flight maps for 2006-2007 seasons-combined surveys for the Florida Bay region showing distributions of: (a) small motorboats(<23 ft) and canoes/kayaks; and (b) large motorboats (>23 ft) and sailboats.

(a)

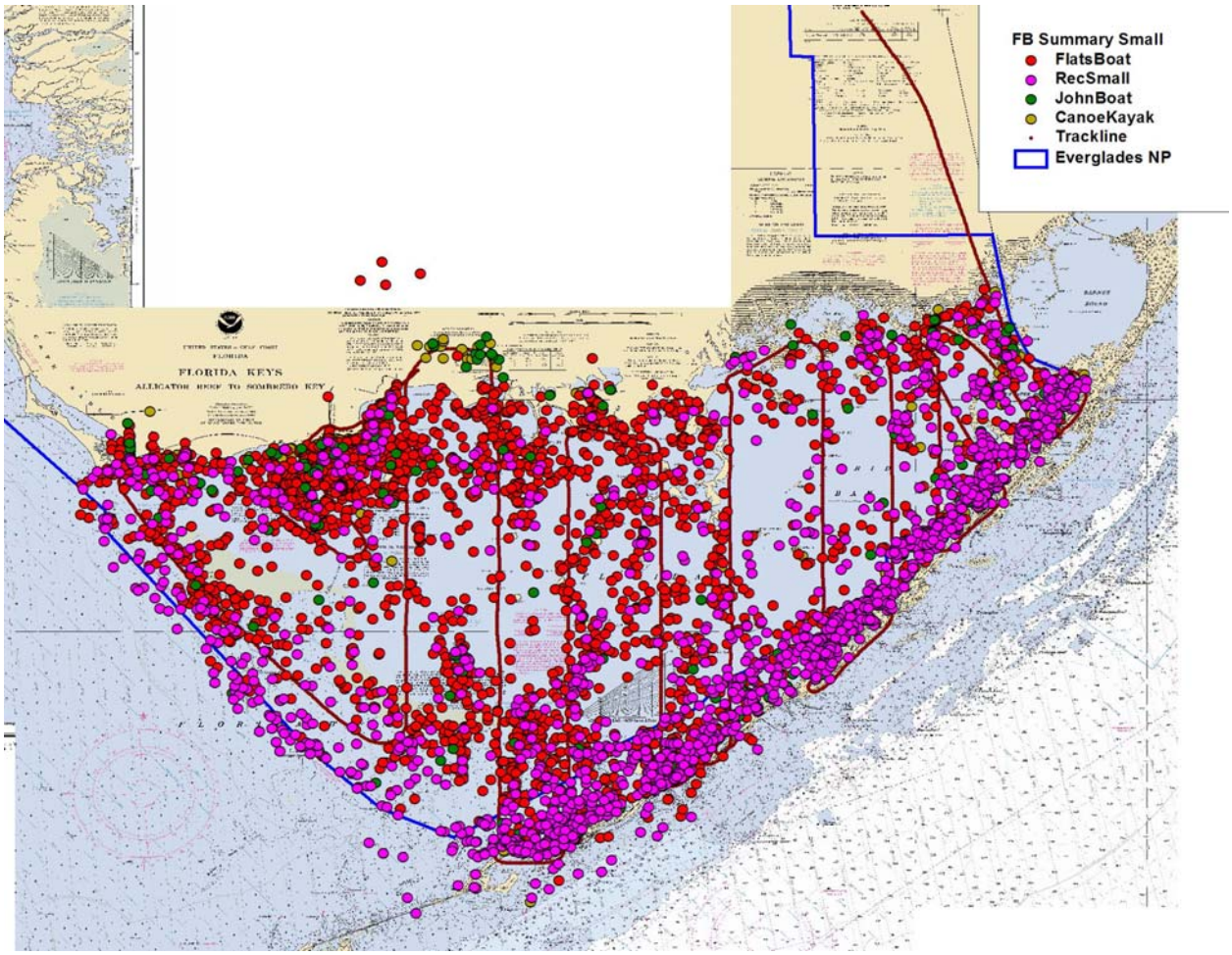


Figure 26 (continued).

(b)

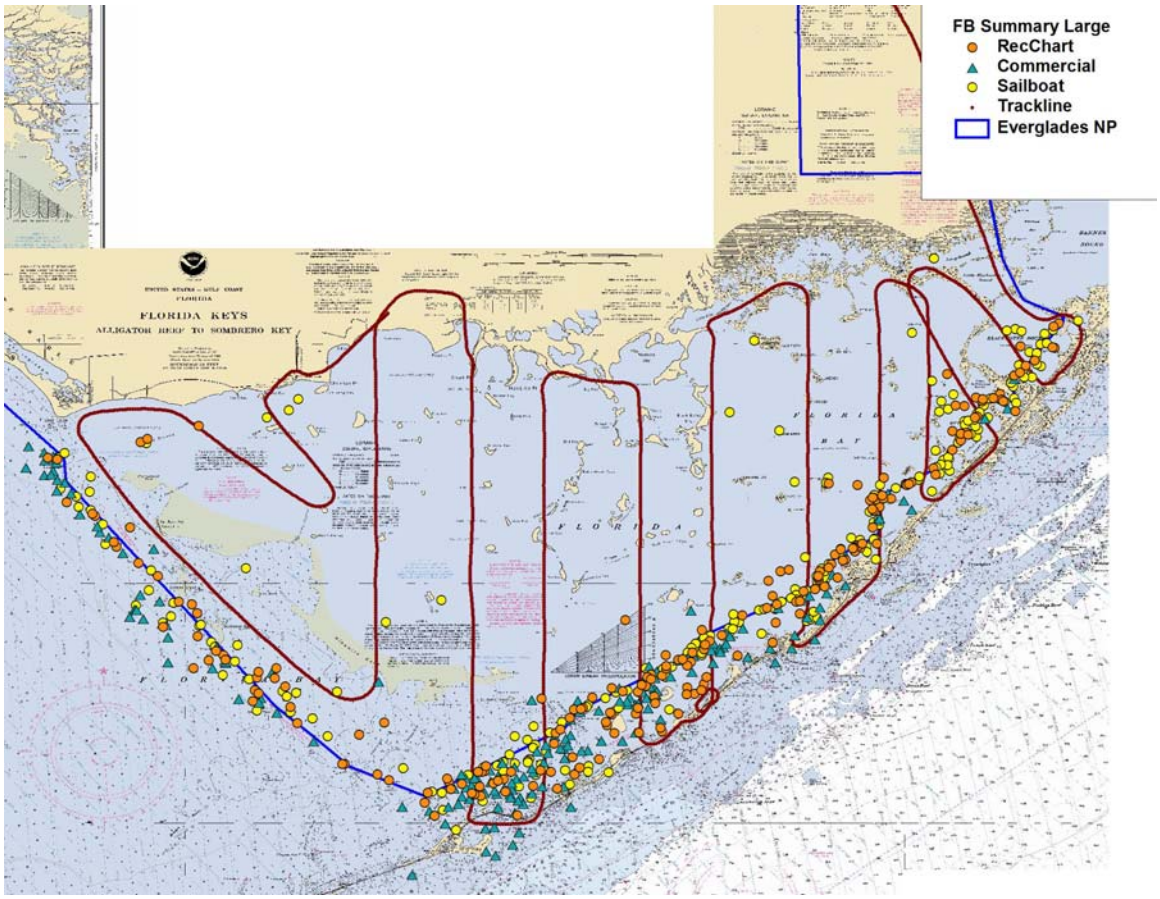


Figure 27. Summary flight maps for 2006-2007 seasons-combined surveys for the Ten Thousand Islands region showing distributions of: (a) small motorboats(<23 ft) and canoes/kayaks; and (b) large motorboats (>23 ft) and sailboats.

(a)

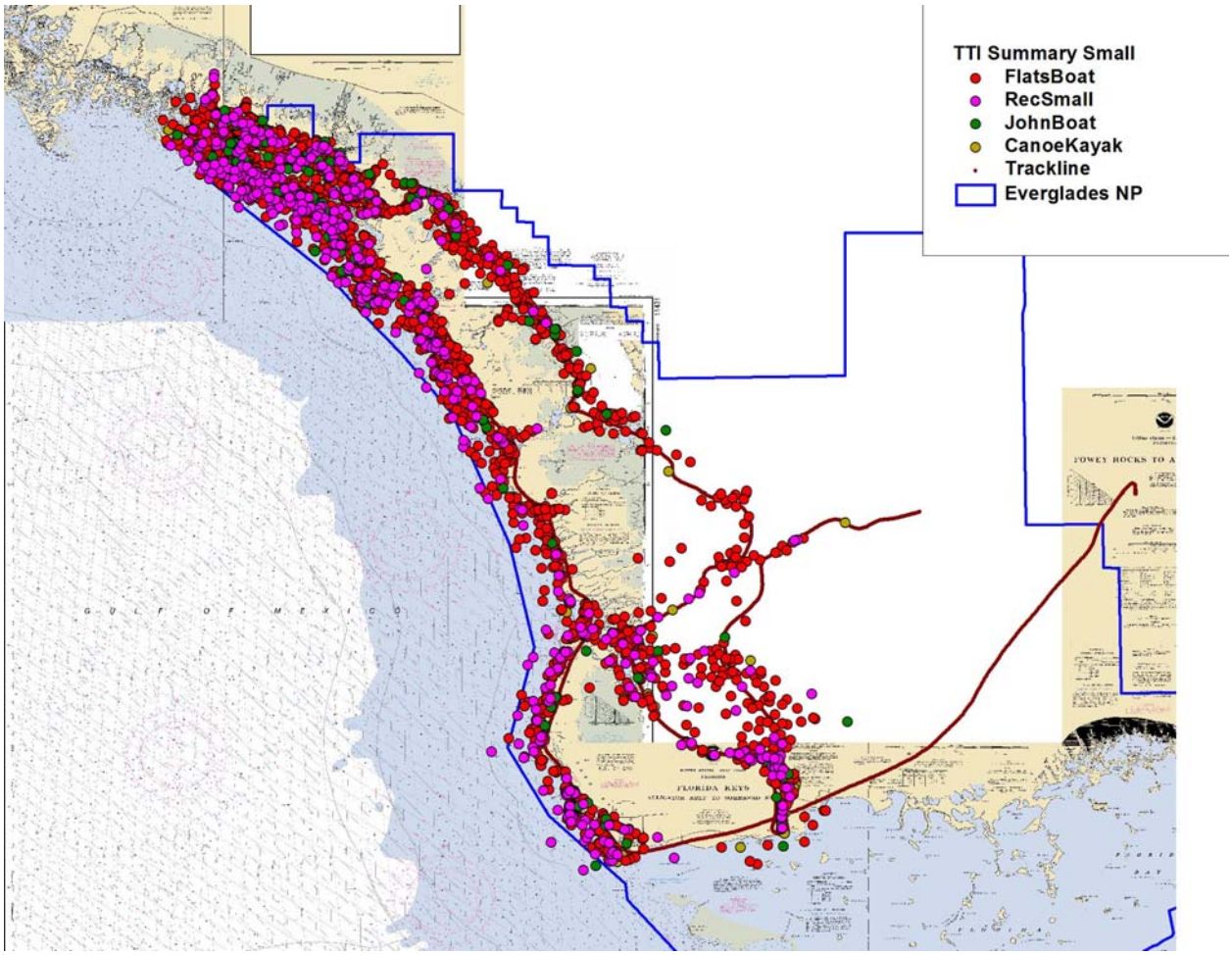
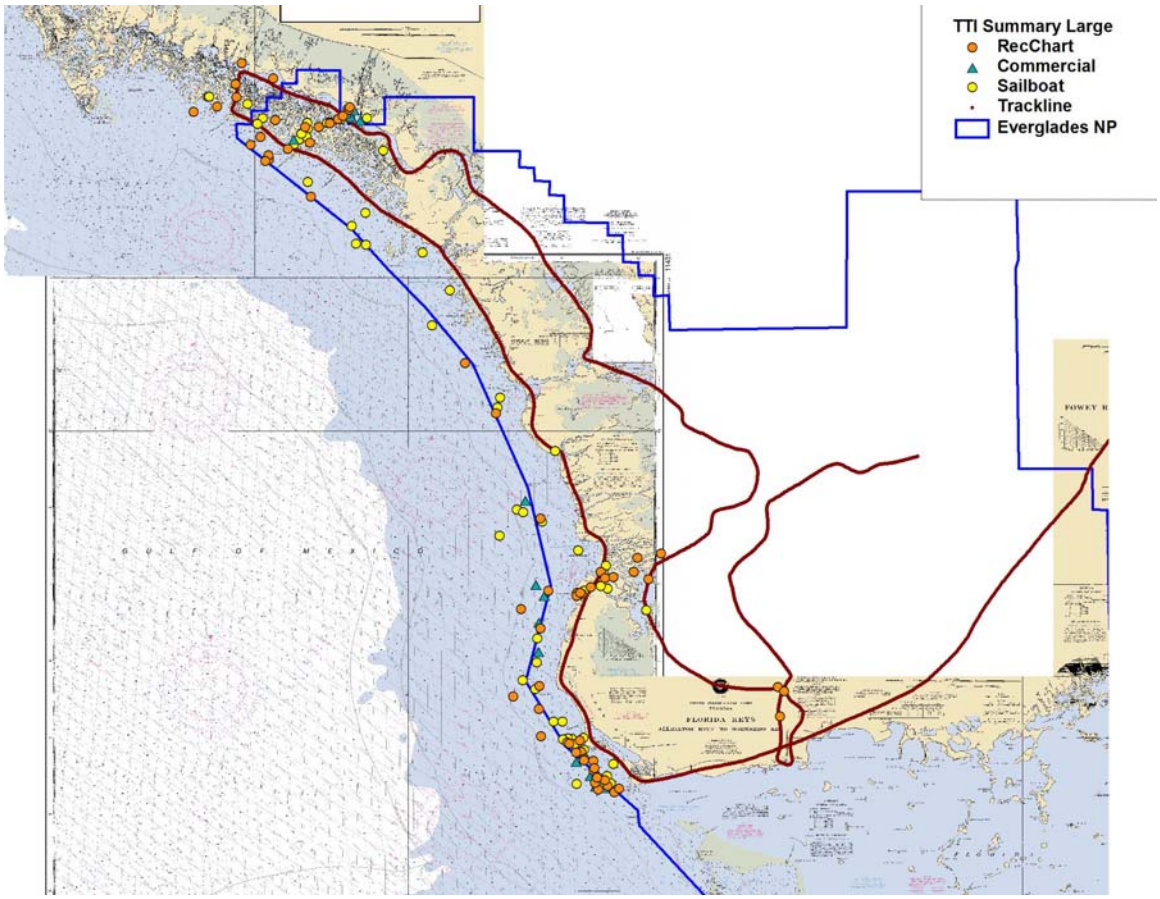


Figure 27 (continued).

(b)



Location coordinates of vessels in Florida Bay were used to classify vessels into two regions, inside ENP waters and outside ENP waters along the southern and western Park boundaries. The distribution of vessels between these two regions of Florida Bay by vessel type is given in **Table 14**. The majority of flatsboats, canoes/kayaks, and johnboats were observed inside Park waters, while the majority of small and large recreational motorboats, sailboats, commercial fishing vessels, and other types of vessels were observed along the southern Park boundary within the Intracoastal Waterway and along the western Park boundary.

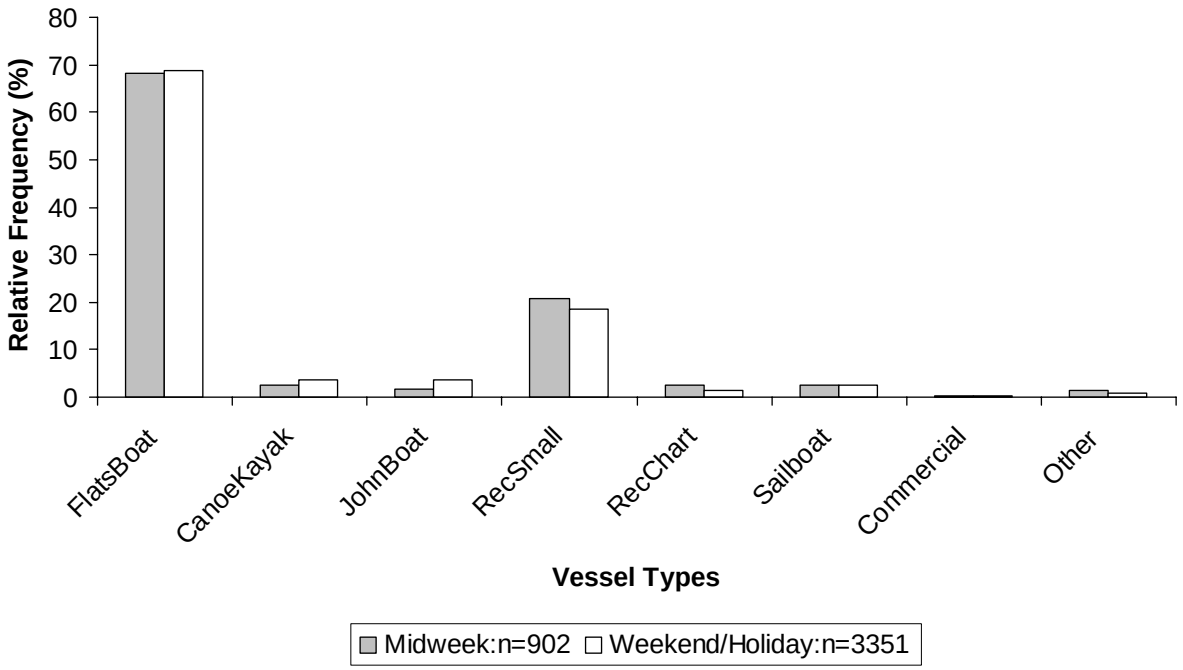
Table 14. Percent distribution of vessel types between two regions in Florida Bay: inside ENP waters and outside ENP waters (along southern and western Park boundaries).

		Distribution (%) Within Florida Bay	
Vessel Type	**Number of Vessels**	**Inside Park**	**Outside Park**
FlatsBoat	3401	86.0	14.0
Canoe/Kayak	199	72.4	27.6
JohnBoat	199	67.8	32.2
RecSmall	2065	39.4	60.6
RecChart	224	33.0	67.0
Sailboat	351	31.6	68.4
Commercial	168	7.7	92.3
Other	181	21.5	78.5

Flatsboats accounted for the majority of vessels irrespective of day of the week inside Park waters of Florida Bay (**Figure 28a**). Outside Park waters, however, small recreational motorboats were the dominant vessel type, followed by sailboats, flatsboats, and commercial fishing vessels (**Figure 28b**). In terms of disposition, the majority of vessels observed inside Park waters were engaged in fishing (**Figure 29a**), whereas the majority of vessels observed outside Park waters were engaged in cruising (**Figure 29b**). The principal vessel types engaged in fishing both inside and outside Park waters of Florida Bay were flatsboats and small recreational motorboats, with commercial fishing vessels accounting for a substantial component of the fishing fleet outside Park waters on weekdays (**Tables 15** and **16**).

Figure 28. Seasons-combined relative composition of vessel types (see Table 3 for description) by day of week category for two regions in Florida Bay: (a) inside ENP waters and (b) outside ENP waters.

(a) Florida Bay, Inside Park



(b) Florida Bay, Outside Park

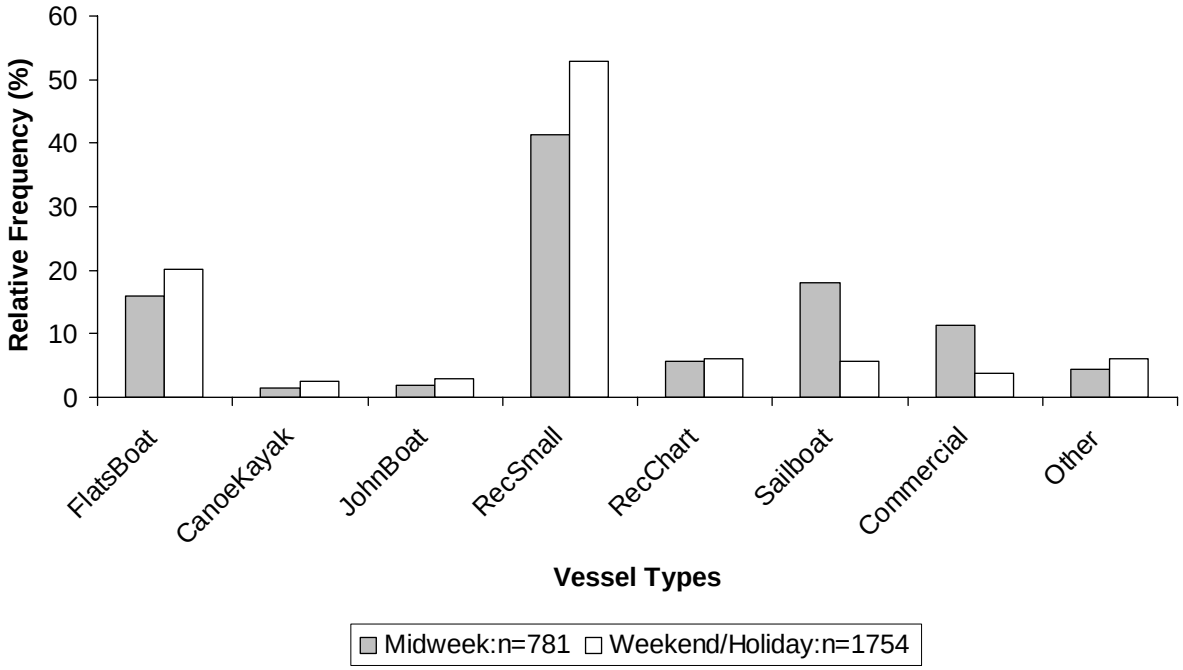
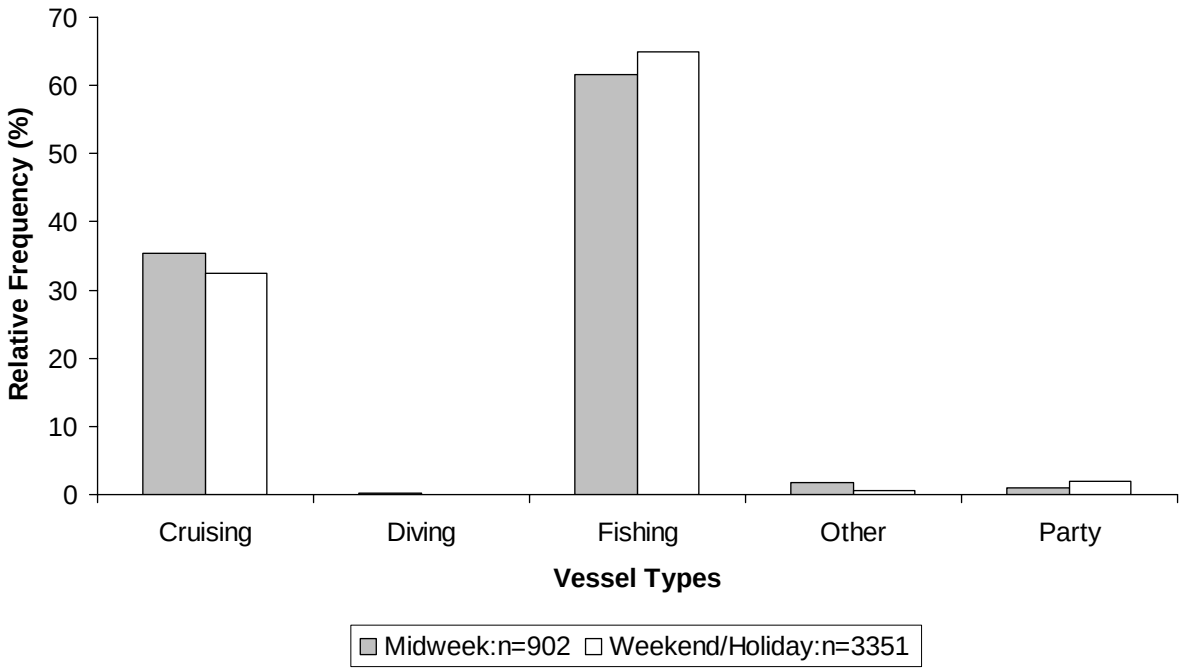


Figure 29. Seasons-combined relative frequency of vessel disposition categories (see Table 4 for description) by day of the week for two regions in Florida Bay: (a) inside ENP waters and (b) outside ENP waters.

(a) Florida Bay, Inside Park



(b) Florida Bay, Outside Park

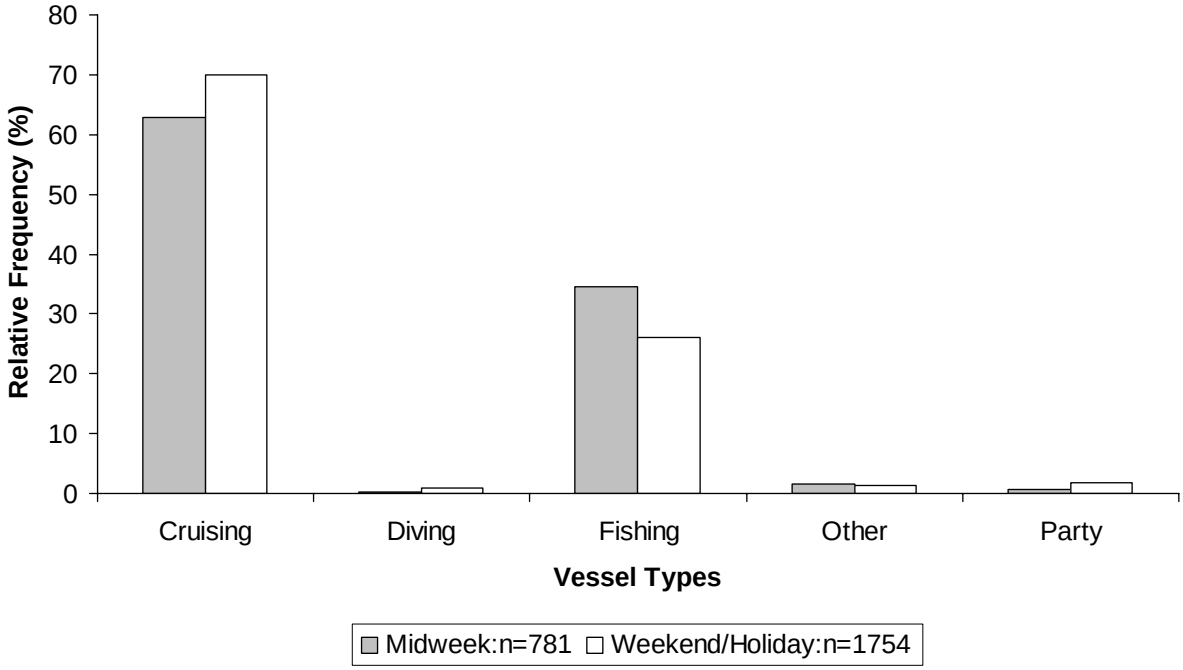


Table 15. Seasons-combined percent disposition by vessel type and day of the week in two regions of Florida Bay: (a) inside ENP waters and (b) outside ENP waters.

(a) Florida Bay, Inside Park

Vessel Type	Day of Week	Number of Vessels	Disposition Category (%)				
			Cruising	Diving	Fishing	Other	Party
FlatsBoat	Midweek	616	29.7	0.0	70.0	0.3	0.0
	Weekend/Holiday	2308	23.6	0.0	75.9	0.1	0.4
Canoe/Kayak	Midweek	22	100.0	0.0	0.0	0.0	0.0
	Weekend/Holiday	122	73.0	0.0	6.6	7.4	13.1
JohnBoat	Midweek	16	12.5	0.0	81.3	0.0	6.3
	Weekend/Holiday	119	13.4	0.0	84.9	0.8	0.8
RecSmall	Midweek	188	37.8	0.0	56.9	3.7	1.6
	Weekend/Holiday	625	46.1	0.0	49.4	0.5	4.0
RecChart	Midweek	24	83.3	0.0	8.3	0.0	8.3
	Weekend/Holiday	50	92.0	0.0	2.0	0.0	6.0
Sailboat	Midweek	22	68.2	9.1	4.5	4.5	13.6
	Weekend/Holiday	89	89.9	0.0	1.1	0.0	9.0
Commercial	Midweek	2	50.0	0.0	50.0	0.0	0.0
	Weekend/Holiday	11	54.5	0.0	45.5	0.0	0.0
Other	Midweek	12	41.7	0.0	8.3	50.0	0.0
	Weekend/Holiday	27	63.0	0.0	0.0	14.8	22.2

(b) Florida Bay, Outside Park

Vessel Type	Day of Week	Number of Vessels	Disposition Category (%)				
			Cruising	Diving	Fishing	Other	Party
FlatsBoat	Midweek	125	40.8	0.0	59.2	0.0	0.0
	Weekend/Holiday	352	52.3	0.3	47.2	0.0	0.3
Canoe/Kayak	Midweek	11	81.8	0.0	18.2	0.0	0.0
	Weekend/Holiday	44	95.5	0.0	0.0	4.5	0.0
JohnBoat	Midweek	14	42.9	0.0	57.1	0.0	0.0
	Weekend/Holiday	50	46.0	4.0	46.0	4.0	0.0
RecSmall	Midweek	323	64.4	0.6	33.7	1.2	0.0
	Weekend/Holiday	929	71.9	1.2	23.7	1.6	1.6
RecChart	Midweek	44	84.1	0.0	9.1	2.3	4.5
	Weekend/Holiday	106	90.6	0.0	2.8	0.0	6.6
Sailboat	Midweek	141	95.0	0.0	3.5	1.4	0.0
	Weekend/Holiday	99	92.9	0.0	3.0	0.0	4.0
Commercial	Midweek	88	22.7	0.0	76.1	0.0	1.1
	Weekend/Holiday	67	35.8	0.0	56.7	3.0	4.5
Other	Midweek	35	74.3	0.0	2.9	17.1	5.7
	Weekend/Holiday	107	92.5	0.0	2.8	1.9	2.8

Table 16. Seasons-combined percent vessel composition by disposition category and day of the week in two regions of Florida Bay: (a) inside ENP waters and (b) outside ENP waters. Day of week codes: MW, midweek; WH, weekend/holiday.

(a) Florida Bay, Inside Park

Disposition	Day of Week	Number of Vessels	Vessel Type (%)							
			FlatsBoat	Canoe/Kayak	JohnBoat	RecSmall	RecChart	Sailboat	Commercial	Other
Cruising	MW	319	57.4	6.9	0.6	22.3	6.3	4.7	0.3	1.6
	WH	1087	50.1	8.2	1.5	26.5	4.2	7.4	0.6	1.6
Diving	MW	2	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0
	WH	1	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fishing	MW	556	77.5	0.0	2.3	19.2	0.4	0.2	0.2	0.2
	WH	2176	80.5	0.4	4.6	14.2	0.0	0.0	0.2	0.0
Other	MW	16	12.5	0.0	0.0	43.8	0.0	6.3	0.0	37.5
	WH	19	10.5	47.4	5.3	15.8	0.0	0.0	0.0	21.1
Party	MW	9	0.0	0.0	11.1	33.3	22.2	33.3	0.0	0.0
	WH	68	13.2	23.5	1.5	36.8	4.4	11.8	0.0	8.8

(b) Florida Bay, Outside Park

Disposition	Day of Week	Number of Vessels	Vessel Type (%)							
			FlatsBoat	Canoe/Kayak	JohnBoat	RecSmall	RecChart	Sailboat	Commercial	Other
Cruising	MW	491	10.4	1.8	1.2	42.4	7.5	27.3	4.1	5.3
	WH	1228	15.0	3.4	1.9	54.4	7.8	7.5	2.0	8.1
Diving	MW	2	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0
	WH	14	7.1	0.0	14.3	78.6	0.0	0.0	0.0	0.0
Fishing	MW	270	27.4	0.7	3.0	40.4	1.5	1.9	24.8	0.4
	WH	456	36.4	0.0	5.0	48.2	0.7	0.7	8.3	0.7
Other	MW	13	0.0	0.0	0.0	30.8	7.7	15.4	0.0	46.2
	WH	23	0.0	8.7	8.7	65.2	0.0	0.0	8.7	8.7
Party	MW	5	0.0	0.0	0.0	0.0	40.0	0.0	20.0	40.0
	WH	33	3.0	0.0	0.0	45.5	21.2	12.1	9.1	9.1

Highest average daily vessel use of the Ten Thousand Islands occurred during spring followed by winter for both midweek and weekend/holiday time periods, with lowest use in fall and summer (**Table 17**). Spring was also the peak vessel use season in Florida Bay (**Table 18**) and in Park waters within Florida Bay (**Table 19**). As expected, higher vessel use occurred on weekends/holidays compared to midweek in all locations and seasons.

Table 17. Minimum, mean, and maximum number of vessels observed per survey by season and day of week in Ten Thousand Islands for two vessel categories: (a) all vessels; and (b) small (<23ft) recreational fishing vessels (FlatsBoat, JohnBoat, RecSmall).

(a) All Vessels

	Midweek				Weekend/Holiday			
		Number of Vessels				Number of Vessels		
Season	**n**	**Min**	**Mean**	**Max**	**n**	**Min**	**Mean**	**Max**
Fall	3	33	52.0	84	4	52	98.8	137
Winter	4	71	109.5	145	6	86	161.7	252
Spring	3	74	125.0	153	5	59	165.8	304
Summer	5	15	28.8	53	8	67	99.3	150

(b) Small Recreational Fishing Vessels

	Midweek				Weekend/Holiday			
		Number of Vessels				Number of Vessels		
Season	**n**	**Min**	**Mean**	**Max**	**n**	**Min**	**Mean**	**Max**
Fall	3	24	42.7	68	4	47	91.8	135
Winter	4	45	85.8	126	6	64	129.5	200
Spring	3	62	107.0	138	5	46	150.4	279
Summer	5	12	24.2	44	8	64	93.1	144

Table 18. Minimum, mean, and maximum number of vessels observed per survey by season and day of week in Florida Bay for two vessel categories: (a) all vessels; and (b) small (<23ft) recreational fishing vessels (FlatsBoat, JohnBoat, RecSmall).

(a) All Vessels

	Midweek				Weekend/Holiday			
		Number of Vessels				Number of Vessels		
Season	**n**	**Min**	**Mean**	**Max**	**n**	**Min**	**Mean**	**Max**
Fall	4	58	81.5	107	9	49	134.8	236
Winter	5	51	91.4	145	9	59	161.6	255
Spring	3	118	142.3	159	5	187	230.2	294
Summer	5	56	94.6	109	7	117	183.9	217

(b) Small Recreational Fishing Vessels

	Midweek				Weekend/Holiday			
		Number of Vessels				Number of Vessels		
Season	**n**	**Min**	**Mean**	**Max**	**n**	**Min**	**Mean**	**Max**
Fall	4	45	60.0	80	9	43	114.3	209
Winter	5	33	70.4	115	9	43	137.2	223
Spring	3	65	94.7	136	5	146	198.4	260
Summer	5	43	81.2	97	7	107	161.0	196

Table 19. Minimum, mean, and maximum number of vessels observed per survey by season and day of week inside Park waters within Florida Bay for two vessel categories: (a) all vessels; and (b) small (<23ft) recreational fishing vessels (FlatsBoat, JohnBoat, RecSmall).

(a) All Vessels

	Midweek				Weekend/Holiday			
		Number of Vessels				Number of Vessels		
Season	**n**	**Min**	**Mean**	**Max**	**n**	**Min**	**Mean**	**Max**
Fall	4	31	45.0	63	9	31	94.6	179
Winter	5	27	53.8	78	9	35	110.4	203
Spring	3	51	70.0	107	5	97	144.4	189
Summer	5	26	48.6	58	7	71	112.0	146

(b) Small Recreational Fishing Vessels

	Midweek				Weekend/Holiday			
		Number of Vessels				Number of Vessels		
Season	**n**	**Min**	**Mean**	**Max**	**n**	**Min**	**Mean**	**Max**
Fall	4	27	39.8	51	9	29	84.6	167
Winter	5	23	48.0	73	9	31	98.8	178
Spring	3	46	66.3	103	5	86	132.2	177
Summer	5	23	44.4	53	7	70	105.9	135

5.0 Boat Trailer Census

5.1 Flamingo and Chokoloskee Marinas

Trailer counts were conducted at the Flamingo marina and Outdoor Resorts marina in Chokoloskee on each flight survey day (**Table 20**). The trailer counts at Flamingo marina were obtained from aerial photos taken during each flight in Florida Bay and Ten Thousand Islands. The counts at Flamingo marina were separated into two parking areas, one for Whitewater Bay which is in the Ten Thousand Islands aerial survey domain, and one for Florida Bay. Chokoloskee trailer counts were obtained from aerial photos taken during each flight in Ten Thousand Islands and from on-site counts by Park personnel during each flight in Florida Bay.

The relationship between trailer counts in the two parking areas of Flamingo marina was linear but somewhat variable (**Figure 30**). Trailer counts at Chokoloskee exhibited a linear relationship with trailer counts at Flamingo (**Figure 31**), although the relationship was less variable with the combined parking areas of Flamingo marina (**Figure 31b**) compared to the relationship with the Whitewater Bay section (**Figure 31a**).

Table 20. Trailer counts at Flamingo marina (separated into two parking areas, Whitewater Bay and Florida Bay) and Outdoor Resorts marina, Chokoloskee, by date and day of week category. A dash (-) denotes no sample taken; day of week codes: MW, midweek; WH, weekend/holiday.

Year	Month	Day	Day of Week	Flamingo, Whitewater Bay	Flamingo, Florida Bay	Chokoloskee, Outdoor Resorts
2006	10	17	MW	22	13	14
2006	10	27	MW	23	17	23
2006	10	28	WH	9	5	24
2006	10	29	WH	17	27	24
2006	10	31	MW	12	8	7
2006	11	5	WH	15	25	21
2006	11	10	WH	33	54	-
2006	11	11	WH	45	58	41
2006	11	12	WH	29	53	24
2006	11	15	MW	14	24	-
2006	11	18	WH	31	41	23
2006	11	19	WH	25	38	16
2006	11	26	WH	41	48	18
2006	11	28	MW	9	8	6
2006	11	29	MW	12	12	-
2006	12	4	MW	12	15	8
2006	12	19	MW	14	12	12
2006	12	23	WH	28	37	9
2007	1	6	WH	70	62	20
2007	1	14	WH	49	25	-
2007	1	16	MW	13	15	11
2007	1	18	MW	14	18	-
2007	1	20	WH	68	55	33
2007	1	21	WH	36	43	22
2007	1	25	MW	12	4	4
2007	1	28	WH	34	17	10
2007	2	1	MW	19	28	21
2007	2	8	MW	18	29	15
2007	2	10	WH	72	98	51
2007	2	11	WH	52	66	36
2007	2	17	WH	20	49	7
2007	2	19	MW	17	36	13
2007	2	20	MW	6	19	8
2007	2	25	WH	36	37	37
2007	2	27	MW	12	13	14
2007	3	1	MW	22	18	-
2007	3	3	WH	51	61	58
2007	3	10	WH	59	71	37
2007	3	11	WH	57	77	31
2007	3	17	WH	49	49	23
2007	4	14	WH	73	63	37
2007	4	15	WH	17	14	7
2007	4	17	MW	20	15	20

Table 20 (continued).

Year	Month	Day	Day of Week	Flamingo, Whitewater Bay	Flamingo, Florida Bay	Chokoloskee, Outdoor Resorts
2007	4	19	MW	22	17	18
2007	4	21	WH	63	71	55
2007	4	22	WH	53	71	39
2007	4	24	MW	15	15	-
2007	4	26	MW	19	19	25
2007	4	29	WH	34	71	46
2007	5	5	WH	34	64	50
2007	5	6	WH	21	48	21
2007	5	8	MW	9	10	13
2007	5	10	MW	9	13	13
2007	5	12	WH	21	53	28
2007	5	13	WH	10	14	10
2007	5	19	WH	22	53	31
2007	6	10	WH	17	63	20
2007	6	17	WH	10	23	10
2007	6	19	MW	7	7	8
2007	6	24	WH	11	65	21
2007	6	26	MW	3	10	4
2007	7	1	WH	13	40	21
2007	7	4	WH	9	45	11
2007	7	7	WH	19	61	26
2007	7	9	MW	3	11	-
2007	7	15	WH	11	44	22
2007	7	16	MW	2	8	7
2007	7	21	WH	16	53	34
2007	7	24	MW	3	9	5
2007	7	28	WH	18	43	36
2007	8	3	MW	6	23	8
2007	8	4	WH	25	67	15
2007	8	11	WH	12	59	23
2007	8	12	WH	6	37	9
2007	8	15	MW	3	8	5
2007	8	18	WH	19	49	30
2007	8	20	MW	2	2	4
2007	8	23	MW	3	8	-
2007	8	26	WH	13	35	17
2007	8	30	MW	2	7	3
2007	9	3	WH	11	50	32
2007	10	27	WH	30	37	28
2007	11	3	WH	37	24	23
2007	11	4	WH	42	40	18
2007	11	17	WH	39	32	-

Figure 30. Scatterplot and fitted linear regression function showing relationship of trailer counts between the Whitewater Bay and Florida Bay sections of the Flamingo Marina parking lot.

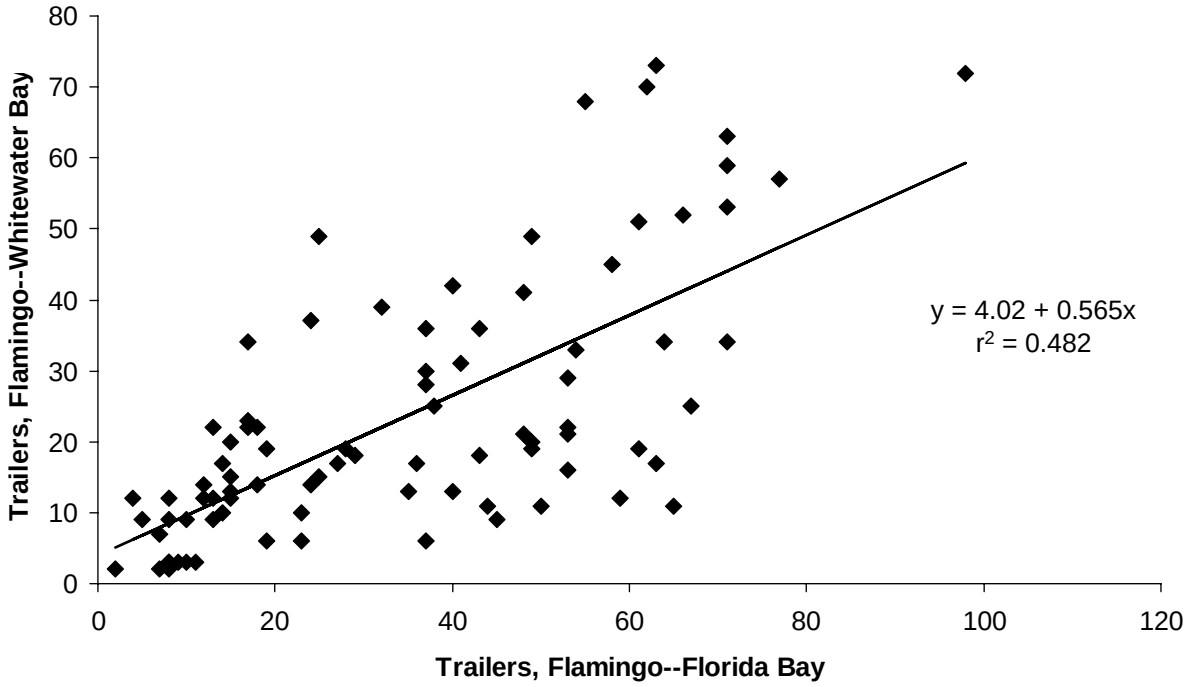
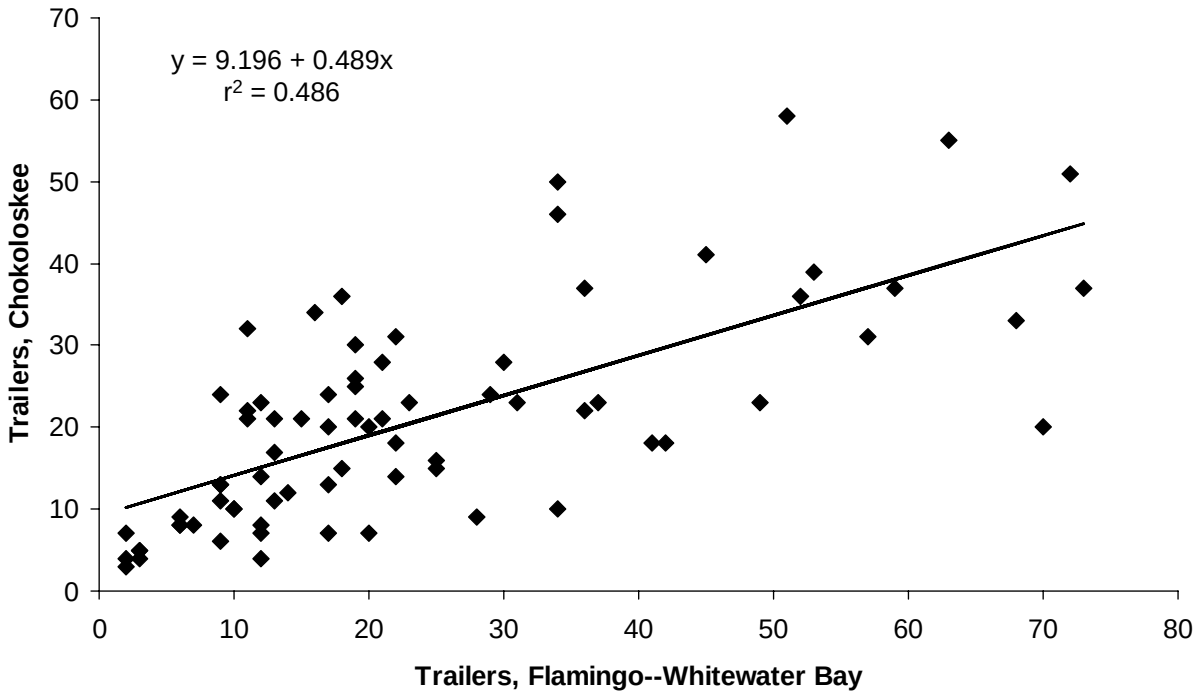
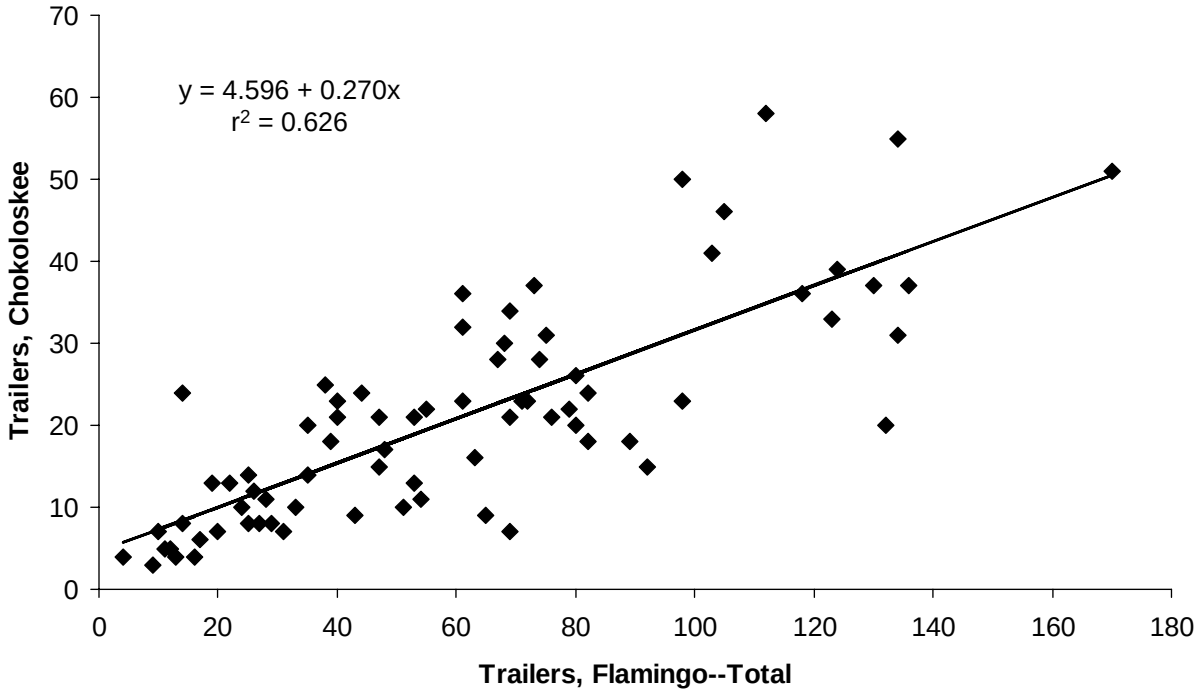


Figure 31. Scatterplots and fitted linear regression functions showing relationships of marina trailer counts between: (a) Chokoloskee and Flamingo—Whitewater Bay; and (b) Chokoloskee and Flamingo—Total (Whitewater Bay and Florida Bay sections combined).

(a)



(b)



5.2 Florida Keys Marinas

Trailer counts were obtained from aerial photos at 7 initial marinas in the Florida Keys taken during each Florida Bay flight. Boat trailers were consistently observed at four of the seven marinas on most flight days, including lower-use midweek days. Trailer counts at these four marinas—Caribbean Club, Founder's Park, La Siesta, and Seabird—for each flight day are given in **Table 21**. In some instances, accurate trailer counts were unable to be obtained at a given marina on some flight days, mostly due to problems in interpreting the aerial photos. The few cases of missing trailer counts at a specific marina were estimated from linear regression functions of trailer counts at either two or three of the other sampled marinas (**Table 22**).

Trailer counts for the combined Florida Keys marinas exhibited a linear relationship with trailer counts at Flamingo (**Figure 32**), although the relationship was less variable with the Florida Bay parking area of Flamingo marina (**Figure 32a**) compared to the relationship with the combined parking areas (**Figure 32b**). The regression relationship of **Figure 32a** was used to estimate the trailer count at the combined Florida Keys marinas on one flight day in which only two of the four Keys marinas were sampled (**Tables 21** and **22**).

Table 21. Trailer counts at four principal marinas in the Florida Keys by date and day of week category. Values denoted with asterisks (*) were estimated by missing value procedures (see Table 22); a dash (-) denotes no sample taken. Day of week codes: MW, midweek; WH, weekend/holiday.

Year	Month	Day	Day of Week	Caribbean Club	Founder's Park	La Siesta	Seabird	Florida Keys, Total
2006	10	17	MW	2	0	0	0	2
2006	10	27	MW	3	2	2	3	10
2006	10	29	WH	3	0	0	1	4
2006	11	5	WH	-	2	-	2	10*
2006	11	10	WH	9	4	4*	2	19
2006	11	11	WH	17	10	2	7	36
2006	11	12	WH	9	7	4	3	23
2006	11	15	MW	2	1	0	1	4
2006	11	18	WH	6*	0	4	2	12
2006	11	26	WH	3	3*	1	5	12
2006	11	29	MW	2	1	1	0	4
2006	12	19	MW	0	2	0	0	2
2007	1	6	WH	13	4	0	6	23
2007	1	14	WH	7*	2	3	2	14
2007	1	16	MW	5	1	1	2	9
2007	1	18	MW	2	2*	2	2	8
2007	1	20	WH	14	3	7	3	27
2007	1	25	MW	1	4	1	0	6
2007	1	28	WH	7*	4	2	1	14
2007	2	10	WH	33	7	8	6	54
2007	2	19	MW	1	0	2	1	4
2007	3	1	MW	3	3	0	1	7
2007	3	3	WH	34	8	5	8	55
2007	3	11	WH	15	5	3	9	32
2007	3	17	WH	4	5	2	1	12
2007	4	14	WH	28	4	8	4	44
2007	4	17	MW	3	0	2	1	6
2007	4	22	WH	18	6	5	0	29
2007	4	24	MW	3	3	7	1	14
2007	4	29	WH	23	9	5	5	42
2007	5	5	WH	23	12	13	5	53
2007	5	10	MW	5	2	10	2	19
2007	5	13	WH	9	5	5	4	23
2007	6	10	WH	28	8	7	4	47
2007	6	17	WH	11	9	7	5	32
2007	6	26	MW	7	2	5	0	14
2007	7	9	MW	5	2	8	2	17
2007	7	16	MW	4	3	4	2	13
2007	7	21	WH	26	15	8	5	54
2007	7	24	MW	7	1	2	0	10
2007	7	28	WH	20	6	3	6	35
2007	8	4	WH	26	9*	2	11	48

Table 21 (continued).

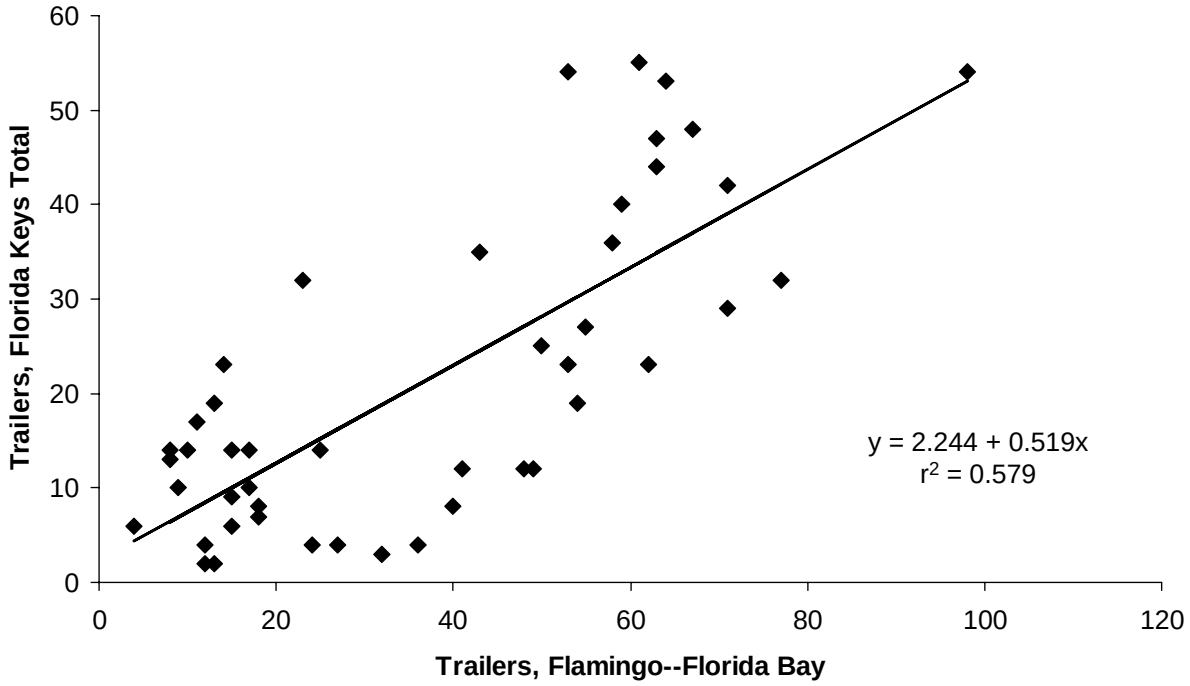
Year	Month	Day	Day of Week	Caribbean Club	Founder's Park	La Siesta	Seabird	Florida Keys Total
2007	8	11	WH	19	8	6	7	40
2007	8	23	MW	7*	3	1	3	14
2007	9	3	WH	11	9	2	3	25
2007	11	4	WH	6	2	0	0	8
2007	11	17	WH	1	1	0	1	3

Table 22. Parameters and r^2 values of linear regression functions for estimating missing values of trailer counts at response marinas from counts at other (explanatory) marinas.

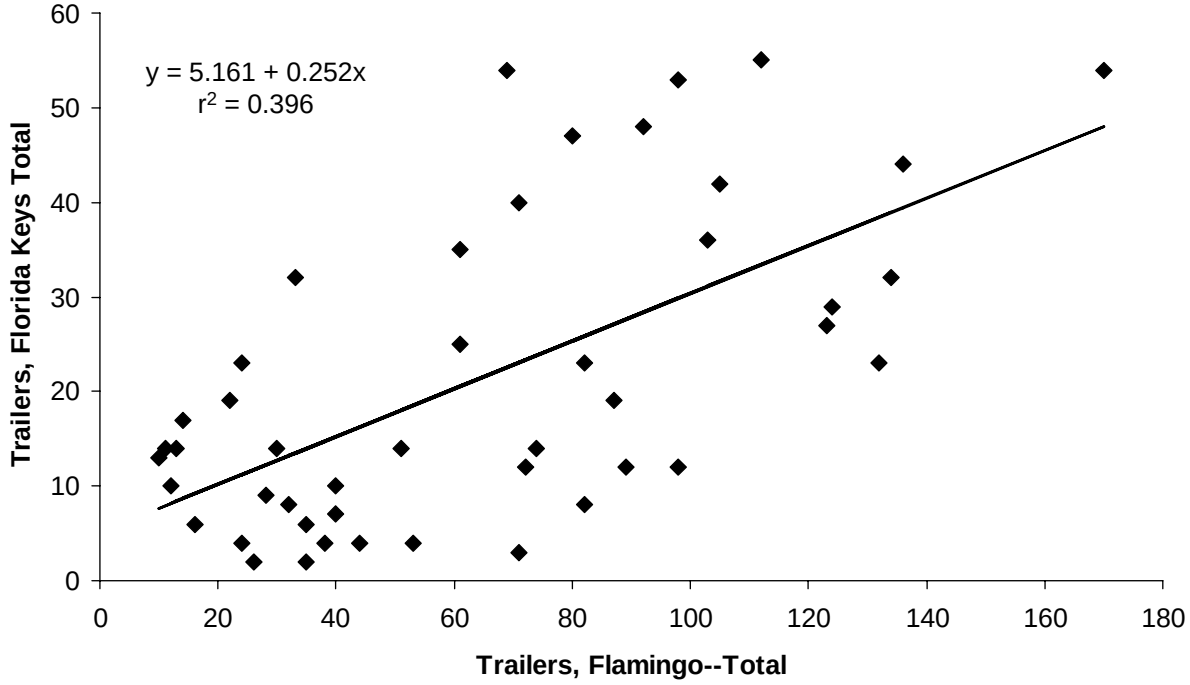
Response Marina	Explanatory Marina(s)	Intercept (SE)	Slope (SE)	r^2
Caribbean Club	Founder's Park, La Siesta, Seabird	-0.352 (1.609)	1.017 (0.118)	0.674
Founder's Park	Caribbean Club, La Siesta, Seabird	0.935 (0.631)	0.200 (0.028)	0.586
La Siesta	Caribbean Club, Founder's Park	1.402 (0.690)	0.156 (0.035)	0.362
Florida Keys Total	Flamingo—Florida Bay	2.244 (2.926)	0.519 (0.067)	0.579

Figure 32. Scatterplots and fitted linear regression functions showing relationships of marina trailer counts between: (a) Florida Keys (total of four individual marinas) and Flamingo—Florida Bay; and (b) Florida Keys and Flamingo—Total.

(a)



(b)



6.0 Regression Analysis of Vessels and Trailers

One of the main objectives of this study was to develop mathematical functions to predict the number of vessels using the Florida Bay and Ten Thousand Island areas of Everglades National Park based on boat trailer counts at principal access-point marinas in the vicinity of ENP. A suite of vessel-trailer regression functions was evaluated based on the results presented above in sections 4 and 5. Functions were developed for three major areas of ENP: Ten Thousand Islands, Florida Bay, and Park waters inside Florida Bay. Three classes of vessels, (i) 'all vessels', (ii) 'all recreational vessels' (Table 3 vessel categories FlatsBoat, Canoe/Kayak, JohnBoat, RecSmall, RecChart, and Sailboat), and (iii) 'small recreational motorboats' (FlatsBoat, JohnBoat, and RecSmall) were examined as the main response variables of the regression functions. The vessel class 'all recreational vessels' corresponds to the historical vessel-trailer regression model of Tilmant (1989; Jim Tilmant, personal communication). 'Small recreational motorboats' were the principal vessel types able to be transported by the types of boat trailers observed at the access-point marinas, and also constituted the vast majority of the recreational fishing fleet. For the Ten Thousand Islands area, various combinations of trailer counts at Chokoloskee and Flamingo were used as the explanatory variables in the regression functions. The vessel-trailer regression dataset for Ten Thousand Islands is given in **Table 23**. For Florida Bay regression functions, various combinations of trailer counts at Florida Keys marinas and Flamingo were used as the explanatory variables. The vessel-trailer regression dataset for Florida Bay is given in **Table 24**, and the dataset for Park waters of Florida Bay is given in **Table 25**.

Table 23. Dataset for vessel-trailer regression analysis in the Ten Thousand Islands region. Day of week codes: MW, midweek; WH, weekend/holiday.

					Number of Vessels			Number of Trailers		
Year	**Month**	**Day**	**Day of Week**	**Season**	**All**	**All Recreational**	**Small Recreational Motorboats**	**Flamingo, Whitewater Bay**	**Flamingo, Total**	**Chokoloskee**
2006	10	28	WH	Fall	52	50	47	9	14	24
2006	10	31	MW	Fall	39	38	36	12	20	7
2006	11	19	WH	Fall	104	100	87	25	63	16
2006	11	28	MW	Fall	84	82	68	9	17	6
2006	12	4	MW	Fall	33	32	24	12	27	8
2006	12	23	WH	Winter	86	85	64	28	65	9
2007	1	21	WH	Winter	187	184	157	36	79	22
2007	2	1	MW	Winter	109	107	92	19	47	21
2007	2	8	MW	Winter	145	140	126	18	47	15
2007	2	11	WH	Winter	170	168	152	52	118	36
2007	2	17	WH	Winter	107	102	83	20	69	7
2007	2	20	MW	Winter	113	108	80	6	25	8
2007	2	25	WH	Winter	168	168	121	36	73	37
2007	2	27	MW	Winter	71	66	45	12	25	14
2007	3	10	WH	Winter	252	246	200	59	130	37
2007	4	15	WH	Spring	59	57	46	17	31	7
2007	4	19	MW	Spring	153	146	138	22	39	18
2007	4	21	WH	Spring	304	300	279	63	134	55
2007	4	26	MW	Spring	148	147	121	19	38	25
2007	5	6	WH	Spring	134	133	127	21	69	21
2007	5	8	MW	Spring	74	72	62	9	19	13
2007	5	12	WH	Spring	161	159	140	21	74	28
2007	5	19	WH	Spring	171	169	160	22	75	31
2007	6	19	MW	Summer	53	51	44	7	14	8
2007	6	24	WH	Summer	129	124	113	11	76	21
2007	7	1	WH	Summer	85	83	80	13	53	21
2007	7	4	WH	Summer	71	71	68	9	54	11
2007	7	7	WH	Summer	150	148	144	19	80	26

Table 23 (continued).

					Number of Vessels			Number of Trailers		
Year	**Month**	**Day**	**Day of Week**	**Season**	**All**	**All Recreational**	**Small Recreational Motorboats**	**Flamingo, Whitewater Bay**	**Flamingo, Total**	**Chokoloskee**
2007	7	15	WH	Summer	95	94	89	11	55	22
2007	8	3	MW	Summer	36	35	35	6	29	8
2007	8	12	WH	Summer	67	65	64	6	43	9
2007	8	15	MW	Summer	20	14	12	3	11	5
2007	8	18	WH	Summer	131	130	123	19	68	30
2007	8	20	MW	Summer	15	14	14	2	4	4
2007	8	26	WH	Summer	67	65	65	13	48	17
2007	8	30	MW	Summer	20	18	16	2	9	3
2007	10	27	WH	Fall	137	135	135	30	67	28
2007	11	3	WH	Fall	102	100	98	37	61	23

Table 24. Dataset for vessel-trailer regression analysis in the Florida Bay region. Day of week codes: MW, midweek; WH, weekend/holiday.

					Number of Vessels			Number of Trailers		
Year	**Month**	**Day**	**Day of Week**	**Season**	**All**	**All Recreational**	**Small Recreational Motorboats**	**Florida Keys**	**Flamingo, Florida Bay**	**Flamingo, Total**
2006	10	17	MW	Fall	58	49	45	2	13	35
2006	10	27	MW	Fall	107	84	80	10	17	40
2006	10	29	WH	Fall	93	89	87	4	27	44
2006	11	5	WH	Fall	49	47	43	10	25	40
2006	11	10	WH	Fall	166	157	144	19	54	87
2006	11	11	WH	Fall	236	228	209	36	58	103
2006	11	12	WH	Fall	164	156	139	23	53	82
2006	11	15	MW	Fall	100	86	69	4	24	38
2006	11	18	WH	Fall	98	92	77	12	41	72
2006	11	26	WH	Fall	121	114	96	12	48	89
2006	11	29	MW	Fall	61	53	46	4	12	24
2006	12	19	MW	Winter	52	49	36	2	12	26
2007	1	6	WH	Winter	222	211	191	23	62	132
2007	1	14	WH	Winter	133	128	113	14	25	74
2007	1	16	MW	Winter	126	115	102	9	15	28
2007	1	18	MW	Winter	83	77	66	8	18	32
2007	1	20	WH	Winter	156	148	130	27	55	123
2007	1	25	MW	Winter	51	40	33	6	4	16
2007	1	28	WH	Winter	79	79	68	14	17	51
2007	2	10	WH	Winter	255	254	223	54	98	170
2007	2	19	WH	Winter	59	49	43	4	36	53
2007	3	1	MW	Winter	145	136	115	7	18	40
2007	3	3	WH	Winter	202	198	177	55	61	112
2007	3	11	WH	Winter	237	234	192	32	77	134
2007	3	17	WH	Winter	111	107	98	12	49	98
2007	4	14	WH	Spring	294	286	260	44	63	136
2007	4	17	MW	Spring	118	113	65	6	15	35
2007	4	22	WH	Spring	187	180	155	29	71	124

Table 24 (continued).

					Number of Vessels			Number of Trailers		
Year	Month	Day	Day of Week	Season	All	All Recreational	Small Recreational Motorboats	Florida Keys	Flamingo, Florida Bay	Flamingo, Total
2007	4	24	MW	Spring	150	144	83	14	15	30
2007	4	29	WH	Spring	205	199	180	42	71	105
2007	5	5	WH	Spring	277	270	251	53	64	98
2007	5	10	MW	Spring	159	149	136	19	13	22
2007	5	13	WH	Spring	188	178	146	23	14	24
2007	6	10	WH	Summer	217	203	183	47	63	80
2007	6	17	WH	Summer	172	156	144	32	23	33
2007	6	26	MW	Summer	99	98	86	14	10	13
2007	7	9	MW	Summer	109	105	97	17	11	14
2007	7	16	MW	Summer	101	92	84	13	8	10
2007	7	21	WH	Summer	178	168	161	54	53	69
2007	7	24	MW	Summer	108	105	96	10	9	12
2007	7	28	WH	Summer	117	113	107	35	43	61
2007	8	4	WH	Summer	175	162	152	48	67	92
2007	8	11	WH	Summer	216	205	196	40	59	71
2007	8	23	MW	Summer	56	51	43	14	8	11
2007	9	3	WH	Summer	212	200	184	25	50	61
2007	11	4	WH	Fall	178	174	129	8	40	82
2007	11	17	WH	Fall	108	108	105	3	32	71

Table 25. Dataset for vessel-trailer regression analysis in the Florida Bay region inside Park waters. Day of week codes: MW, midweek; WH, weekend/holiday.

					Number of Vessels			Number of Trailers		
Year	Month	Day	Day of Week	Season	All	All Recreational	Small Recreational Motorboats	Florida Keys	Flamingo, Florida Bay	Flamingo, Total
2006	10	17	MW	Fall	31	30	27	2	13	35
2006	10	27	MW	Fall	46	44	44	10	17	40
2006	10	29	WH	Fall	48	48	48	4	27	44
2006	11	5	WH	Fall	31	31	29	10	25	40
2006	11	10	WH	Fall	133	131	125	19	54	87
2006	11	11	WH	Fall	179	177	167	36	58	103
2006	11	12	WH	Fall	106	102	95	23	53	82
2006	11	15	MW	Fall	63	61	51	4	24	38
2006	11	18	WH	Fall	66	66	62	12	41	72
2006	11	26	WH	Fall	77	77	65	12	48	89
2006	11	29	MW	Fall	40	39	37	4	12	24
2006	12	19	MW	Winter	35	35	25	2	12	26
2007	1	6	WH	Winter	157	156	146	23	62	132
2007	1	14	WH	Winter	52	52	51	14	25	74
2007	1	16	MW	Winter	77	77	73	9	15	28
2007	1	18	MW	Winter	52	52	46	8	18	32
2007	1	20	WH	Winter	113	112	98	27	55	123
2007	1	25	MW	Winter	27	25	23	6	4	16
2007	1	28	WH	Winter	35	35	31	14	17	51
2007	2	10	WH	Winter	203	202	178	54	98	170
2007	2	19	WH	Winter	40	36	35	4	36	53
2007	3	1	MW	Winter	78	76	73	7	18	40
2007	3	3	WH	Winter	141	141	134	55	61	112
2007	3	11	WH	Winter	169	167	137	32	77	134
2007	3	17	WH	Winter	84	82	79	12	49	98
2007	4	14	WH	Spring	180	177	170	44	63	136
2007	4	17	MW	Spring	51	51	46	6	15	35
2007	4	22	WH	Spring	112	111	98	29	71	124

Table 25 (continued).

					Number of Vessels			Number of Trailers		
Year	Month	Day	Day of Week	Season	All	All Recreational	Small Recreational Motorboats	Florida Keys	Flamingo, Florida Bay	Flamingo, Total
2007	4	24	MW	Spring	52	52	50	14	15	30
2007	4	29	WH	Spring	144	143	130	42	71	105
2007	5	5	WH	Spring	189	186	177	53	64	98
2007	5	10	MW	Spring	107	106	103	19	13	22
2007	5	13	WH	Spring	97	96	86	23	14	24
2007	6	10	WH	Summer	146	145	135	47	63	80
2007	6	17	WH	Summer	92	90	84	32	23	33
2007	6	26	MW	Summer	58	57	52	14	10	13
2007	7	9	MW	Summer	55	54	53	17	11	14
2007	7	16	MW	Summer	53	53	48	13	8	10
2007	7	21	WH	Summer	113	111	106	54	53	69
2007	7	24	MW	Summer	51	50	46	10	9	12
2007	7	28	WH	Summer	71	71	70	35	43	61
2007	8	4	WH	Summer	120	118	113	48	67	92
2007	8	11	WH	Summer	127	127	126	40	59	71
2007	8	23	MW	Summer	26	26	23	14	8	11
2007	9	3	WH	Summer	115	112	107	25	50	61
2007	11	4	WH	Fall	136	136	96	8	40	82
2007	11	17	WH	Fall	75	75	74	3	32	71

Results of vessel-trailer regression analyses for the Ten Thousand Islands region are shown in **Table 26**. In all cases, the relationship between vessels and trailers was strongly linear with approximately homoscedastic error residuals (i.e., constant variance of vessel observations along the range of trailer counts). In some cases, however, the error residuals departed from the normality assumption. The best overall model was selected based on the combination of r^2 value and satisfaction of the normality assumption of the error residuals. For the three vessel classes, the model using combined trailer counts from Chokoloskee and the Whitewater Bay portion of the Flamingo parking area provided the best overall fit. The selected regression models for the three vessel classes are shown in **Figure 33**. The r^2 values for the three selected models ranged from 0.80 to 0.81.

Results of vessel-trailer regression analyses for the Florida Bay region are given in **Table 27**. For the three vessel classes, the model using combined trailer counts from the Florida Bay portion of the Flamingo parking area and the Florida Keys marinas provided the best overall fit (**Figure 34**). The r^2 values for the three selected models were relatively precise and ranged from 0.69 to 0.74.

The results of **Figures 33** and **34** indicate that our strategy of allocating flight days over an annual time period among four seasons and between midweek and weekend/holiday days was able to capture a wide range of environmental and boating conditions within ENP.

Regression results for inside Park waters of Florida Bay are given in **Table 28**. Again, the model using combined trailer counts from Flamingo—Florida Bay and the Florida Keys provided the best overall fit for the three vessel classes (**Figure 35**). The r^2 values for the three selected models ranged from 0.78 to 0.79.

The r^2 values of the vessel-trailer regressions shown in **Figures 33-35** are comparable to the historical regression model of Tilmant (1989) who reported an r value of 0.84, which equates to an r^2 value of 0.71. Tilmant's (1989) vessel-trailer regression model for n=243 flight surveys conducted in the 1970s and 1980s was based on the 'all recreational vessels' class and utilized trailer counts from the total parking area at Flamingo. The survey domain was all Park waters in both the Ten Thousand Islands and Florida Bay regions.

Table 26. Results of vessel-trailer regression analysis for the Ten Thousand Islands region (n=38 surveys) for three vessel types: (a) all vessels; (b) all recreational vessels; and (c) small recreational motorboats. In each case, the model using combined trailer counts from Chokoloskee and Flamingo—Whitewater Bay provided the best overall fit; PDF=probability density function.

(a) All Vessels

Marina(s)	Intercept (SE)	Slope (SE)	r^2	Error PDF Description
Chokoloskee	21.207 (9.949)	4.701 (0.459)	0.745	Symmetric, approximately normal
Flamingo—Total	19.208 (9.812)	1.711 (0.162)	0.757	Slightly skewed, asymmetric
Flamingo—Whitewater Bay	38.090 (9.179)	3.610 (0.379)	0.716	Symmetric, approximately normal
Chokoloskee & Flamingo—Total	13.003 (8.860)	1.350 (0.109)	0.811	Slightly skewed, asymmetric
Chokoloskee & Flamingo—Whitewater Bay	22.379 (8.317)	2.264 (0.184)	0.807	Symmetric, approximately normal

(b) All Recreational Vessels

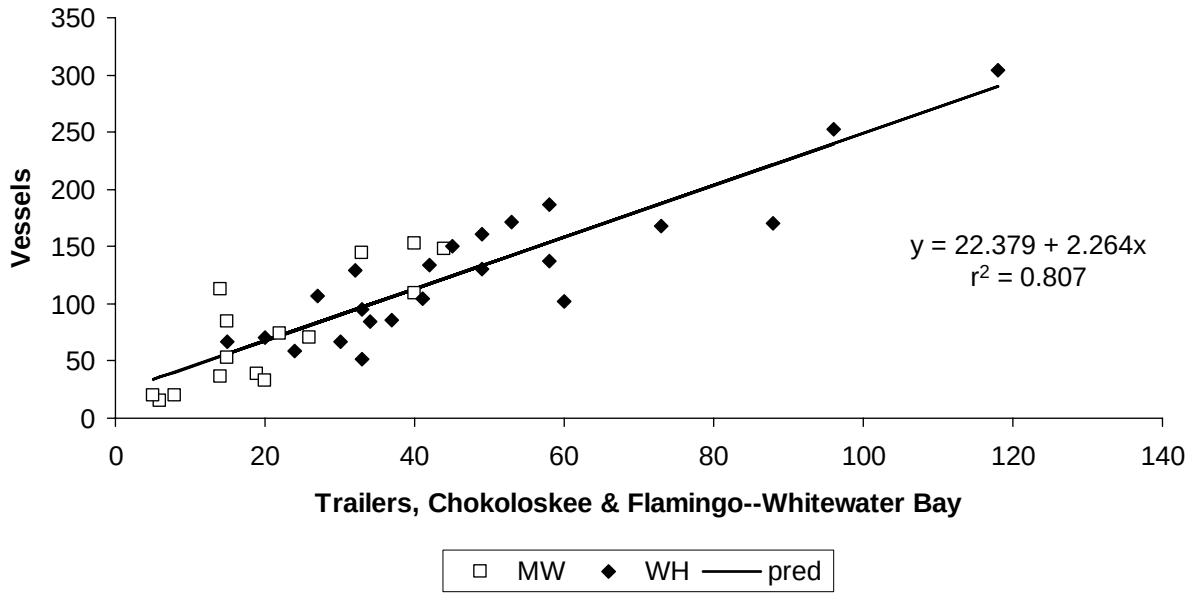
Marina(s)	Intercept (SE)	Slope (SE)	r^2	Error PDF Description
Chokoloskee	18.732 (9.655)	4.699 (0.445)	0.756	Symmetric, approximately normal
Flamingo—Total	17.086 (9.632)	1.704 (0.159)	0.762	Slightly skewed, asymmetric
Flamingo—Whitewater Bay	35.987 (9.062)	3.590 (0.375)	0.718	Symmetric, approximately normal
Chokoloskee & Flamingo—Total	10.808 (8.621)	1.346 (0.106)	0.818	Skewed, asymmetric
Chokoloskee & Flamingo—Whitewater Bay	20.160 (8.099)	2.256 (0.180)	0.814	Symmetric, approximately normal

(c) Small Recreational Motorboats

Marina(s)	Intercept (SE)	Slope (SE)	r^2	Error PDF Description
Chokoloskee	14.630 (8.299)	4.277 (0.383)	0.776	Symmetric, approximately normal
Flamingo—Total	13.917 (8.550)	1.536 (0.141)	0.767	Slightly skewed, asymmetric
Flamingo—Whitewater Bay	32.751 (8.641)	3.142 (0.357)	0.683	Symmetric, approximately normal
Chokoloskee & Flamingo—Total	8.037 (7.522)	1.216 (0.092)	0.829	Skewed, asymmetric
Chokoloskee & Flamingo—Whitewater Bay	17.576 (7.523)	2.010 (0.167)	0.801	Symmetric, approximately normal

Figure 33. Scatterplots of vessel-trailer observations for the Ten Thousand Islands region denoting day of week category (MW, midweek; WH, weekend/holiday) for three vessel types: (a) all vessels; (b) all recreational vessels; and (c) small recreational motorboats. Fitted regression lines correspond to the best overall model in Tables 26a-c, respectively.

(a) All Vessels



(b) All Recreational Vessels

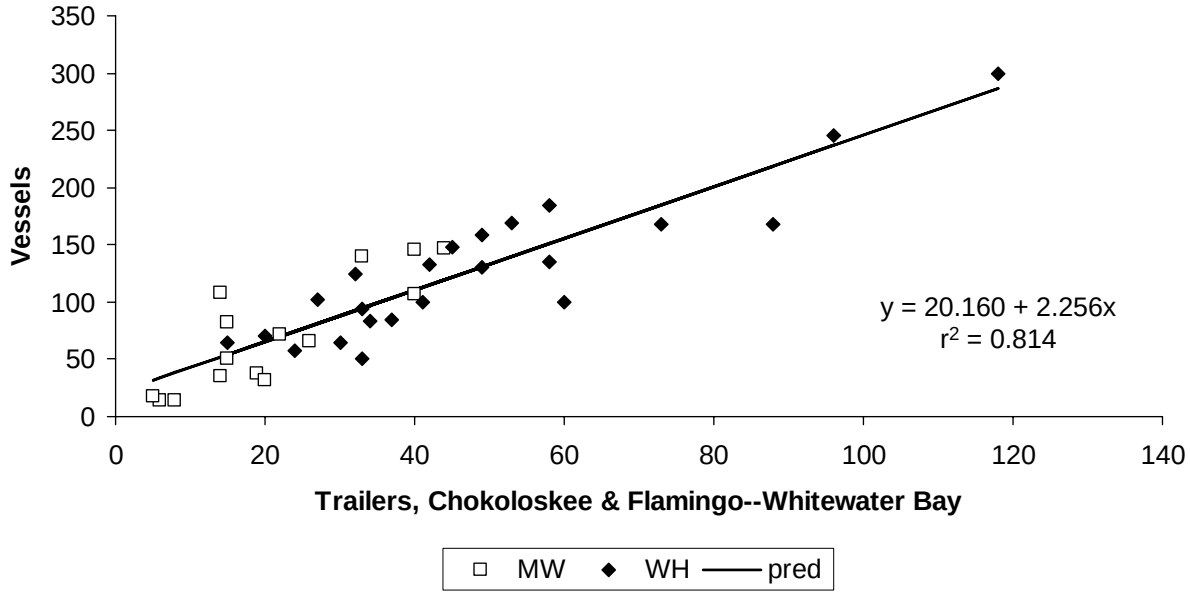


Figure 33 (continued).

(c) Small Recreational Motorboats

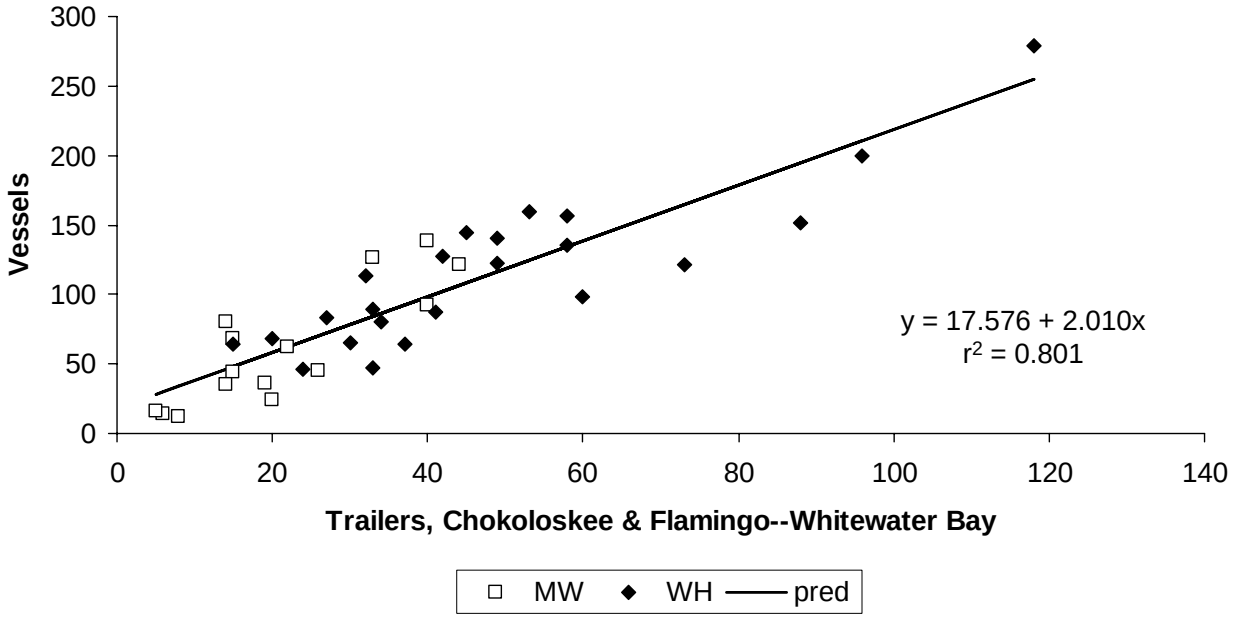


Table 27. Results of vessel-trailer regression analysis for the Florida Bay region (n=47 surveys) for three vessel types: (a) all vessels; (b) all recreational vessels; and (c) small recreational motorboats. In each case, the model using combined trailer counts from Flamingo—Florida Bay and the Florida Keys provided the best overall fit.

(a) All Vessels

Marina(s)	Intercept (SE)	Slope (SE)	r^2	Error PDF Description
Flamingo—Total	71.429 (12.310)	1.145 (0.163)	0.522	Symmetric, approximately normal
Flamingo—Florida Bay	68.412 (11.204)	2.076 (0.257)	0.591	Symmetric, approximately normal
Florida Keys	77.347 (9.298)	3.175 (0.350)	0.646	Symmetric, approximately normal
Flamingo—Total & Florida Keys	60.167 (10.696)	0.993 (0.108)	0.654	Skewed, asymmetric
Flamingo—Florida Bay & Florida Keys	62.509 (9.682)	1.419 (0.141)	0.693	Symmetric, approximately normal

(b) All Recreational Vessels

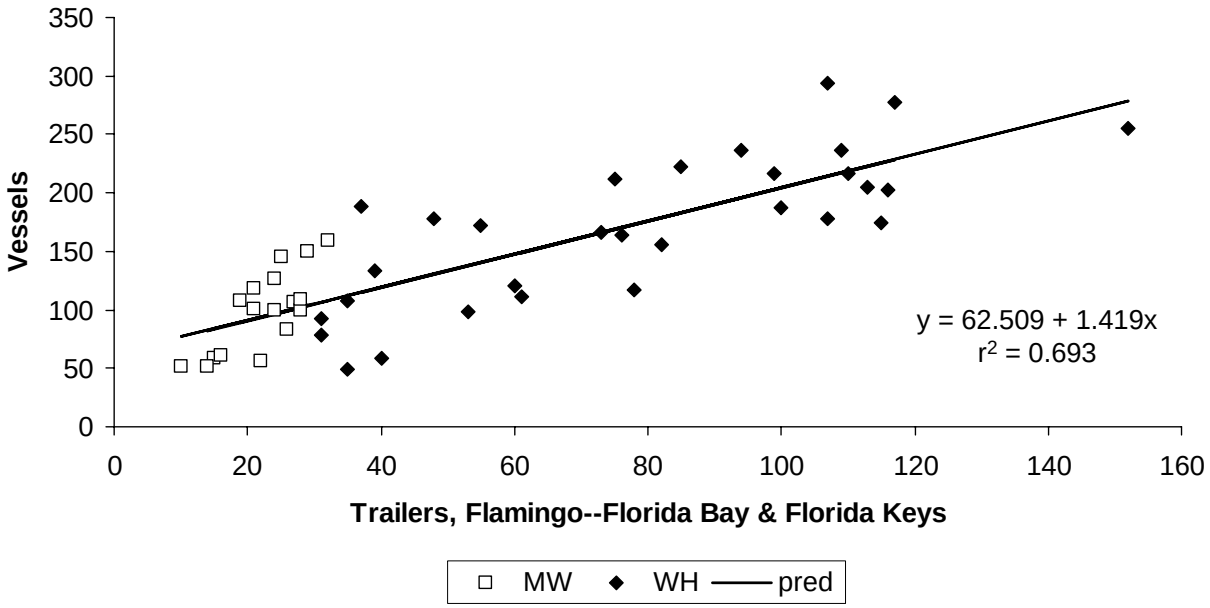
Marina(s)	Intercept (SE)	Slope (SE)	r^2	Error PDF Description
Flamingo—Total	63.240 (11.966)	1.157 (0.159)	0.541	Slightly skewed, asymmetric
Flamingo—Florida Bay	60.846 (10.961)	2.080 (0.252)	0.602	Symmetric, approximately normal
Florida Keys	70.501 (9.242)	3.147 (0.348)	0.645	Symmetric, approximately normal
Flamingo—Total & Florida Keys	52.358 (10.360)	0.997 (0.194)	0.671	Symmetric, approximately normal
Flamingo—Florida Bay & Florida Keys	55.291 (9.493)	1.415 (0.138)	0.700	Symmetric, approximately normal

(c) Small Recreational Motorboats

Marina(s)	Intercept (SE)	Slope (SE)	r^2	Error PDF Description
Flamingo—Total	52.720 (11.081)	1.063 (0.147)	0.537	Slightly skewed, asymmetric
Flamingo—Florida Bay	48.990 (48.990)	1.954 (0.226)	0.625	Skewed, asymmetric
Florida Keys	56.679 (7.851)	3.022 (0.296)	0.699	Symmetric, approximately normal
Flamingo—Total & Florida Keys	41.661 (9.356)	0.929 (0.094)	0.684	Skewed, asymmetric
Flamingo—Florida Bay & Florida Keys	43.068 (43.068)	1.341 (0.119)	0.739	Symmetric, approximately normal

Figure 34. Scatterplots of vessel-trailer observations for the Florida Bay region denoting day of week category (MW, midweek; WH, weekend/holiday) for three vessel types: (a) all vessels; (b) all recreational vessels; and (c) small recreational motorboats. Fitted regression lines correspond to the best overall model in Tables 27a-c, respectively.

(a) All Vessels



(b) All Recreational Vessels

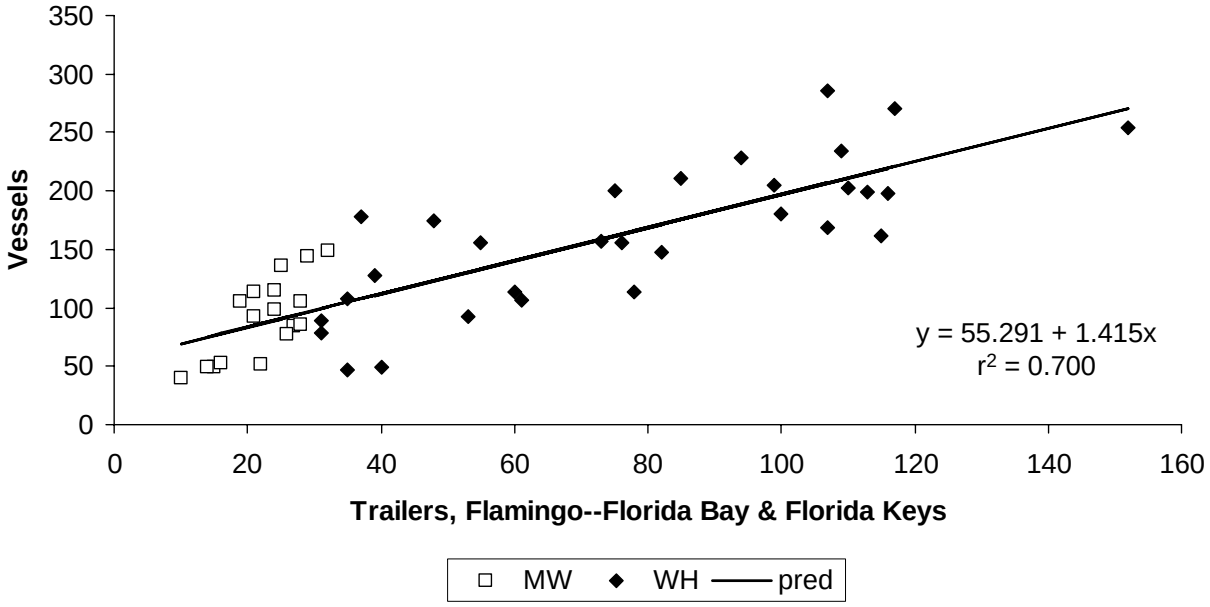


Figure 34 (continued).

(c) Small Recreational Motorboats

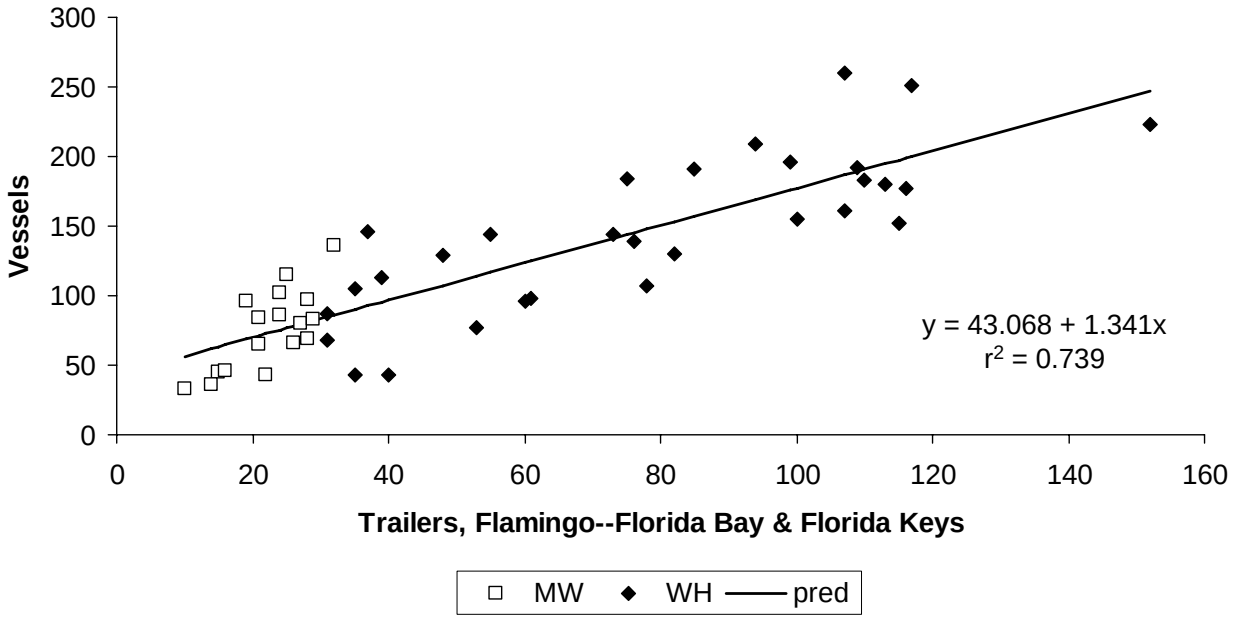


Table 28. Results of vessel-trailer regression analysis for inside Park waters of Florida Bay (n=48 surveys) for three vessel types: (a) all vessels; (b) all recreational vessels; and (c) small recreational motorboats. In each case, the model using combined trailer counts from Flamingo—Florida Bay and the Florida Keys provided the best overall fit.

(a) All Vessels

Marina(s)	Intercept (SE)	Slope (SE)	r^2	Error PDF Description
Flamingo—Total	27.977 (7.929)	0.980 (0.105)	0.658	Symmetric, approximately normal
Flamingo—Florida Bay	26.132 (6.950)	1.758 (0.160)	0.729	Symmetric, approximately normal
Florida Keys	40.028 (7.253)	2.388 (0.273)	0.630	Slightly skewed, asymmetric
Flamingo—Total & Florida Keys	21.041 (6.721)	0.818 (0.068)	0.765	Symmetric, approximately normal
Flamingo—Florida Bay & Florida Keys	24.358 (6.286)	1.145 (0.091)	0.777	Symmetric, approximately normal

(b) All Recreational Vessels

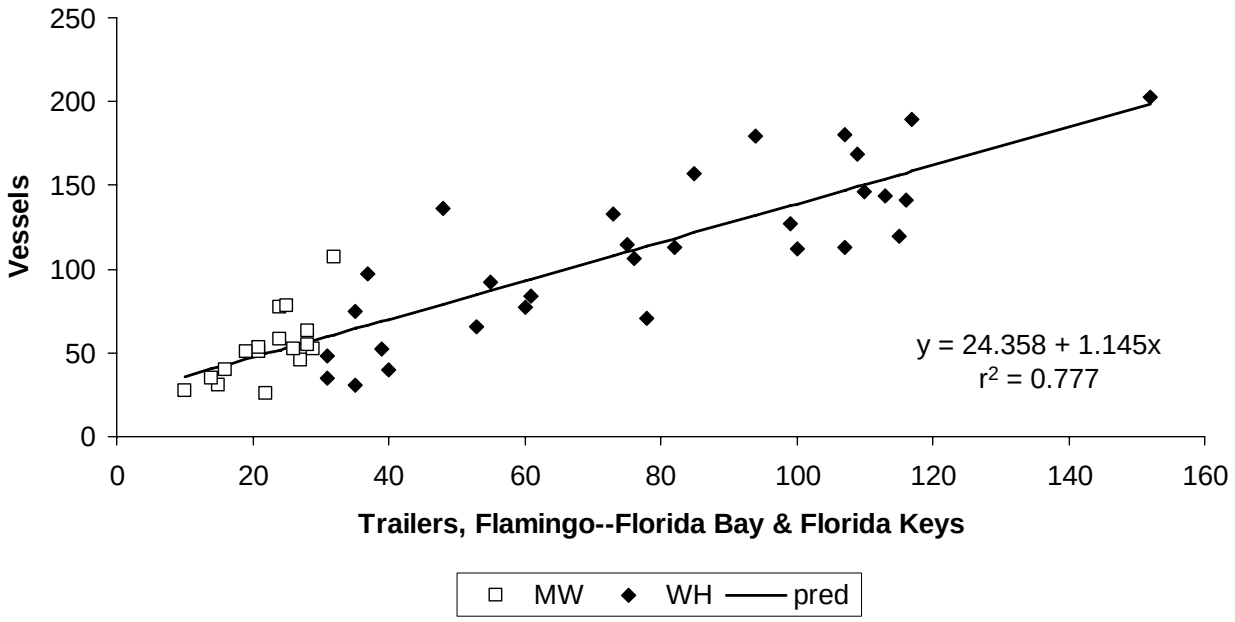
Marina(s)	Intercept (SE)	Slope (SE)	r^2	Error PDF Description
Flamingo—Total	27.282 (7.855)	0.974 (0.104)	0.660	Symmetric, approximately normal
Flamingo—Florida Bay	25.551 (6.910)	1.743 (0.159)	0.728	Symmetric, approximately normal
Florida Keys	39.280 (7.194)	2.371 (0.271)	0.630	Symmetric, approximately normal
Flamingo—Total & Florida Keys	20.402 (6.654)	0.813 (0.067)	0.766	Symmetric, approximately normal
Flamingo—Florida Bay & Florida Keys	23.764 (6.254)	1.136 (0.091)	0.777	Symmetric, approximately normal

(c) Small Recreational Motorboats

Marina(s)	Intercept (SE)	Slope (SE)	r^2	Error PDF Description
Flamingo—Total	26.652 (7.545)	0.874 (0.100)	0.628	Symmetric, approximately normal
Flamingo—Florida Bay	24.306 (6.526)	1.586 (0.150)	0.713	Symmetric, approximately normal
Florida Keys	34.762 (6.215)	2.254 (0.234)	0.673	Symmetric, approximately normal
Flamingo—Total & Florida Keys	19.447 (6.268)	0.741 (0.063)	0.755	Symmetric, approximately normal
Flamingo—Florida Bay & Florida Keys	21.644 (5.604)	1.052 (0.082)	0.787	Symmetric, approximately normal

Figure 35. Scatterplots of vessel-trailer observations for inside Park waters of Florida Bay denoting day of week category (MW, midweek; WH, weekend/holiday) for three vessel types: (a) all vessels; (b) all recreational vessels; and (c) small recreational motorboats. Fitted regression lines correspond to the best overall model in Tables 28a-c, respectively.

(a) All Vessels



(b) All Recreational Vessels

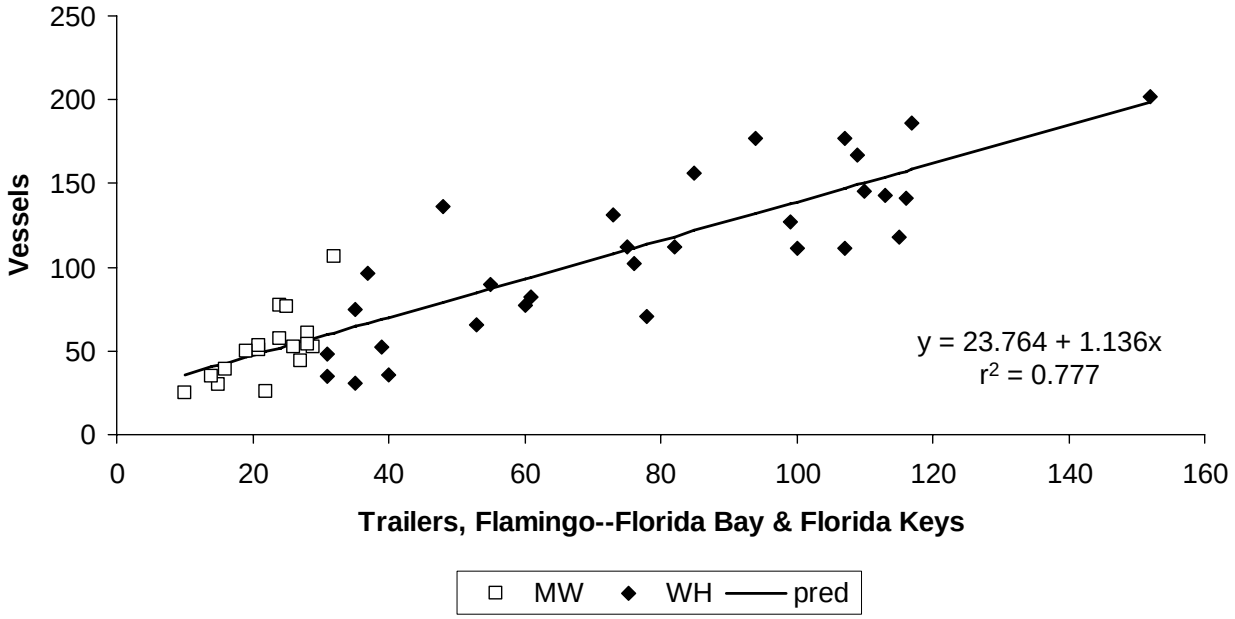
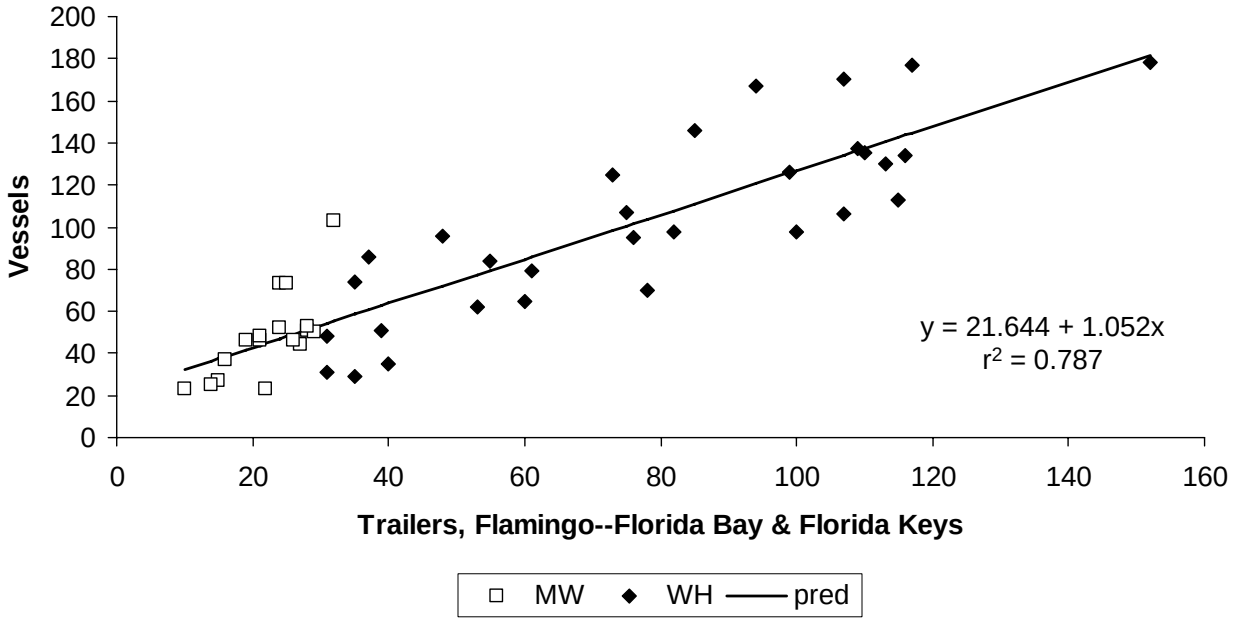


Figure 35 (continued).

(c) Small Recreational Motorboats



7.0 Historical Comparisons of Vessel Use

To compare our results with previous studies of boater use in Everglades NP, historical data were obtained from two sources: (1) original vessel count data from flights conducted during 1972-1975; and (2) the vessel-trailer regression model of Tilmant (1989) based on aerial surveys of vessels and corresponding marina surveys of boat trailers conducted during the periods 1972-1975, 1977-1978, and 1983-1984. Although we obtained some historical data for the1977-78 period, it was incomplete with respect to various vessel categories and flight dates. Unfortunately, the complete historical dataset of vessel-trailer counts that were used in the regression model of Tilmant was not available; consequently, we were only able to compare the fitted regression line of Tilmant (1989), who reported the intercept and slope parameter values, to our regression results.

The Florida Bay portions of the flight domains differed somewhat between the historical surveys and the present study (Jim Tilmant, personal communication). While both the historical and current flight domains included vessels on either side of the western boundary of Florida Bay, the historical domain attempted to exclude the majority of vessels in the Intra-Coastal Waterway region along the southern boundary of Florida Bay, with the exception of recreational vessels just outside the southern boundary that were either fishing or cruising into or out of the Park. In contrast, the 2006-2007 flight domains included the Intra-Coastal Waterway region. To match the historical and current flight domains as closely as possible, the 2006-2007 vessel data were analyzed in two ways for the Florida Bay area. The first was to only include vessels strictly within the western and southern boundaries of the Park (e.g., **Table 25**), thus representing the minimum bound of the 1972-1984 flight domain. The second was to include vessels from the entire Florida Bay region, including along the western boundary and the Intra-Coastal Waterway area along the southern boundary (e.g., **Table 24**), thus representing the maximum bound of the 1972-1975 flight domain.

The original flight data from 1972-1975 were provided by Park personnel. For these surveys, vessels were counted in the combined Ten Thousand Islands and Florida Bay regions during a single flight. To compare vessel counts from the 2006-2007 surveys, daily flights from the two separate areas were combined by matching flights for the same day of week category in the same season by the closest corresponding dates. A total of 37 'combined' flights (n=15 weekday flights and n=22 weekend/holiday flights) were able to be constructed in this manner from the original 81 flights divided between the Florida Bay and Ten Thousand Island regions in 2006-2007. **Figure 36** shows frequency histograms of daily counts of all vessels during midweek flight days for 1972-1975 (upper panel) and 2006-2007 (middle and bottom panels). **Figure 37** shows a similar comparison for daily counts of all vessels during weekend/holiday flight days. In each case, the mean and distributions of vessels for the 2006-2007 period have increased (shifted to the right) compared to the 1972-1975 period. The corresponding distributional statistics (minimum, average, and maximum vessel counts) for **Figures 36** and **37** are given in **Table 29a**.

Figure 36. Frequency histograms of counts of all vessels during midweek flight days for 1972-1975 (upper panel) and 2006-2007 (middle and bottom panels). The survey domain is denoted on each panel (TTI=Ten Thousand Islands; FB=Florida Bay). The domains for the middle and bottom panels represent the respective minimum and maximum bounds of the flight domain in 1972-1975.

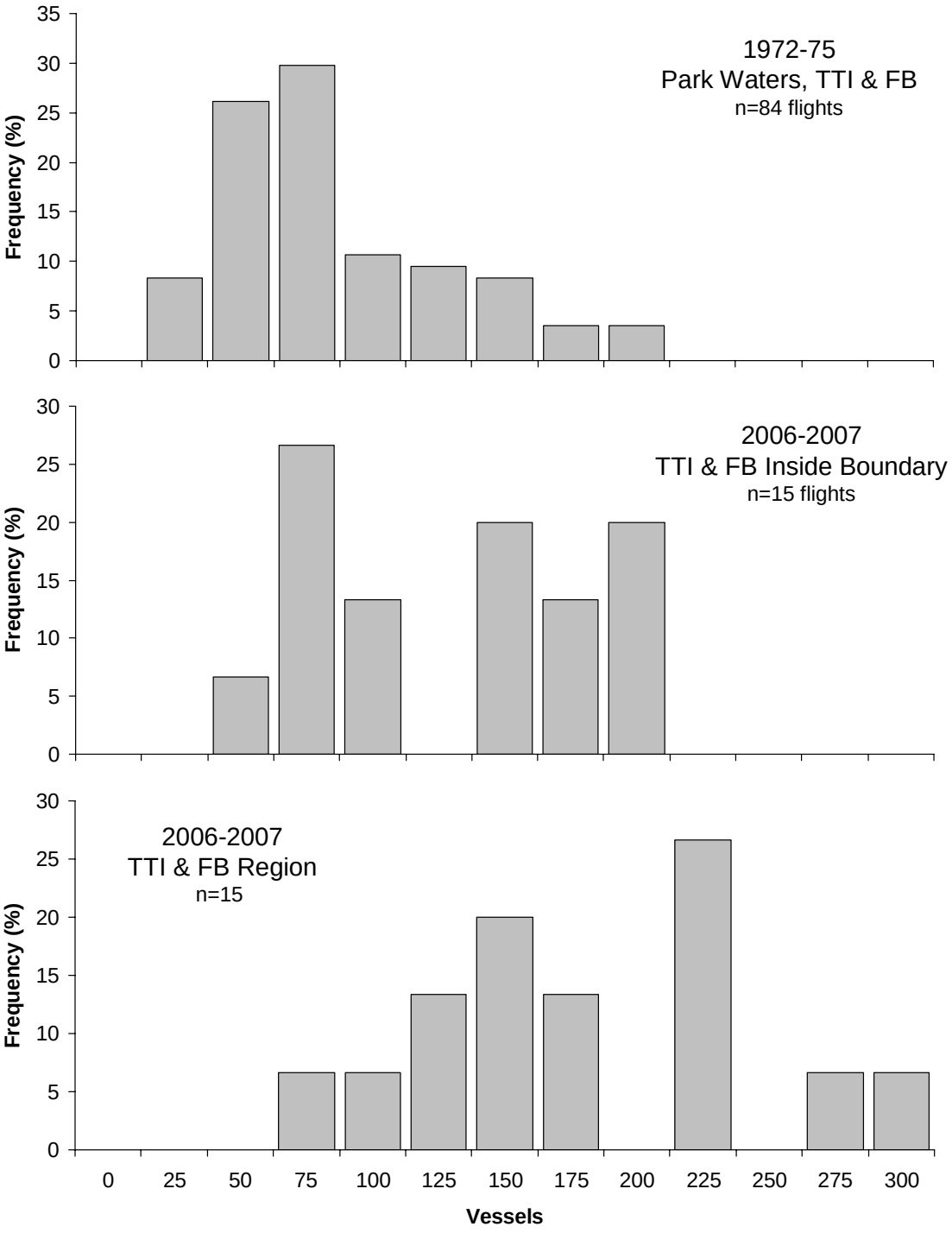


Figure 37. Frequency histograms of counts of all vessels during weekend/holiday flight days for 1972-1975 (upper panel) and 2006-2007 (middle and bottom panels). The survey domain is denoted on each panel (TTI=Ten Thousand Islands; FB=Florida Bay). The domains for the middle and bottom panels represent the respective minimum and maximum bounds of the flight domain in 1972-1975.

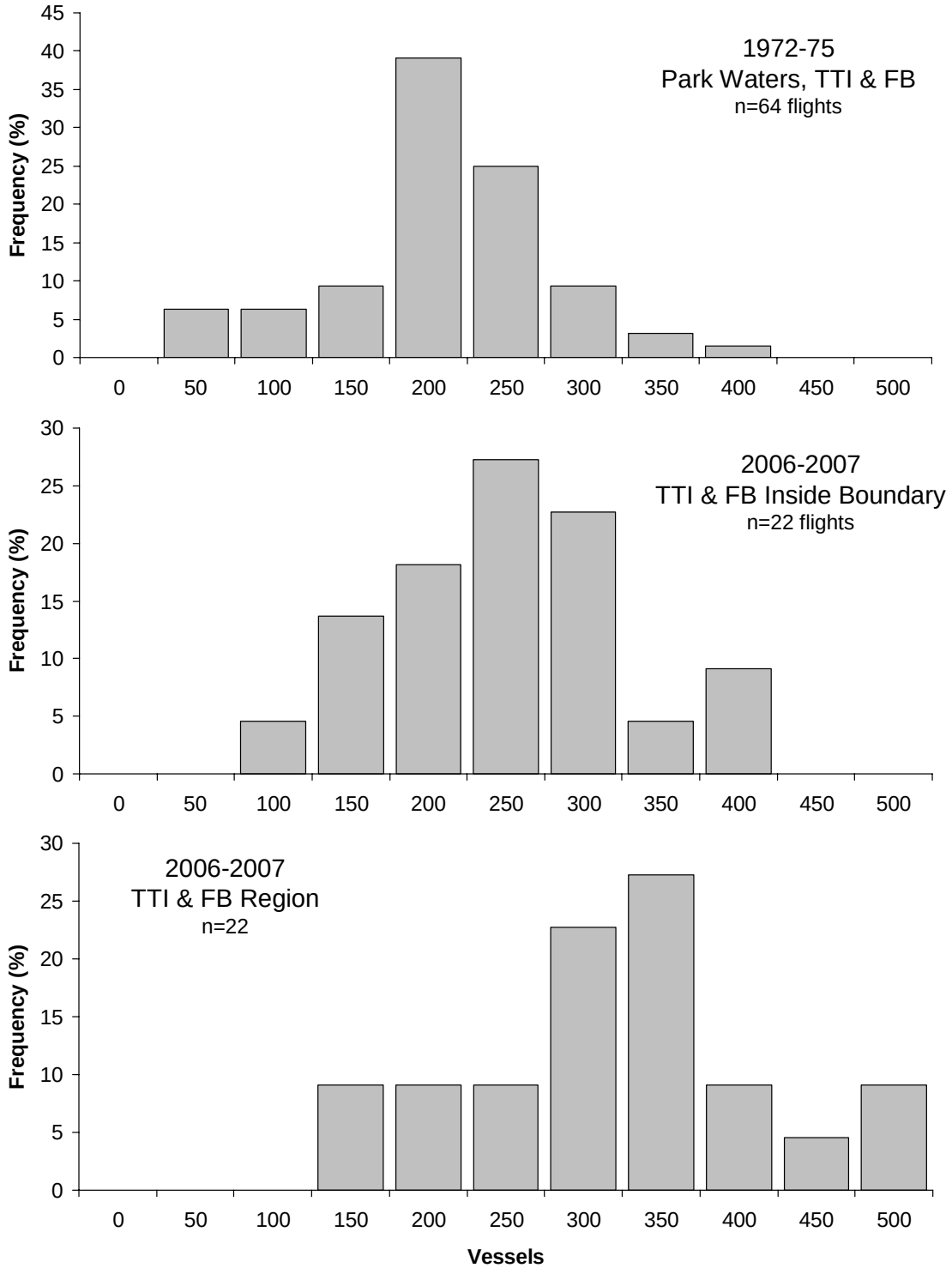


Table 29. Minimum, average, and maximum vessel counts for flight surveys conducted in 1972-1975 and 2006-2007 by day of week category for two vessel classes: (a) all vessels; and (b) recreational fishing vessels (FlatsBoat, JohnBoat, RecSmall, RecChart, and Canoe/Kayak).

(a) All Vessels

	Number of Vessels, Midweek			Number of Vessels, Weekend/Holiday		
Time Period and Survey Domain	**Min**	**Average**	**Max**	**Min**	**Average**	**Max**
1972-1975, TTI & FB Park Waters	21	85.6	209	34	208.8	421
2006-2007, TTI & FB Inside Park Boundary	46	129.9	204	100	253.3	421
2006-2007, TTI & FB Region	76	179.1	298	145	317.1	491

(b) Recreational Fishing Vessels

	Number of Vessels, Midweek			Number of Vessels, Weekend/Holiday		
Time Period and Survey Domain	**Min**	**Average**	**Max**	**Min**	**Average**	**Max**
1972-75, TTI & FB Park Waters	17	72.5	196	29	193.1	394
2007, TTI & FB Inside Park Boundary	44	123.0	191	98	243.5	402
2007, TTI & FB Region	66	155.5	236	138	297.2	465

Figures 38 and **39** compare respective midweek and weekend/holiday counts of recreational fishing vessels (FlatsBoat, JohnBoat, RecSmall, RecChart, and Canoe/Kayak from **Table 3**; Jim Tilmant, personal communication) for the two time periods. Again, the distributions of vessels have shifted upward between the earlier and later periods. The corresponding distributional statistics (minimum, average, and maximum vessel counts) for **Figures 38** and **39** are given in **Table 29b**.

Figure 38. Frequency histograms of counts of recreational fishing vessels during weekday flight days for 1972-1975 (upper panel) and 2006-2007 (middle and bottom panels). The survey domain is denoted on each panel (TTI=Ten Thousand Islands; FB=Florida Bay). The domains for the middle and bottom panels represent the respective minimum and maximum bounds of the flight domain in 1972-1975.

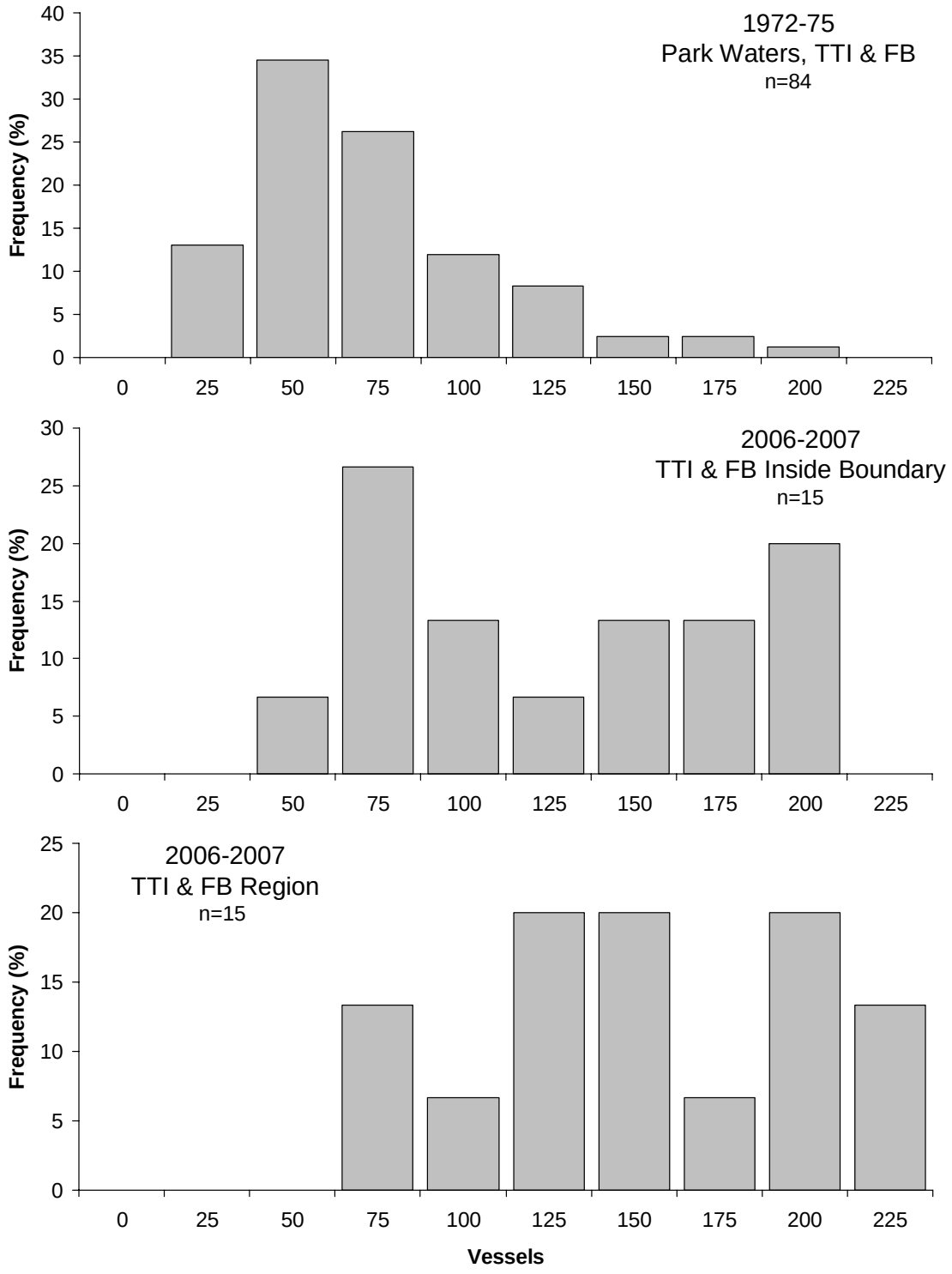
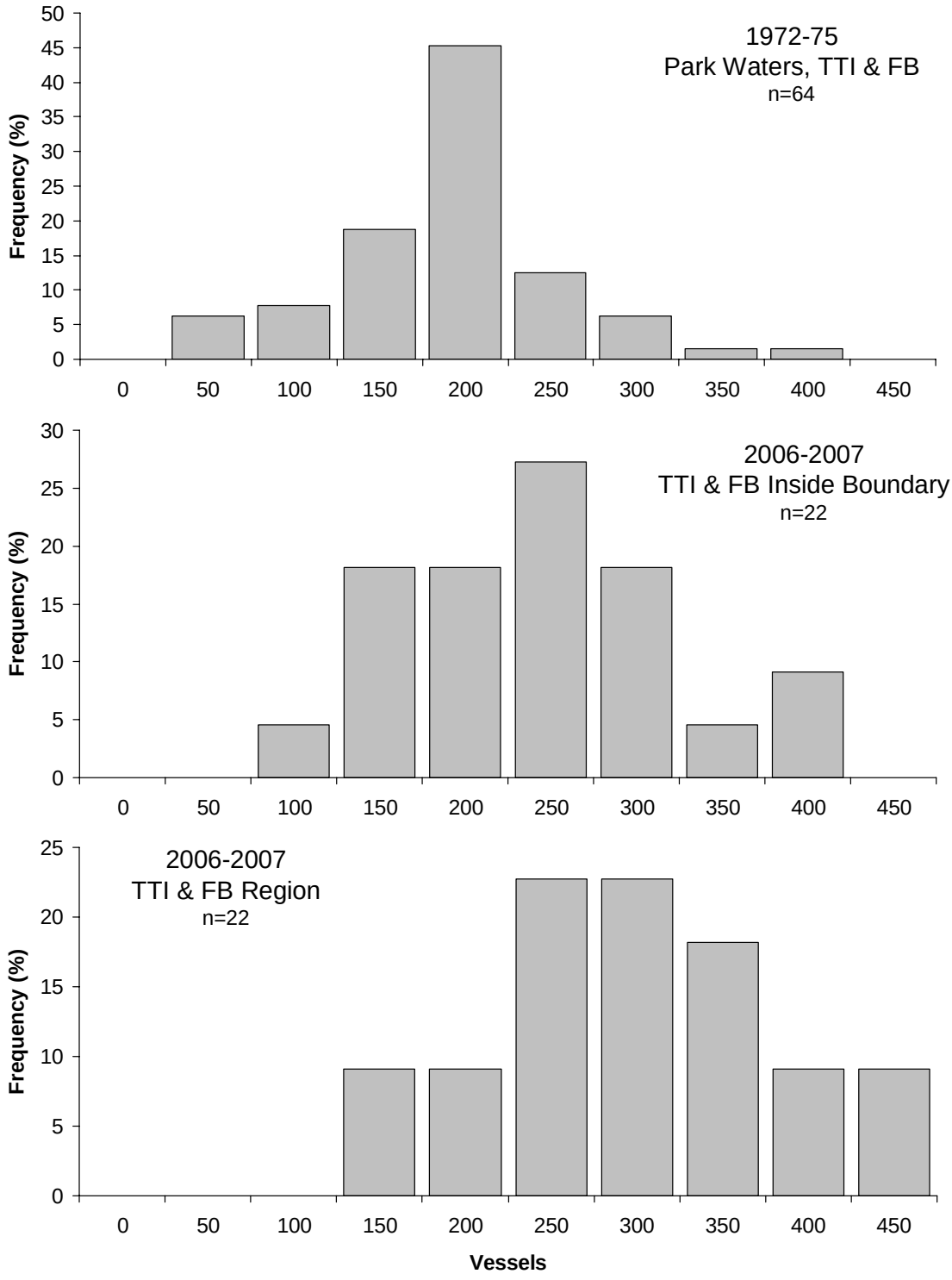


Figure 39. Frequency histograms of counts of recreational fishing vessels during weekend/holiday flight days for 1972-1975 (upper panel) and 2006-2007 (middle and bottom panels). The survey domain is denoted on each panel (TTI=Ten Thousand Islands; FB=Florida Bay). The domains for the middle and bottom panels represent the respective minimum and maximum bounds of the flight domain in 1972-1975.



For comparison with Tilmant's (1989) vessel-trailer regression model, separate regression functions were estimated for Ten Thousand Islands and Florida Bay for the 2006-2007 time period (**Figure 40**), and then the two lines were added together (i.e., the respective intercepts and slopes for the two lines were summed) to match the full domain function for the period 1972-1984. The response variable for these regression models was 'all recreational vessels' (FlatsBoat, JohnBoat, RecSmall, RecChart, Canoe/Kayak, and Sailboat from **Table 3**; Jim Tilmant, personal communication). The explanatory variable for these regression models was trailer counts for the total parking area at Flamingo marina. Parameter estimates for the fitted lines shown in **Figure 40** were previously given in **Table 26b** (Ten Thousand Islands), **Table 27b** (Florida Bay region), and **Table 28b** (Florida Bay, inside Park). Regression lines for the 1972-1984 and 2006-2007 time periods are compared in **Figure 41**. The upper line for 2006-2007 was obtained by combining the regression lines from **Figures 40a** and **40b**. The lower line for 2006-2007 was obtained by combining the regression lines from **Figures 40a** and **40c.** The results suggest that recreational boater use in Everglades NP has increased approximately 2 to 2.5 times in the past 25 to 30 years. The increase in boater use is highly correlated with regional increases in human population size and vessel registrations (Ault et al. 2005a; **Figure 42**).

Figure 40. Scatterplots of vessel-trailer observations (MW denotes midweek, WH denotes weekend/holiday) and corresponding fitted regression lines for comparison with the historical regression model of Tilmant (1989). The response variable is counts of all recreational vessels; the explanatory variable is trailer counts at Flamingo—Total. The survey domain is denoted on each panel.

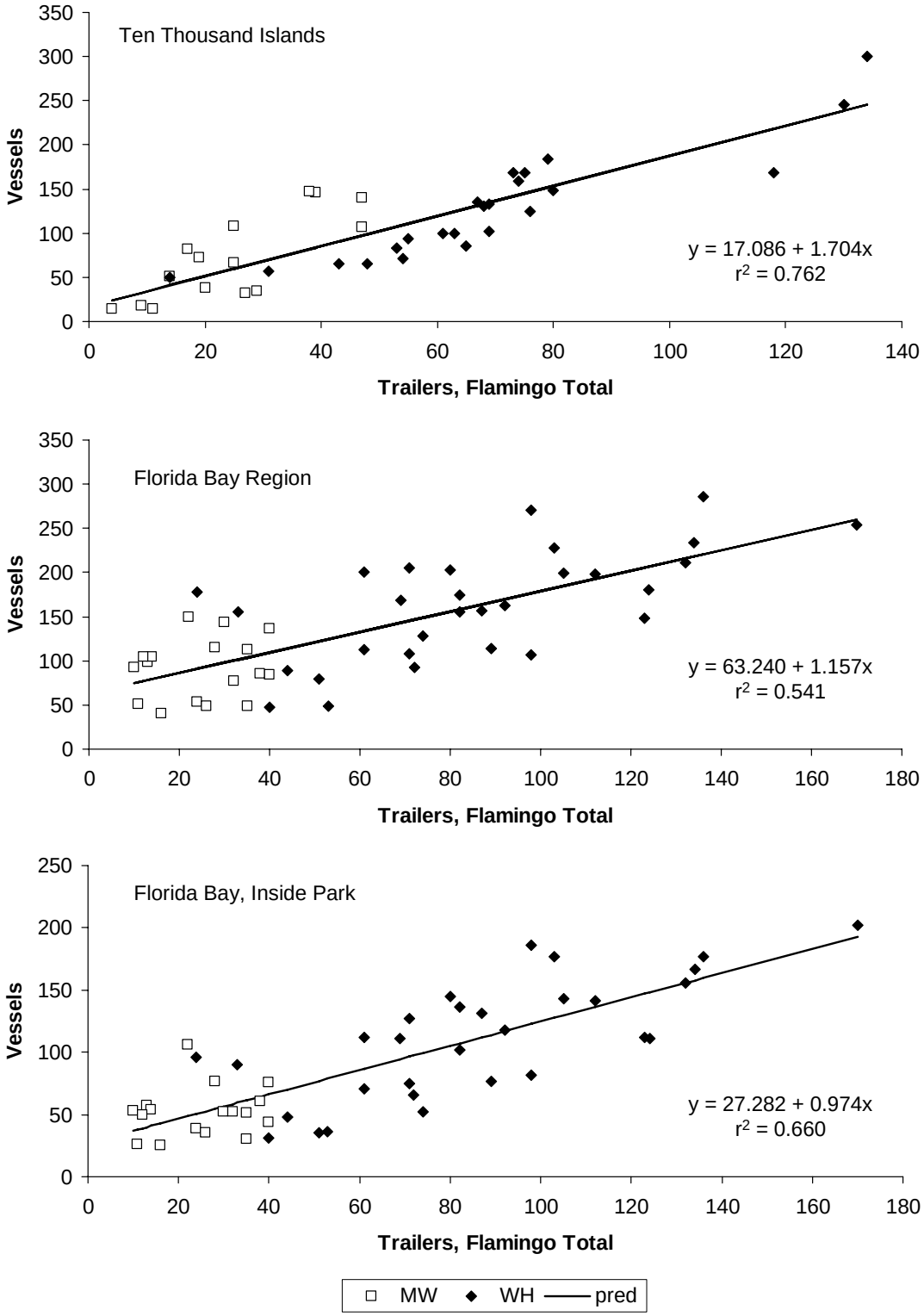


Figure 41. Comparison of vessel-trailer regression models for flight surveys conducted during 1972-1984 (Tilmant, 1989) and 2006-2007. The response variable is counts of all recreational vessels; the explanatory variable is trailer counts at Flamingo—Total. The survey domain is denoted for each line (TTI=Ten Thousand Islands; FB=Florida Bay). The domains for the 2006-2007 regression lines represent the respective minimum and maximum bounds of the flight domain in 1972-1984. The results suggest that recreational boater use in Everglades NP has increased approximately 2 to 2.5 times in the past 25 to 30 years.

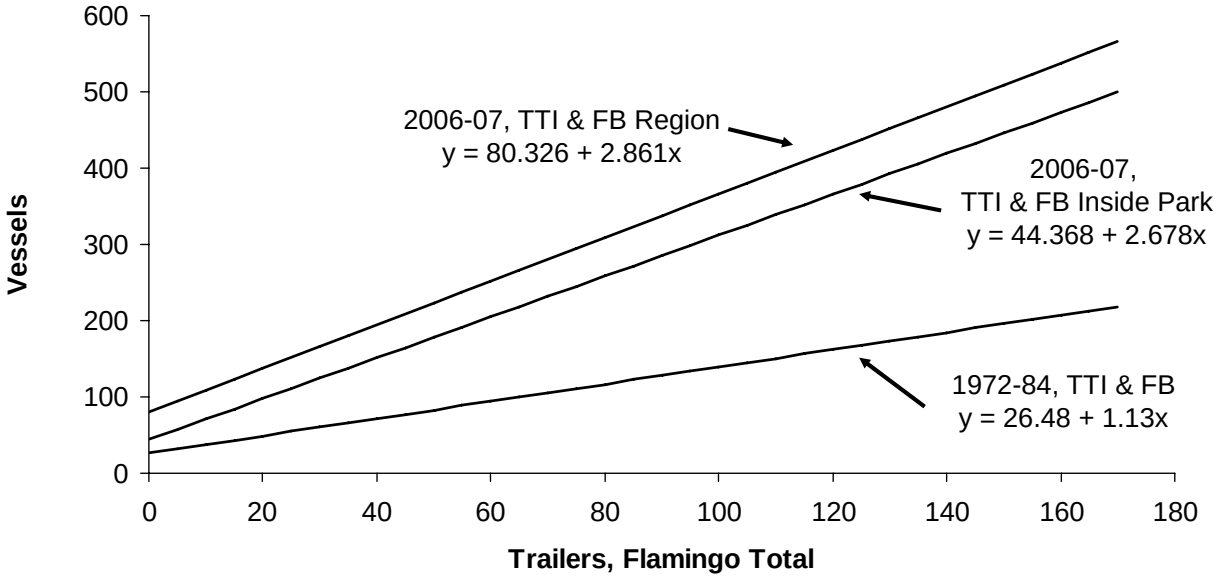
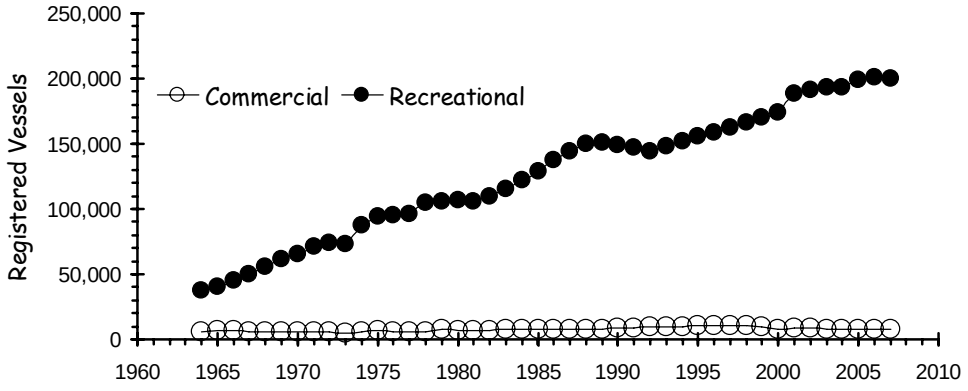


Figure 42. Registered vessels in the 5-county (Collier, Dade, Broward, Monroe and Palm Beach) south Florida region from 1964-2007.



8.0 Future Work

This study developed models that reliably predicted boater use (i.e., numbers of vessels) of Park marine waters using data from counts of trailers at specific marinas in Flamingo, Chokoloskee, and the upper Florida Keys. Model fits, and thus predictive capabilities, were improved by incorporating trailer counts from other areas in addition to Flamingo, the only marina censused for boat trailers in the historical modeling of vessel-trailer relationships by Tilmant (1989). For practical implementation, we recommend deployment of an automated system (e.g., digital cameras) capable of producing daily marina trailer counts at various locations identified in this study. These data, along with the models developed in this study, will enable estimation of the number of vessels using Park waters on a daily basis. These estimates could then be used to estimate boater use on a weekly, monthly, annual bases. Our results show that the vessel-trailer regression functions will likely need periodic updating due to observed regional changes human population size, number of registered vessels, and available access points in the vicinity of Park waters. Our analyses further suggests that an effective allocation strategy for future aerial surveys of vessels would be to conduct the majority of flights during higher-use seasons (winter, spring) and days (weekends & holidays).

The vessel-trailer survey database developed in this study can be further used to investigate a variety of issues pertaining to conservation and management of Park natural resources (e.g., fishing and boating activities). Spatial data on vessel position and disposition make it possible to analyze patterns of Park resource use, including spatial patterns of fishing within ENP creel survey zones or fishing habitats, etc. Vessel-trailer survey data could be integrated with the creel survey database to potentially improve estimation of population abundance indices for key sportfish and to analyze conditions for sustainable fisheries. Understanding spatial patterns of boater use is a critical component of Park resource management, particularly for evaluating habitat damage caused by small and large motorboats. Vessel-survey data could be combined with those on vessel groundings, propeller scarring of seagrass beds, etc., to guide development of boating regulations, placement of navigational markers or potential corridors to minimize future habitat damage by boaters in Park waters.

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