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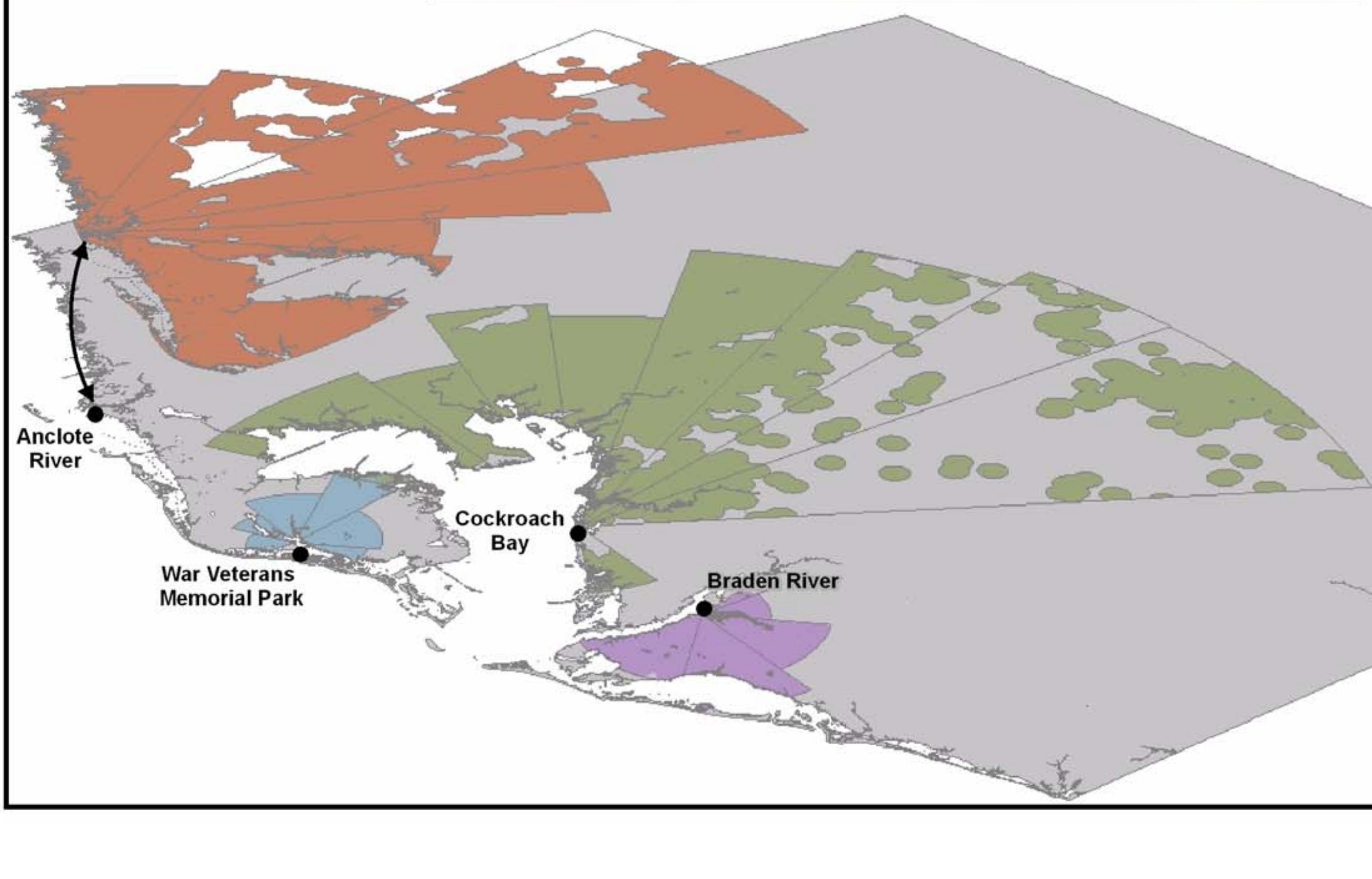

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A publication of the University of Florida Sea Grant Program and the Florida Fish and Wildlife Conservation Commission funded in part by the Florida Department of Environmental Protection, Florida Coastal Management Program, pursuant to National Oceanic and Atmospheric Administration award number NA04NOS4190035 with additional support from the Federal Aid in Sport Fish Restoration Program. The views expressed herein are those of the authors and do not necessarily reflect the views of the State of Florida, NOAA or any of their sub-agencies.

September 2005

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Abbreviations

DDPI	Destination Draw Potential Index
DHSMV	Department of Highway Safety and Motor Vehicles
DSUP	Destination Specific Use Potential
DUCI	Destination Use Concentration Index
FSG	Florida Sea Grant
FWC	Florida Fish and Wildlife Conservation Commission
FWRI	Fish and Wildlife Research Institute
GIS	Geographic Information System
PSA	Primary Service Area
RCI	Ramp Competition Index
RDPI	Ramp Draw Potential Index
RSA	Regional Service Area
SDR	Specific Destination Regions
UI	Use Intensity
UCL	Upper Confidence Limit
VTRS	Vessel Title Registration System
WSUP	Wedge Specific Use Potential

Acknowledgments

The Florida Fish and Wildlife Conservation Commission Fish and Wildlife Research Institute (FWRI) funded this project through a grant from the Florida Department of Environmental Protection Florida Coastal Management Program (FDEP FCMP) pursuant to National Oceanic and Atmospheric Administration (NOAA) award number NA04NOS4190035.

Larry Bearse (Florida Sea Grant), Debbie Leffler and staff (FWRI Fisheries Independent Monitoring Program), and Richard Sullivan and staff at Hillsborough County conducted the ramp surveys. Dick Tudor and James Harrison of Smart Mail Inc. (Alachua, Florida) implemented the mailing. David Fann, (Florida Sea Grant) assisted with the GIS analysis. Praveena Pepalla (Utah State University graduate student intern) was responsible for the ArcObjects programming to automate the cell-based Primary Service Area optimization model.

We especially thank the many Tampa and Sarasota Bay boaters who donated their time to complete and return the questionnaire. It is our intention that this effort be translated into planning strategies to improve waterway access and management.

Chapter 1. Introduction

Background

Tampa and Sarasota Bays are a microcosm of Florida's tremendous growth in marine saltwater recreation which is the largest in the nation at an estimated 22 million annual participants (Leeworthy and Wiley, 2001). An estimated 136,389 recreational boats are currently registered in the four counties that border Tampa and Sarasota Bays—Pinellas, Hillsborough, Manatee, and Sarasota (Department of Highway Safety and Motor Vehicles, Vessel Title Registration System, 2005). The number of registered boats in the region has increased by 70 percent since 1980 (Florida Bureau of Economic and Business Research, 1981; 2004). Moreover, it is projected that an additional 15,395 recreational vessels will be registered in the four county region by the year 2010 (Bell, 1995).

Recreational boaters have four principal choices to gain access to the waterways of Tampa and Sarasota Bays: marinas, dry storage facilities, private docks, or ramps. Many of the boaters who reside in Pinellas, Hillsborough, Manatee, and Sarasota counties trailer their boats from home to one of 31 public boat ramps in the region (Figure 1). The steady increase in the number of ramp users has led to heavy use and congestion, particularly on the weekends and holidays (Bell, 1995; Thomas and Stratis, 2001). Mounting evidence suggests that the current number of ramp facilities is inadequate to meet the estimated demand. For example, Bell (1995) projected a need for 280 additional ramp lanes in Sarasota, Manatee, Hillsborough, and Pinellas counties by 2010 (using a 30 minute wait scenario). This projection represents an increase of 98 percent from the 1992 baseline estimate of 299 ramp lanes. Furthermore, forty-one percent of the 1,908 responses to a more recent survey of Tampa and Sarasota Bay boaters cited boating infrastructure improvements, including more ramps and improved ramp facilities, as the regions top need (Sidman, Fik, and Sargent, 2004). The goal to maintain (and expand) public access to Florida's waterways prompted the Florida Fish and Wildlife Conservation Commission (FWC) Boating and Waterways Section to initiate a statewide inventory and economic analysis of boating access facilities.

Past boat ramp studies have focused on the economic impacts of boat ramps (Thomas and Stratis, 2001) and estimating demand for ramp facilities based on vessel characteristics, vessel registrations, and demographic variables such as age and income (Bell, 1995). These studies were conducted at a regional scale and, therefore, did not profile individual ramps or the spatial use-patterns (i.e., land- and water-based use patterns) of ramp patrons. This study builds upon ongoing efforts, initiated by the FWC Fish and Wildlife Research Institute (FWRI) and Florida Sea Grant (FSG), to determine where boaters travel from to access ramps, and to map their spatial patterns of waterway use. This research augments information acquired from a previous recreational boating characterization for Tampa and Sarasota Bays (Sidman, Fik, and Sargent, 2004). The research addresses the need for a science-based method that can: (1) delineate and map land-side service or market areas for individual boat ramps, (2) determine use potential and market overlap for specific ramps, and (3) map waterway use patterns generated by individual ramps.

Goal and Objectives

The study goal was to develop a spatial model to delineate and map, within a geographic information system (GIS), land- and water-side service areas, and to assess use potential for saltwater boat ramps in the Tampa and Sarasota Bay boating region. Specific objectives included (1) a survey of boat ramp users, (2) the delineation of land-side primary service areas (PSA) for particular boat ramps, (3) a determination of the use potential for specific ramps, and (4) an assessment of the contribution of individual ramps to recreational use within specific water-side destination regions (SDR).

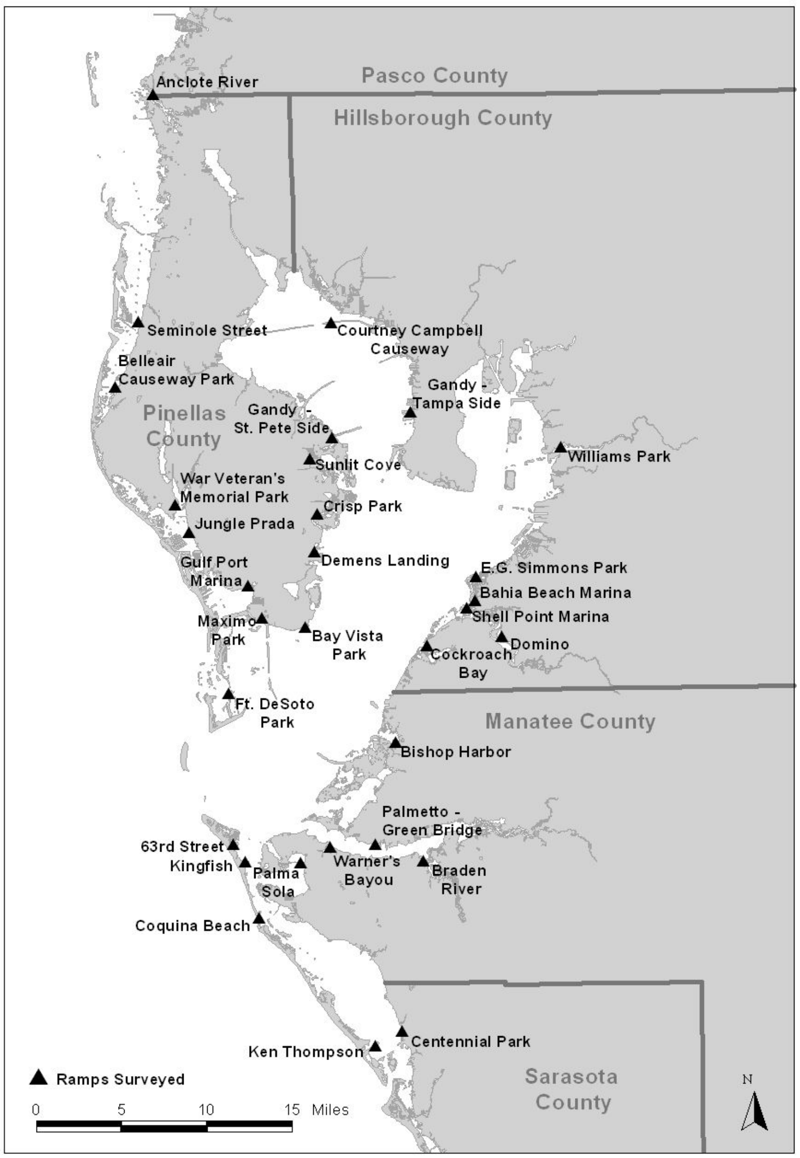


Figure 1. Public Boat Ramps Surveyed.

Chapter 2. Mail Survey of Ramp Patrons

Data Collection

Ramp patron data were collected as part of a two-year effort, initiated by the FWRI and FSG, to determine where boaters travel from in order to access popular ramps, and where they travel to on the water (i.e., departure origins, favorite destinations, and intervening travel routes).

During 2003 and 2004, FWRI, FSG, and Hillsborough County personnel repeatedly visited 31 area ramps (Figure 1) and collected 6,088 unique (i.e., excluding repeat visitors) license tag numbers from tow vehicles and trailers in ramp parking lots (Figures 2 and 3). License tag information was compared to the state's Vessel Title Registration System (VTRS), maintained by the Florida Department of Highway Safety and Motor Vehicles (DHSMV), yielding a subset of 3,089 name and address matches. Approximately 51 percent of the trailer license numbers observed at the ramps did not have a corresponding VTRS name or address match. The high rate of unmatched records is partially explained by the fact that many boat owners requested that their personal information not be disclosed thus, DHSMV blocked their records. Boater names and mailing addresses were used to (1) mail questionnaires, and (2) determine GIS coordinates for mapping land–side origin locations.

Figure 2. Empty Boat Trailers in Parking Lot.

Figure 3. Typical Boat Trailer with Registration Tag.

Survey Instrument

The survey questionnaire used for the ramp study was one developed for a Tampa and Sarasota Bay recreational boating characterization conducted in 2003 (see Sidman, Fik, and Sargent, 2004 for a copy of the questionnaire). The questionnaire was designed to: (1) capture spatial information regarding trip departure sites, favorite boating destinations, intervening travel routes, and congested areas; (2) characterize boaters with respect to types of vessels owned and used, activity preferences, and the timing, frequency, and duration of recreational outings; and (3) identify problems and solutions, and information needs from the perspective of the boating community.

The survey instrument was a two-sided 17 X 22-inch questionnaire that folded in quarters to 8.5 X 11-inches. One side of the questionnaire consisted of a map (1:160,000 scale; 1 inch is about 2.5 miles) of the Tampa Bay and Sarasota Bay region, and the other side contained a series of questions. The questionnaire asked survey recipients to mark, on the map, the location of the trip departure site, travel routes, favorite destinations, and congested areas associated with their last two pleasure boating trips. Complementary questions allowed recipients to characterize their last two trips according to vessel type, the departure date and time, and time spent on the water. In addition, recipients were asked the number of days per month that they take “typical” trips and the primary activities that they engaged in while at a particular destination. They were also asked to identify and rank reasons for selecting departure sites, travel routes, and favorite destinations. Finally, a series of open-ended questions addressed problems, needed improvements, and the kinds of information that would enhance recreational boating experiences.

Survey Return Breakdown

The number of mailings to patrons of particular ramps was a function of (1) available names and addresses matched from trailer and automobile license numbers, and (2) a return rate multiplier of 25 percent calculated from previous survey return experience. A random sample of 2,453 surveys were mailed to Tampa and Sarasota Bay ramp patrons, yielding a 25 percent return rate (620 returns) (Table 1). The target sample size of 30 unique trips was not achieved for some ramps due, in part, to (1) a comparatively small number of trailers observed at those ramps during the survey period, and (2) poor matching rates between observed trailer tag numbers and the VTRS. The 620 returned questionnaires yielded a sample of 1,248 total trips, 906 of which were unique (some respondents only reported one of their last two trips, or reported that their last two trips were identical). Respondents reported 2,475 favorite destinations associated with their trips. Boat owner mailing addresses obtained from the VTRS were geo-referenced to map coordinates using GIS street/address matching software. The geocoded addresses were then used to determine land-side primary service areas (PSA) for individual ramps (see Chapter 3). Favorite destinations from the questionnaire map were digitized into ArcGIS (geographic information system) and used to determine water-side specific destination regions (SDR) for individual ramps (see Chapter 4). The GIS database structure allows information from survey questions to be ‘linked’ to geo-referenced spatial information (i.e., reported destinations or geocoded mailing address coordinates) by using a survey control number, which uniquely identified trip, home location, and ramp information obtained from each survey respondent.

Table 1. Survey Mailings, Returns, and Trip Data by Ramp.

Ramp Name	Ramp Survey		GIS Data	
	Mailed	Returned	TOTAL Trips*	Unique** Trips
Anclote River	66	21	44	33
Seminole Street	61	17	48	33
Belleair Beach Causeway	69	14	40	28
War Veterans Memorial Park	84	22	77	55
Jungle Prada	86	24	34	22
Gulfport Marina	94	26	41	25
Maximo Park	115	23	72	53
Fort De Soto Park	131	33	100	79
Bay Vista Park	33	11	17	12
Demens Landing	21	3	5	4
Crisp Park	36	13	27	17
Sunlit Cove	17	8	11	8
Gandy – St. Pete Side	0	0	8	6
Gandy – Tampa Side	140	39	58	44
Courtney Campbell Causeway	56	14	21	17
Williams Park	29	8	49	37
E.G. Simmons Park	70	28	40	28
Bahia Beach Marina	63	16	31	23
Shell Point Marina	66	14	41	32
Domino	37	11	15	10
Cockroach Bay	132	42	57	45
Bishop Harbor	74	11	24	16
Braden River	53	14	20	13
Palmetto – Green Bridge	113	24	40	28
Warners Bayou	114	26	57	42
Palma Sola Causeway	99	17	22	15
Kingfish	151	39	70	53
63rd St. Memorial Park	100	31	33	21
Coquina Beach	153	32	51	40
Ken Thompson	99	20	31	21
Centennial Park	91	19	64	46
TOTALS	2453	620 **25%**	1248	906

*The discrepancy between surveys returned (column 2) versus total trips (column 3) is because the ramp where a respondents trailer tag was observed was not necessarily the ramp(s) that the respondent reported as their launch site.

**The discrepancy between total trips (column 3) and unique trips (column 4) is due to the fact that some respondents reported that their last two trips (i.e., routes and destinations) were identical. Unique trips refers to separate trips originating from a particular ramp (though the separate trips could be associated with the same individual).

Locating Ramp Patrons

A determination of land-side service areas for ramps is dependent upon accurately locating the homes of boaters that use particular ramps. The *TeleAtlas* on-line geocoding service (*www.geocode.com*) was used to generate a GIS point layer that mapped the home location of ramp patrons. Geocoding refers to the process of matching address information between two data sources[1],

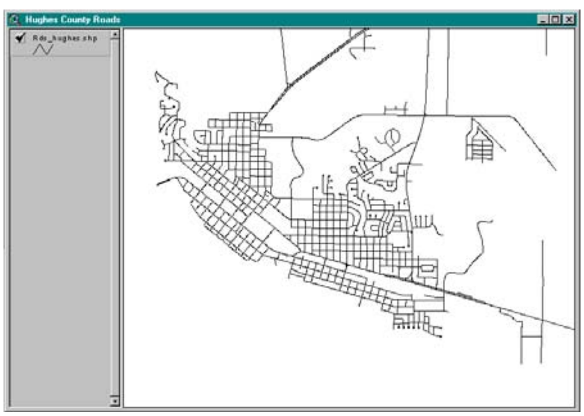
(1) a database that contains the mailing address of ramp users *without* map position information such as latitude (Y-Coordinate) and longitude (X-Coordinate) reference, and

Before geocoding:

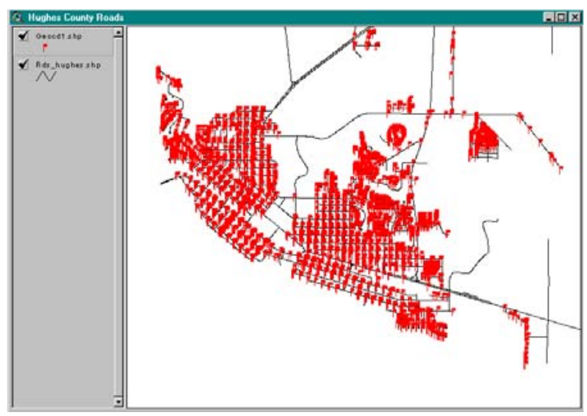
Address	Zip Code	**X-Coord**	**Y-Coord**
2425 E Pawn St	57501		

(2) a reference street, parcel or other database/GIS layer *with* map position information such as latitude (Y-Coordinate) and longitude (X-Coordinate) reference.

BEFORE
GIS street reference database with street segment address ranges.



AFTER
GIS street reference database with geocoded addresses as red points.



The geocoding process assigns a latitude and longitude position to each address based on a comparison of address elements to a GIS reference database (a street database in the case of this example). The result of the geocoding process is a GIS point data layer that contains map position information.

After geocoding:

Address	Zip Code	**X-Coord**	**Y-Coord**
2425 E Pawn St	57501	-100.318837	44.35275

[1] The description of the geocoding process was adapted from a document produced by Alex Rodriguez alex.rodriguez@state.sd.us.

TeleAtlas was used to geocode 3,089 VTRS mailing addresses associated with trailer and automobile license numbers observed at the 31 ramps (Table 2). The *TeleAtlas* geocoding service returns the most accurate geographic location possible for each input street address. It works by first looking for an exact street-segment match (street segments are the portions of streets between two intersections) and, if not found, searching successively larger areas from approximate street segment matches to a series of ever widening geographic vicinities (e.g., near street, block, zip code, census tract) - until a match is found.

Of the 3,089 VTRS mailing records, 2,801 matched a street-segment (exact match) and a near street match was achieved for an additional 106 records. Remaining were 182 records, 124 of which were P.O. Boxes that matched to a ZIP code or a census tract.

Table 2. Geocoding Results.

Ramp Name	Geocoded Addresses	Ramp Name	Geocoded Addresses
Anclote River	216	E.G. Simmons Park	86
Seminole Street	139	Bahia Beach Marina	79
Bellair Causeway Park	120	Shell Point Marina	78
War Veterans Memorial Park	158	Domino	51
Jungle Prada	107	Cockroach Bay	132
Gulfport Marina	116	Bishop Harbor	110
Maximo Park	115	Braden River	78
Fort De Soto Park	131	Palmetto – Green Bridge	121
Bay Vista Park	37	Warners Bayou	114
Demens Landing	20	Palma Sola Causeway	126
Crisp Park	46	Kingfish	151
Sunlit Cove	22	63^{rd} St. Holmes Beach	104
Gandy – St. Pete Side	39	Coquina Beach	153
Gandy – Tampa Side	132	Ken Thompson	127
Courtney Campbell Causeway	56	Centennial Park	91
Williams Park	29	**TOTAL GEOCODES**	**3,089**

Table 3. The Top Counties Contributing to Ramp Use in Tampa and Sarasota Bays.

County	Geocode Counts*	Percent of Total
Pinellas	846	27.4
Hillsborough	830	26.9
Manatee	595	19.3
Polk	279	9.0
Sarasota	200	6.5
Pasco	142	4.6
TOTAL	2,892	93.6

* Results are based on aggregate geocode counts.

The majority of addresses associated with greater Tampa and Sarasota Bay ramp users (n = 2,892; 93.6% of the total) geocoded to locations within Pinellas, Hillsborough, Manatee, Polk, Sarasota, and Pasco Counties (Table 3). A small number of addresses (n = 169; 5.4% of the total) geocoded to other counties in the state. Twenty-eight addresses (1% of the total) geocoded to out-of-state locations. The results show that Polk (n = 279; 9%) and Pasco (n = 142; 4.6%) counties contribute the greatest amount of outside use to area ramps (i.e., use from counties outside of the immediate four-county study region). Manatee County accounted for the greatest amount of use when the ramp patron data were aggregated by county and normalized by the number of households (Figure 4).

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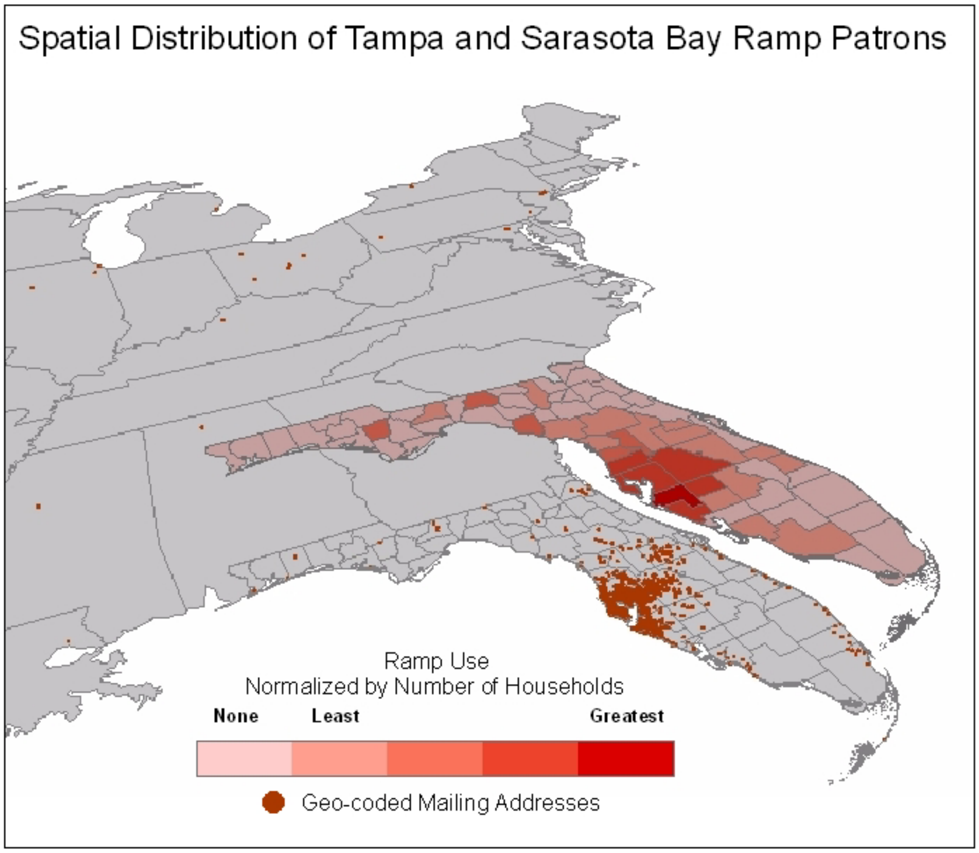


Figure 4. Spatial Distribution of Ramp Patrons.

Figure 5 presents the spatial distribution of ramp patrons, normalized by the number of households, for each of the four counties that comprise the Tampa and Sarasota Bay boating region (i.e., Sarasota, Manatee, Hillsborough, and Pinellas Counties). The greatest use per household for Sarasota County ramps originated from Manatee and Hardee counties; while Hardee and Polk counties contributed the greatest amount of ‘outside’ use for Manatee County ramps. Polk County contributed the greatest number of non-resident users to Hillsborough County ramps and Hillsborough County accounted for the greatest number of non-resident users to Pinellas County ramps.

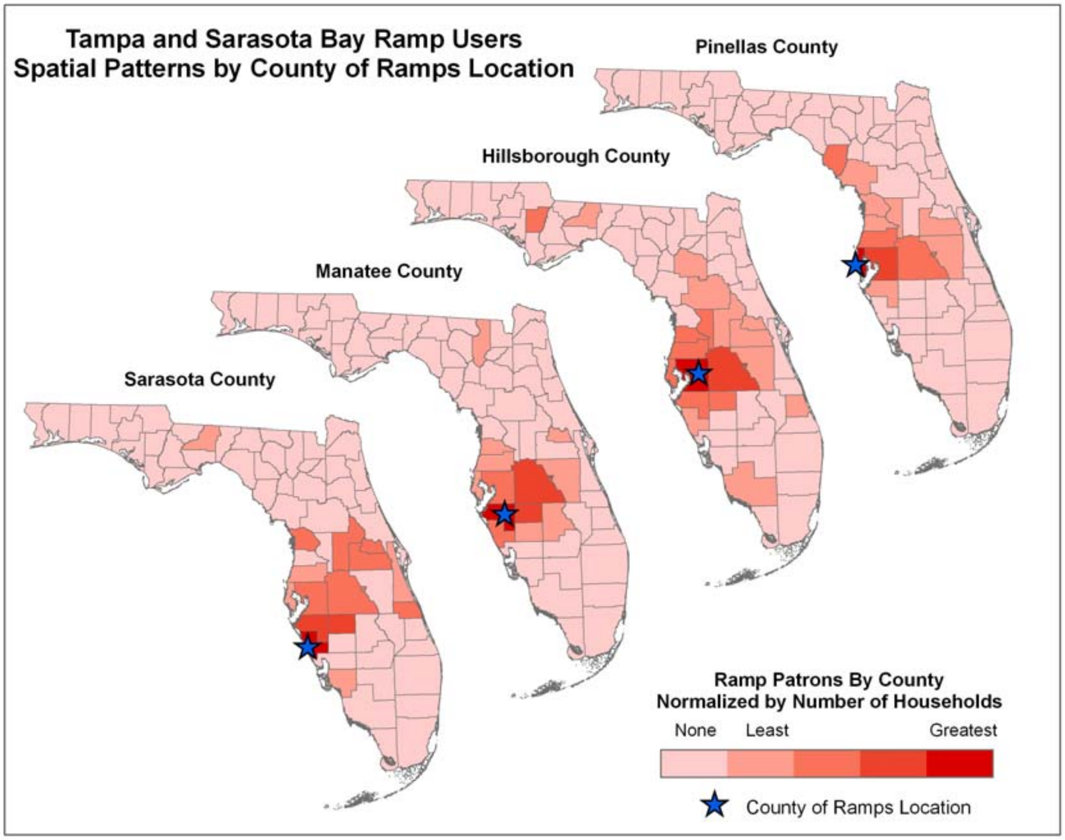


Figure 5. Spatial Patterns of Ramp Use by County.

Chapter 3. Delineating Land-Side Service Areas

Approaches

Conventional approaches to the delineation of service/trade areas include radial ring-based studies, drive-time analyses, and gravity models. Radial ring-based analyses are performed by selecting and evaluating demographics (e.g., census information aggregated to tract, block, or block-group boundaries) that fall within pre-defined radial distances from a location. This technique assumes that a service or trade area is circular, and it does not consider behavioral or geographic/physical conditions that can restrict or promote patronage (Thrall and McMullen, 2000; Thrall, 2002).

A drive-time model utilizes digitized roadways that are attributed with speed limit and/or congestion parameters that dictate impedance or ease of travel along the road segments. Through this process, a polygon is generated that represents the extent to which a vehicle can travel outward from a location in all directions along the existing roadway system. Unlike radial distance based service area approximations, drive time analyses account for phenomena that can hinder or facilitate patronage. However, the method does not consider behavioral factors, site characteristics, or the location of actual patrons – factors that can also influence use.

The gravity or 'spatial interaction' model also has been applied to delineate trade/service areas (Fotheringham, 1981, 1983; Huff, 1964). A principal assumption of the gravity model is that patrons are distance minimizers – the farther a person resides from a particular location, the less likely that person is to visit it. A strength of this model is its ability to measure relative differences in use or association (i.e., spatial interaction) between people and locations by incorporating site profiles, customer behavior, and distance parameters (Haynes and Fotheringham, 1988). A drawback of the gravity model is that it is more difficult to implement than radial ring-based and drive-time models within a GIS environment.

The circular market area approach has been refined using GIS-based algorithms that incorporate pie-shaped wedges drawn about a central point to derive irregularly shaped market areas. Pie-shaped wedges capture directional differences in the extent of market share based on consumer location, preferences, and behavior (Thrall, 2002). The pie wedge-based approach has its roots in studies conducted by Applebaum (1965; 1966), which established the procedure and criteria for determining a retail market share boundary based on consumer travel distances. Applebaum suggested that the boundaries of a primary service area encompass a geographic area that accounts for between 70 and 80 percent of the users or consumers within that market. A similar wedge-casting approach and benchmark has been adopted for this analysis to delineate primary service areas for public access ramps.

Wedge-Casting Model Design

This section describes the pie wedge-casting methodology developed to delineate the regional service area (RSA) and primary service areas (PSA) for public access ramps in the Tampa and Sarasota Bay study region. The regional service area (RSA) can be thought of as an abstract representation of the region's land-side boater traffic-shed, showing the outward reach and directional variations in reach and use intensity from the “average” ramp location. The RSA is based on the aggregate analysis of geocoded patron data pertaining to the 31 sampled ramps and highlights the extent to which boaters are drawn to ramps and the variability in the intensity of ramp use. The PSA is ramp specific and delineates the geographic area that best encompasses the locations of boaters most likely to use a specific ramp facility.

To delineate the RSA and PSA, we employed a wedge-casting method similar to one used by the *EdgeMap* GIS (Thrall and Casey, 2002) and by Thrall, Borden, and Thrall (2002) to delineate hospital market areas. According to Thrall and Casey (2002):

> “wedge-casting derives trade areas by first spatially partitioning the region around a facility into wedges with equal angles at the center. The wedge-casting algorithm essentially allows a wedge to move an increment outward if by that increment it will bring more customers into the trade area than the outward movement of another wedge. Wedges are allowed to grow outward until a target percentage of customers to be included in the trade area is reached.”

This approach assumes that use-intensity typically declines with increasing distance from a given ramp. In addition, the rate of decline or decay and the subsequent “reach” or draw of a ramp will vary depending on location and direction. Thus, it can be said that use-intensity of a given ramp will, in general, decay or decline with distance. However, the rate of decline will not be the same in all directions.

Measuring Directional Variability

Directional variability may be attributable to variations in accessibility related to the location of the ramp relative to the spatial distribution of patrons. Directional variability was captured by mapping the point distributions of ramp patrons for each ramp in the study region using latitude and longitude location coordinates provided by the GIS address geocoding algorithm. Next, a series of transects and wedges, centered about each ramp, were drawn within the GIS for equally spaced intervals of 15-degrees (i.e., from 0 to 360 degrees) to cover all possible land-based origins of boaters that were observed using a particular ramp (Figure 6).

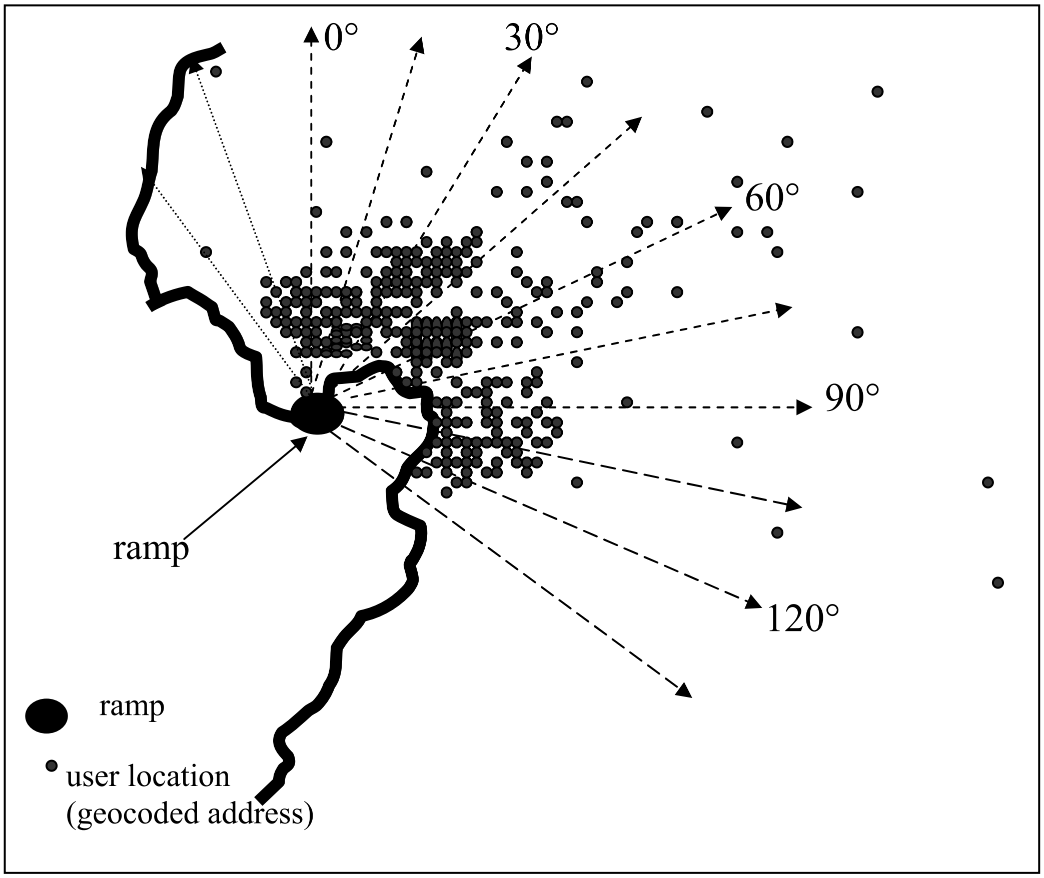


Figure 6. Wedge-Casting Method to Capture Directional Variability.

Measuring Distance and Use-Intensity

Grid cells of a fixed size (i.e., 2.5 miles-square) were superimposed over the wedges and transects. A derivation of the Pythagorean Theorem was employed within the GIS to calculate the distance, in miles, between each 2.5 square-mile grid centroid and individual boat ramps. The formula is as follows:

$$a^2 + b^2 = c^2$$

or

$$c = \sqrt{(a + b)} \text{ hence,}$$

$$c \text{ (distance)} = \sqrt{\{(X_b - X_a)^2 + (Y_b - Y_a)^2\}} \text{ where,}$$

X_b = boat ramp longitude
X_a = 2.5 square-mile grid cell centriod longitude
Y_b = boat ramp latitude
Y_a = 2.5 square-mile grid cell centroid latitude

Use-intensity was measured by mapping and summing the number of ramp patron mailing addresses that geocoded within each 2.5 square-mile grid cell contained within each 15-degree wedge cast about a ramp (Figure 7). A spreadsheet was developed to track the distance and use-intensity for each 2.5 square-mile cell within a 15-degree wedge. Only cells with non-zero entries (i.e., with at least one geocoded ramp patron address) were used in the distance threshold analysis. Appendix A presents the GIS wedge-casting method that provided data input for the model.

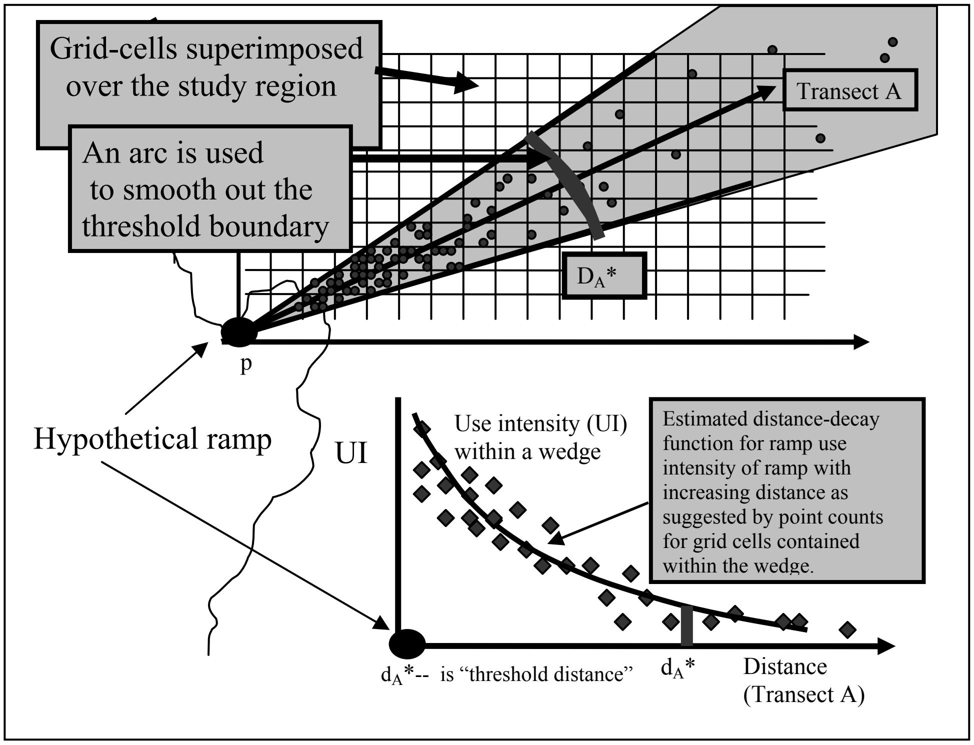


Figure 7. Model to Estimate Threshold Use Distances for Wedges.

Estimating Distance Thresholds

A negative exponential model was used to estimate distance thresholds as a function of the observed number of ramp users for non-zero entry 2.5 square-mile grid cells within a wedge, and the distance of the centroid of each grid cell from the ramp. The model is as follows:

Use-Intensity (UI) as a function of distance (d):

$$\begin{aligned} UI &= f(d) \\ &= \theta \exp ß(d) \end{aligned}$$

The estimation procedure involved a semi-logarithmic transformation:

$$Ln(UI) = Ln(\theta) + ß(d) + \zeta$$

where Ln(θ) is the constant term, ß is the friction-of-distance parameter, ζ is a random error component, and E(ß) < 0.

A threshold distance (d_A*) for any given wedge or combination of wedges was determined by using the estimated parameters from the negative exponential function distance-decay model, setting use-intensity equal to UI lower 99%–the lower limit of the 99% confidence interval for the mean use-intensity associated with that wedge or transect–then solving for d*.

For wedges where the negative exponential function did not produce distance-decay parameter estimates that were significant at $\geq$ 90% confidence (e.g., due to small or insufficient sample sizes, multi-modality in the spatial point distributions along a transect, or non-conformity of use-intensity to the distance-decay functions), the "*median distance traveled*" or, preferably, the *upper-limit of the confidence interval for the median distance traveled* (i.e., the median UCL) was used as a surrogate for threshold distance. The median UCL was calculated for situations where a large sample was either unavailable or when there was zero variance in the point counts for 2.5 square-mile cells within a wedge. The use of the median UCL helps to avoid overstatement of the wedge-specific boundaries in cases where extreme values are present. When the analysis was conducted on wedges that contained small samples, it was often necessary to combine adjacent wedges to facilitate the estimation of the threshold distance and the median UCL (see Appendix B for model results and distance thresholds).

Service Area Wedge Analysis

The service area boundary of a given ramp was delineated by linking the end points of the arcs associated with the threshold distances for each wedge, similar to Homer Hoyt's sectoral approach (Hoyt, 1939), thus revealing the underlying primary service area (PSA). As such, the outer boundary of individual or combinations of wedges is represented as an arc (Figure 8).

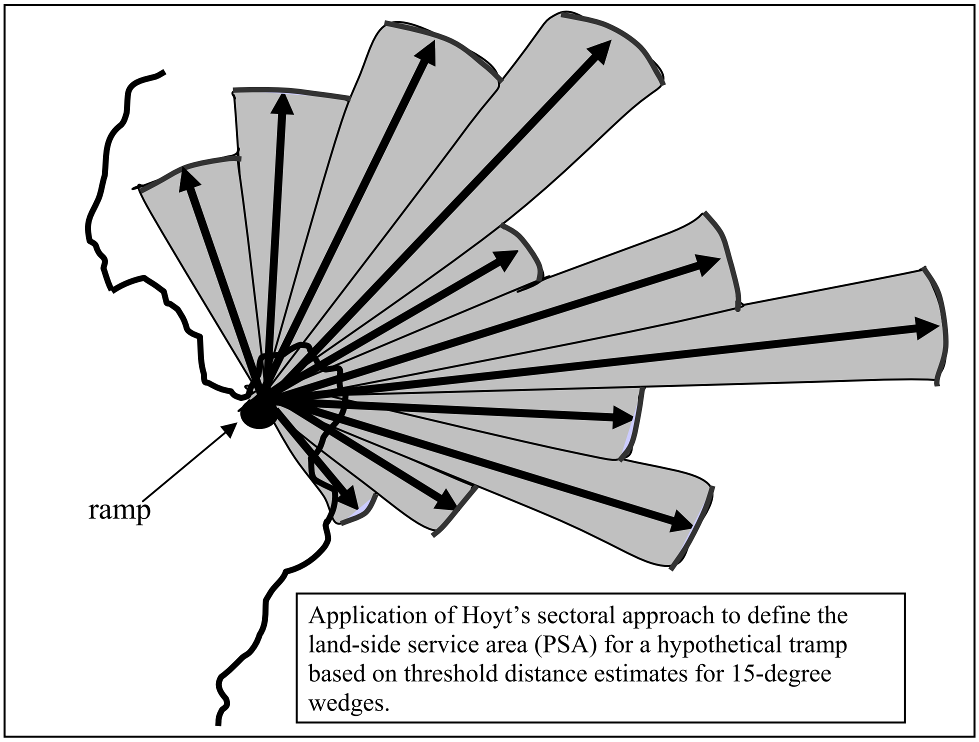
While it is acknowledged that the "outer range" of users for a given ramp may lie beyond the delineated PSA boundary, the PSA is the area that should encompass the lion's share (i.e., roughly 70 - 80 percent) of observed users (Thrall, 2002). A review of the literature suggests that overall the PSA should delineate an area that contains at least two-thirds of the ramp patrons while taking into account directional variations in use intensity and its distance decay properties (Applebaum, 1965; Thrall, 1996, 2002). The following rationale was used to select the appropriate threshold distance of a given wedge or combination of wedges that comprise a sector:

(a) The threshold distance should be such that 70 to 80 percent of observations are captured within the resulting PSA.

(b) Use the distance threshold generated by the negative exponential model if the model was significant and the resulting area captured roughly 70 - 80 percent of the observations. If the percentage of observations captured greatly exceeded or fell below 70 - 80 percent, default to the median UCL value (i.e., if the UCL value produced a wedge that captured closer to 70 - 80 percent of the observations).

(c) If the negative exponential model was found to be not significant, default to the median value. Use the median UCL as necessary to capture 70 - 80 percent of the observations.

A summary of the percent of ramp patron observations captured by the derived PSA for each ramp is presented in Table 4. Appendix B identifies the method (b or c above) that was used to determine the threshold distance for each wedge or combination of wedges.



Application of Hoyt's sectoral approach to define the land-side service area (PSA) for a hypothetical tramp based on threshold distance estimates for 15-degree wedges.

Figure 8. Connecting Wedge Thresholds to Delineate Land-side Service Areas.

Table 4. Primary Service Area Percent Capture Rate.

Ramp	Capture Rate (%)	Ramp	Capture Rate (%)	Ramp	Capture Rate (%)
Anclote River	81	Sunlit Cove	45.5	Bishop Harbor	67.3
Seminole Street	80.6	Gandy – St. Pete Side	69.2	Braden River	65.4
Belleair Cswy Park	90.0	Gandy – Tampa Side	71.2	Palmetto – Green Bridge	76.0
War Veterans	73.4	Courtney Campbell Cswy	73.2	Warners Bayou	78.9
Jungle Prada	81.3	Williams Park	65.5	Palma Sola Cswy	80.2
Gulfport Marina	81.0	E.G. Simmons Park	76.7	Kingfish	80.1
Maximo Park	82.6	Bahia Beach Marina	70.9	63rd Street	75.0
Fort De Soto Park	77.9	Shell Point Marina	69.2	Coquina Beach	77.1
Bay Vista Park	64.9	Domino	76.5	Ken Thompson	86.6
Demens Landing	65.2	Cockroach Bay	77.2	Centennial Park	75.8
Crisp Park	80.4				

The final GIS procedure implemented eliminated areas from the derived PSA where registered boaters do not reside. This was accomplished by using the ArcGIS ERASE function to exclude areas that did not contain geocoded boater address information obtained from the VTRS (See Appendix C).

Chapter 4. DELINEATING WATER-SIDE DESTINATION REGIONS

Cluster Analysis to Define Specific Destination Regions

A K-means clustering algorithm (Kachigan, 1986) was used to determine if spatial associations existed for the favorite destinations reported by survey respondents. Cluster analysis is a statistical procedure used to group and/or classify individual observations in a data set according to their spatial similarities. Individual observations that are deemed 'similar' are grouped together to form clusters of observations. In this way, the cluster analysis was used to determine the number and geographic extent of water-side specific destination regions (SDR). To determine regions by cluster analysis, favorite destinations were partitioned into near-shore (i.e., less than two miles from the shoreline) and offshore (i.e., greater than two miles from the shoreline) destinations[2]. This division was in keeping with the determination that certain activities tend to take place close to the shore (e.g., near-shore fishing, nature viewing, anchoring, beach camping and picnicking, restaurant visitation) while others take place at a greater distance from the shore (e.g., sailing, cruising, off-shore fishing).

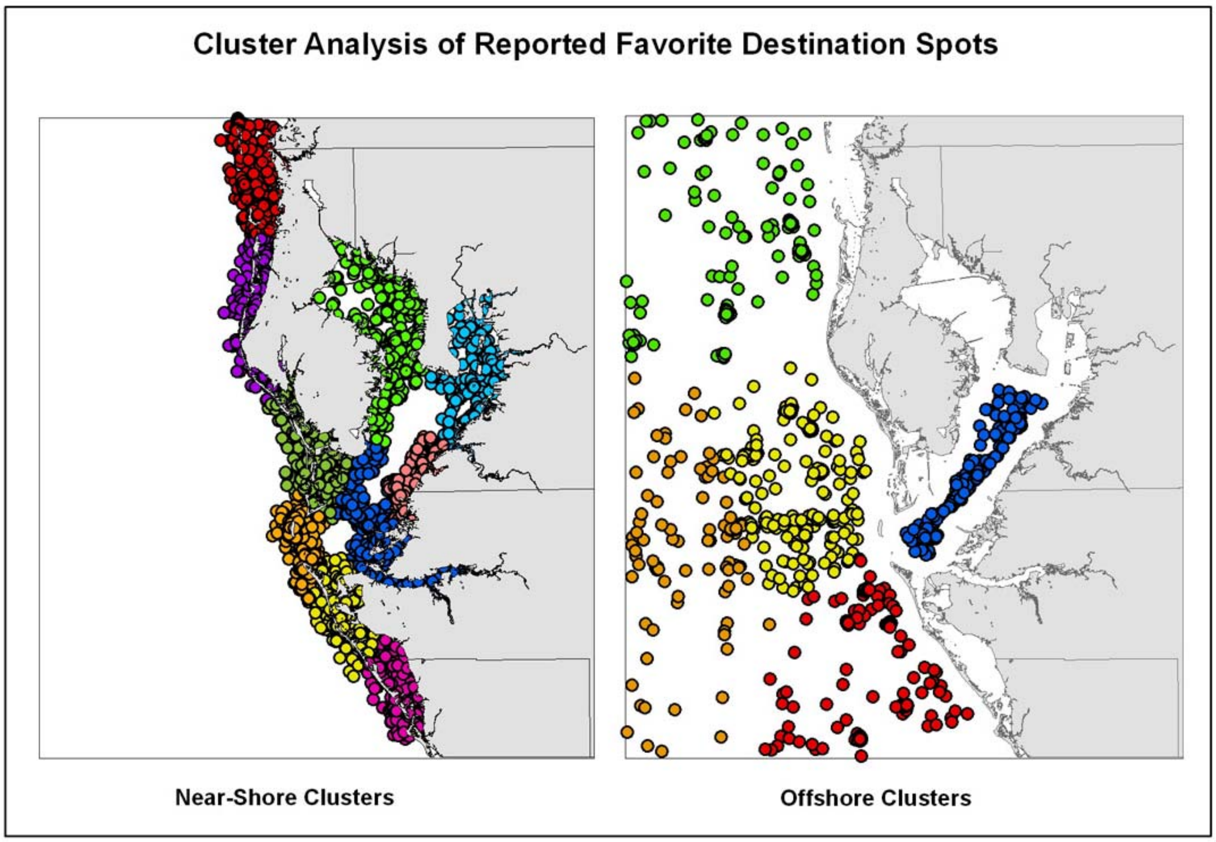


Figure 9. Cluster Analysis to Spatially Associate Favorite Destinations.

[2] A two-mile buffer of the USGS 1:24,000 DLG shoreline was selected as a reasonable distance to differentiate between near-shore and offshore destinations, based on a visual inspection of mapped destination activities.

The cluster analysis revealed ten near-shore and five offshore destination clusters (Figure 9). The K-means clustering algorithm could not be spatially constrained by the shoreline. So, in some instances, destinations that should not have been associated were placed within the same cluster. Some adjustments to the SDR boundaries were necessary to refine destination placement in the appropriate cluster in order for clusters to more accurately reflect and the geography of the boating region. The derived SDR boundaries are depicted in Figure 10.

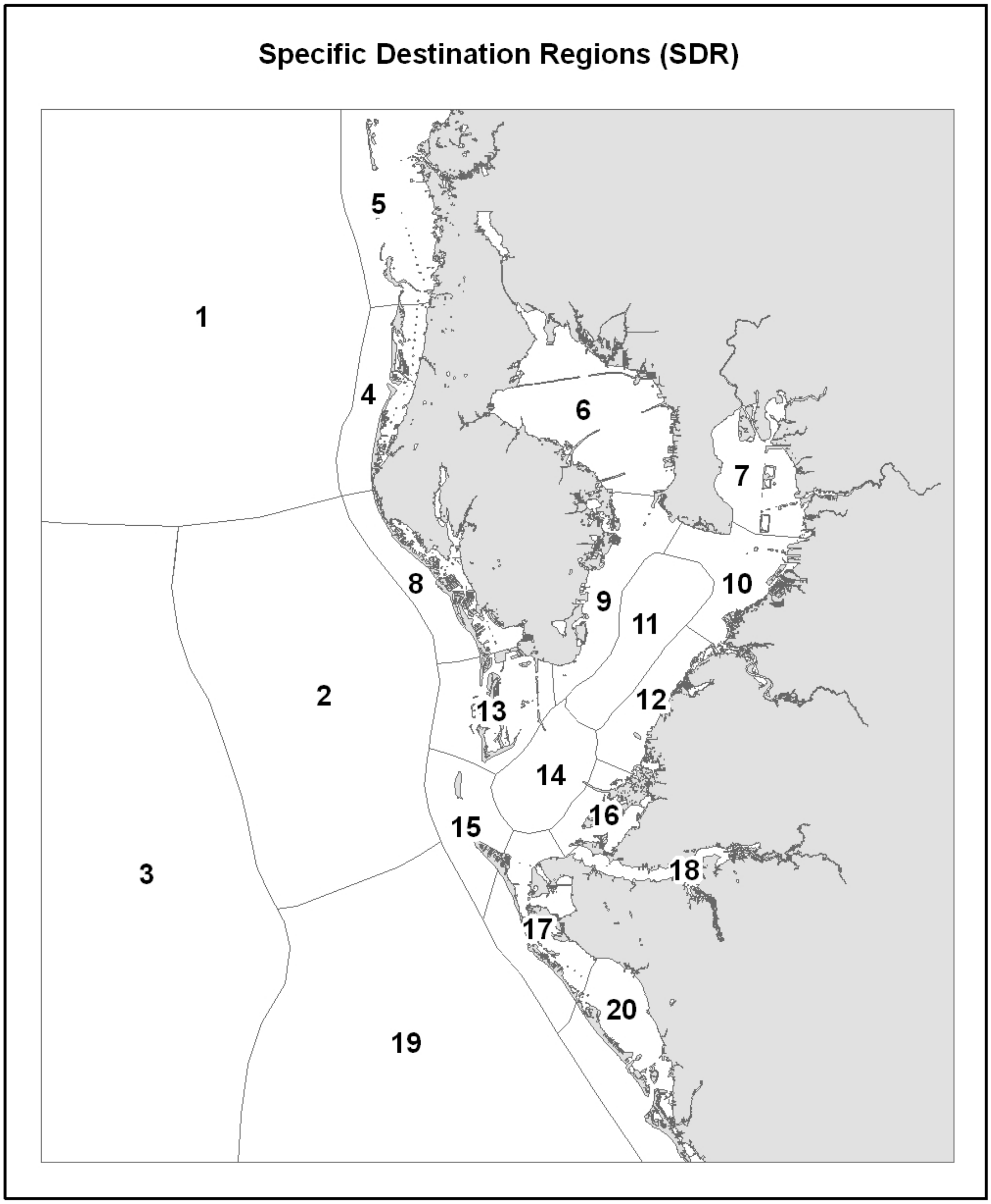


Figure 10. Specific Destination Regions Based on K-Means Cluster Analysis.

Chapter 5. MAPPING SERVICE AREAS

Regional Service Area

The regional service area (RSA) can be described as an abstract representation of the market boundary for all of the ramps in the region, illustrating the outward reach and directional variations in reach and use intensity (Figure 11). The wedges which comprise the RSA reveal the estimated distance-decay properties of use over various directions (as one moves away) from the "average ramp location" (i.e., RSA ramp centroid). It can also be viewed as a theoretical composite of all PSA's, a meso-scale model that reveals not only the aerial coverage of the ramp service area for the Tampa and Sarasota Bay region, but the extent to which all ramps are likely to draw from the underlying geographic distribution of boaters, and the geographic variability in the propensity of boaters within the region to launch from public access ramps contained within the study area.

The delineation of the regional service area (RSA**)** is based on the sample of 3,089 boaters that launched from the 31 ramps sampled within the study region. Model threshold distance estimates for each wedge or combination of wedges cast about the regional ramp centroid identify the RSA boundary. The RSA analysis highlights the degree to which use intensity varies in terms of reach and direction within the study region as a whole. For example, pie wedge four, spanning the 45 to 60-degree range, exhibits the greatest outward reach from the regional ramp centroid (Figure 11). Wedges with longer reaches depict portions of the RSA where patrons tend to travel greater distances to access one of the 31 sampled ramps. Conversely, wedges with shorter reaches identify areas where ramp patronage tends to be more localized. Note that although wedge six exhibits a large geographic reach, based on the estimated distance threshold, it draws upon a limited patronage given that much of the area (shaded tan) is void of owners of registered vessels.

A wedge specific use potential index (WSUP) was developed to account for the uneven spatial distribution of ramp patrons between wedges that comprise the RSA (see Chapter 6 for a discussion of the WSUP index). A destination specific use potential index (DSUP) was developed to account for the spatial variability in destination choice or the density of reported use between specific destination regions SDR (see Chapter 7 for a discussion of the DSUP index). Land-side and water-side service areas for the RSA are illustrated in Map 1. Use potential indices are mapped, illustrating low, medium, and high use potential per unit area, by wedge and SDR, with yellow areas indicating the lowest use potential and red areas indicating the highest use potential.

Primary Service Areas

Primary service areas (PSA) represent the predominant market areas for individual ramps. The PSA delineates the geographic area from which users of a specific ramp are drawn. Estimated threshold distances were calculated by wedge or combination of wedges to delineate the PSA boundary as was done for the RSA. The PSA is further classified according to a wedge specific use potential (WSUP) index–the contribution to the overall use of a given ramp from each of the wedges that comprise the PSA. In addition, a destination specific use potential (DSUP) index was calculated for each of the 20 SDR defined by the cluster analysis and illustrated in Figure 10. The DSUP identifies an individual ramp's relative contribution to use within each SDR, as defined by

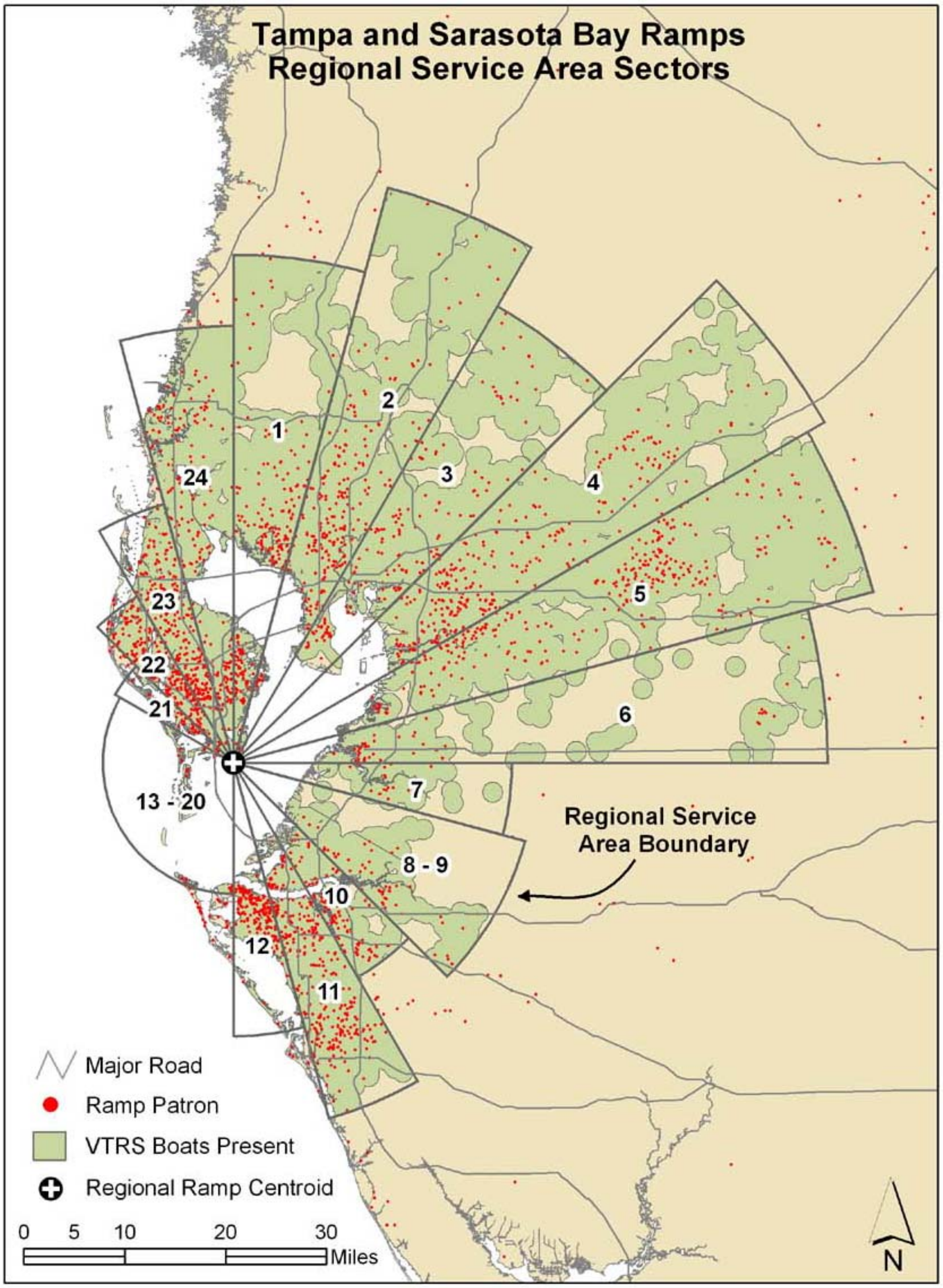
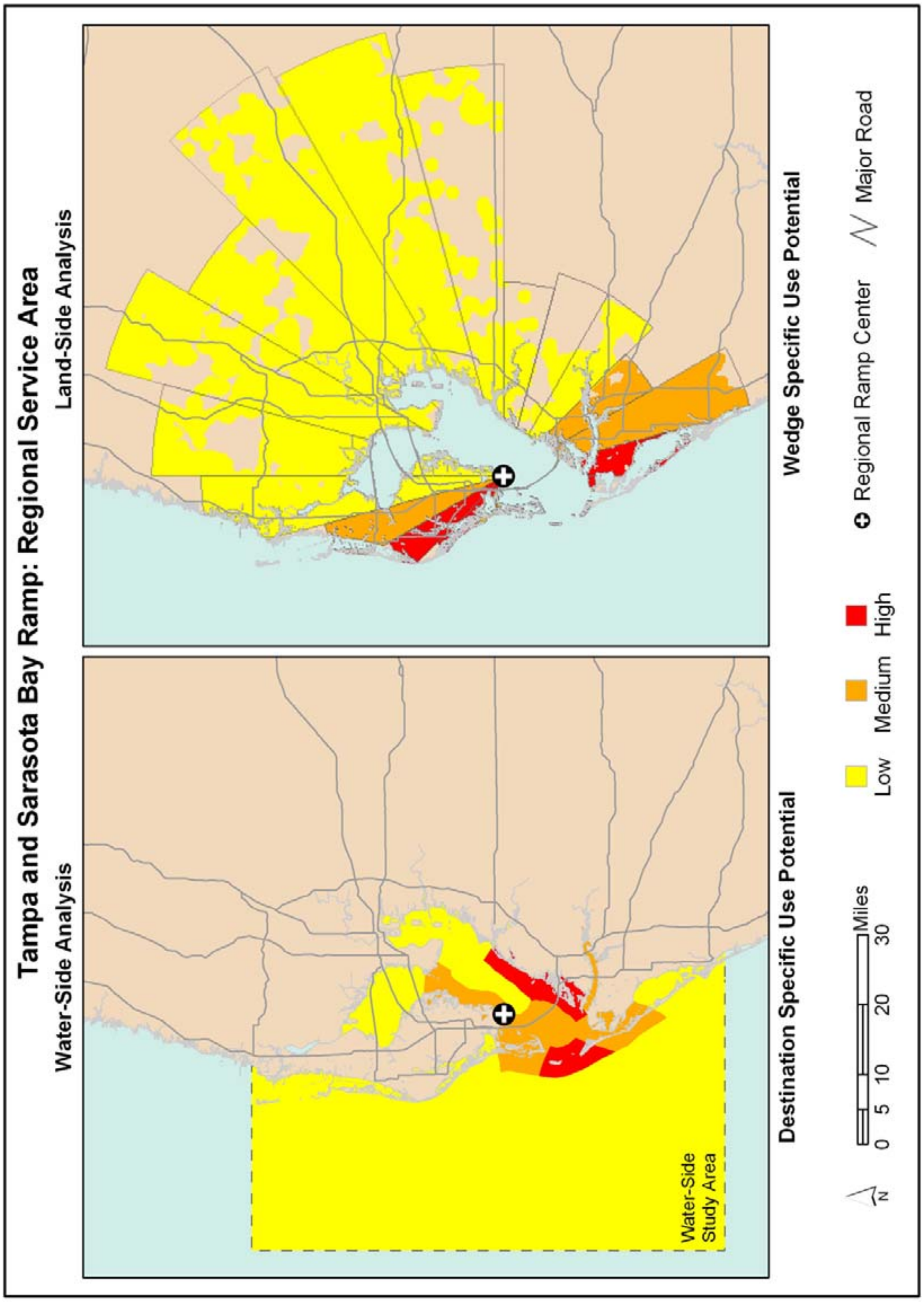


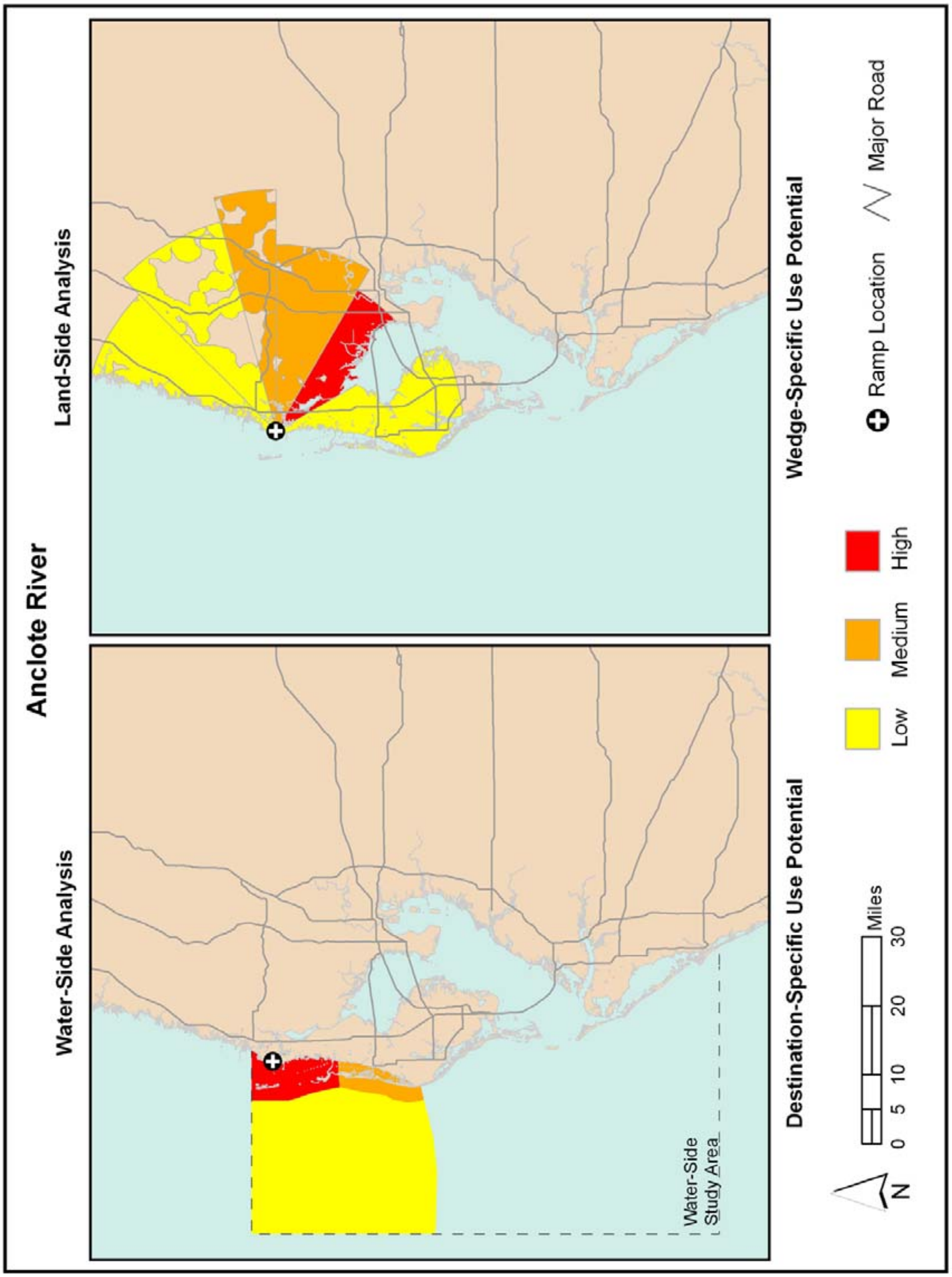
Figure 11. Regional Service Area Sectors and Boundary.

favorite destinations reported by survey respondents. Land-side (WSUP) and water-side (DSUP) service areas and use potential for each ramp in the study region are illustrated in Maps 2 – 32. Use potential indices are mapped, illustrating low, medium, and high use potential per unit area (by PSA wedge and SDR) with yellow areas indicating the lowest use potential, orange areas illustrating moderate use potential, and red areas indicating the highest use potential. The maps illustrate the presence of a distance-decay relationship: declining use with increasing distance from a ramp. This is observed generally in both the land-side and water-side analyses and is consistent with survey responses that identified "proximity to home" and "easiest access to favorite destinations" as the primary reasons for selecting ramps and on-water travel routes.

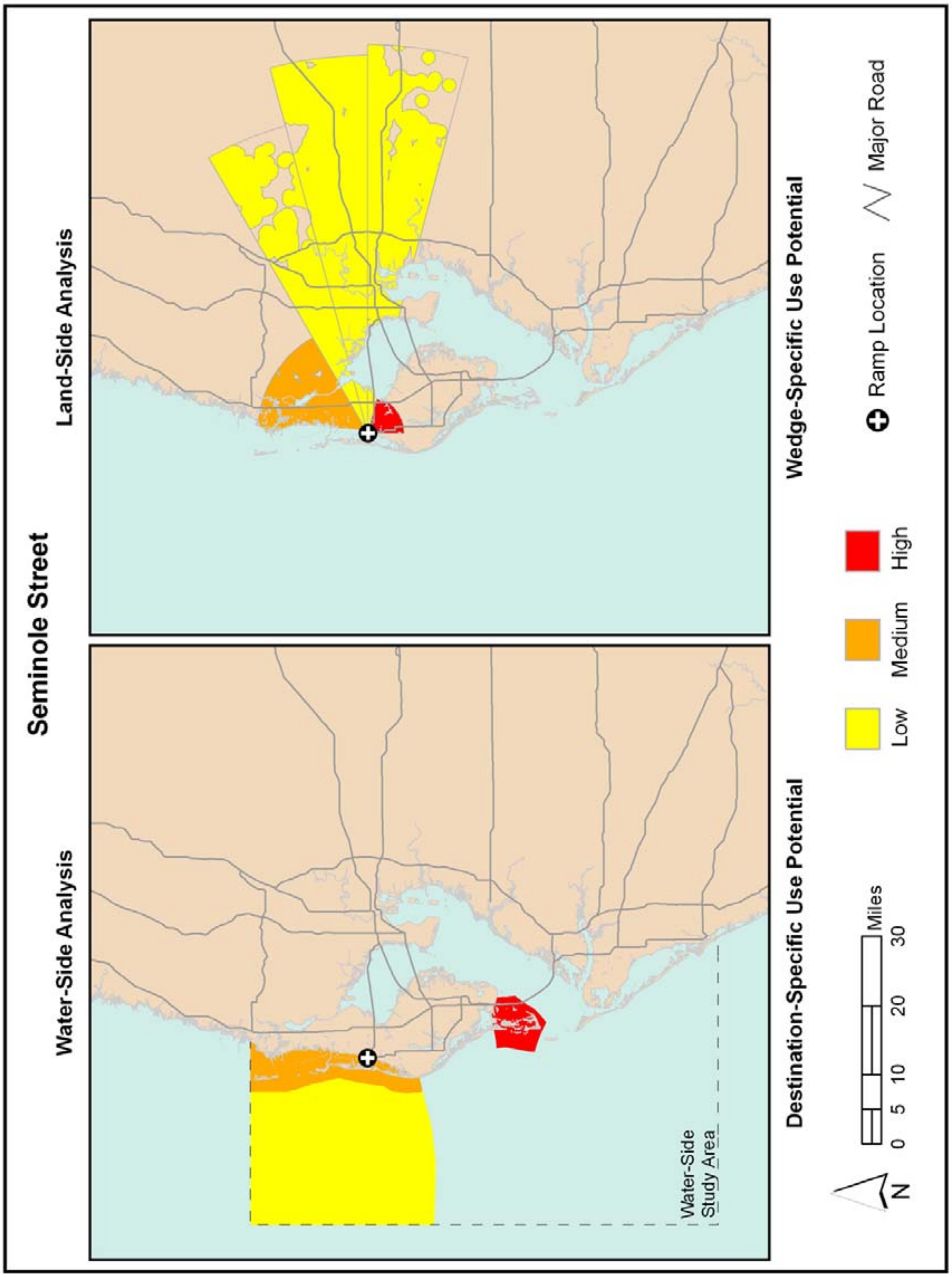
The shape of the market service area and the variability in reach and use intensity associated with the RSA and/or individual primary service areas (PSA) is a byproduct of numerous factors which include: (1) the underlying geographic distribution and location of boaters within the study region; (2) the accessibility or proximity of public access ramps to the boating population (i.e., where boat ramps are located relative to boaters within the region); (3) coastal geomorphology and the geography of the shoreline; (4) distance-decay properties associated with boaters' relative location, distance-minimizing tendencies, destination and launch preferences, and their willingness to travel–where use intensity is shown to decline with increasing distance; and (5) the regional transportation network which affects accessibility to ramps from various locations within the service areas.



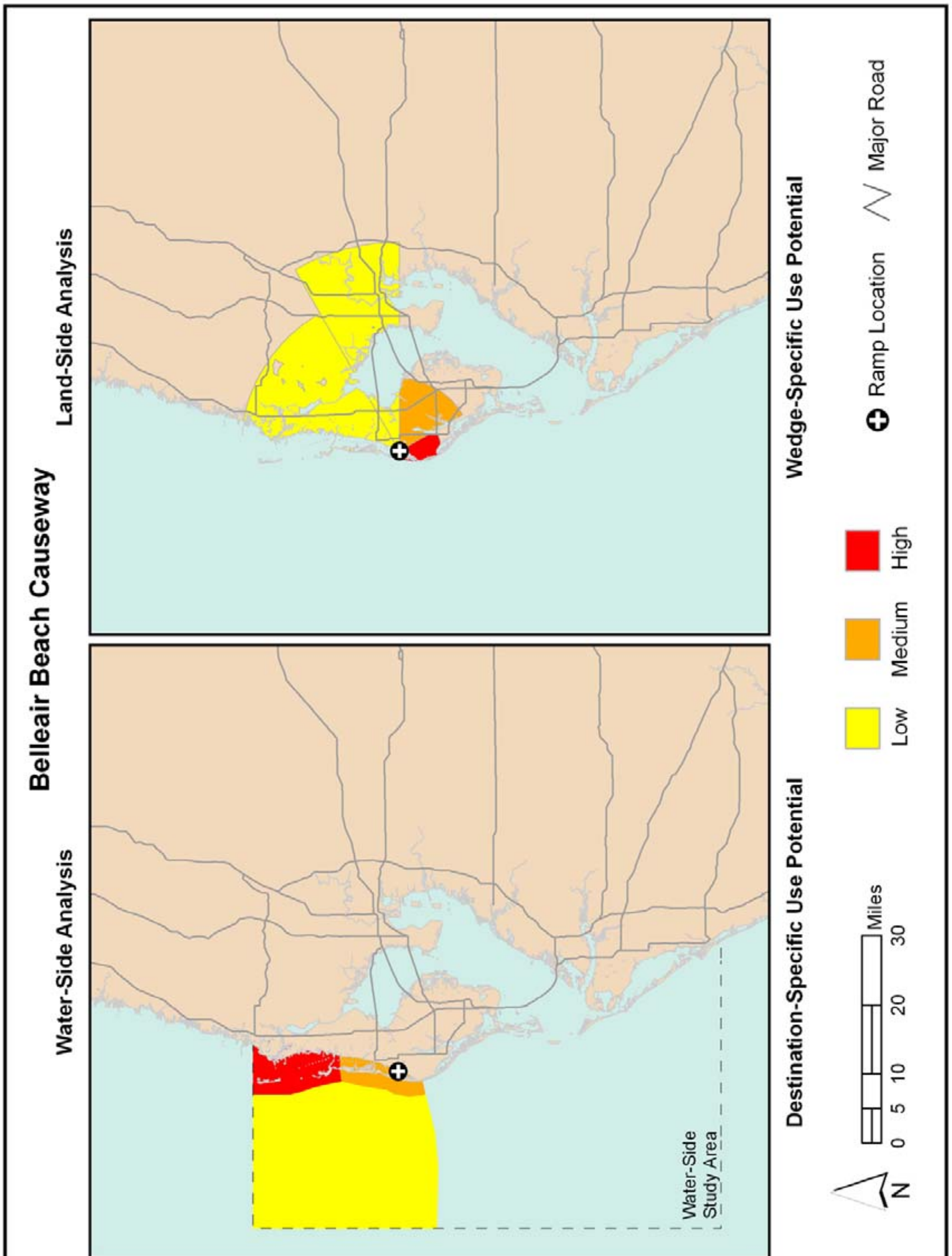
Map 1. Regional Service Area Analysis.



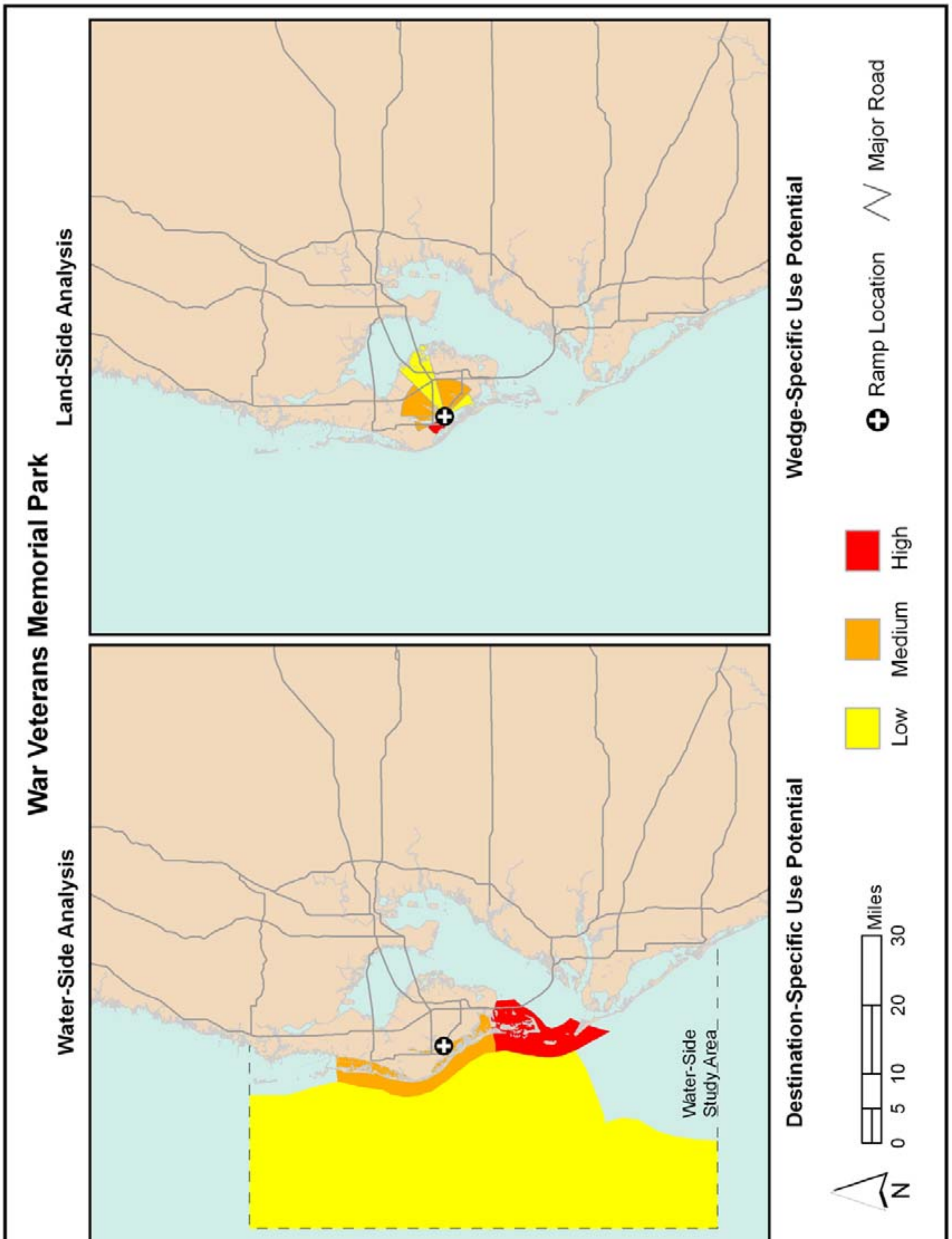
Map 2. Land and Water Use Analysis: Anclote River.



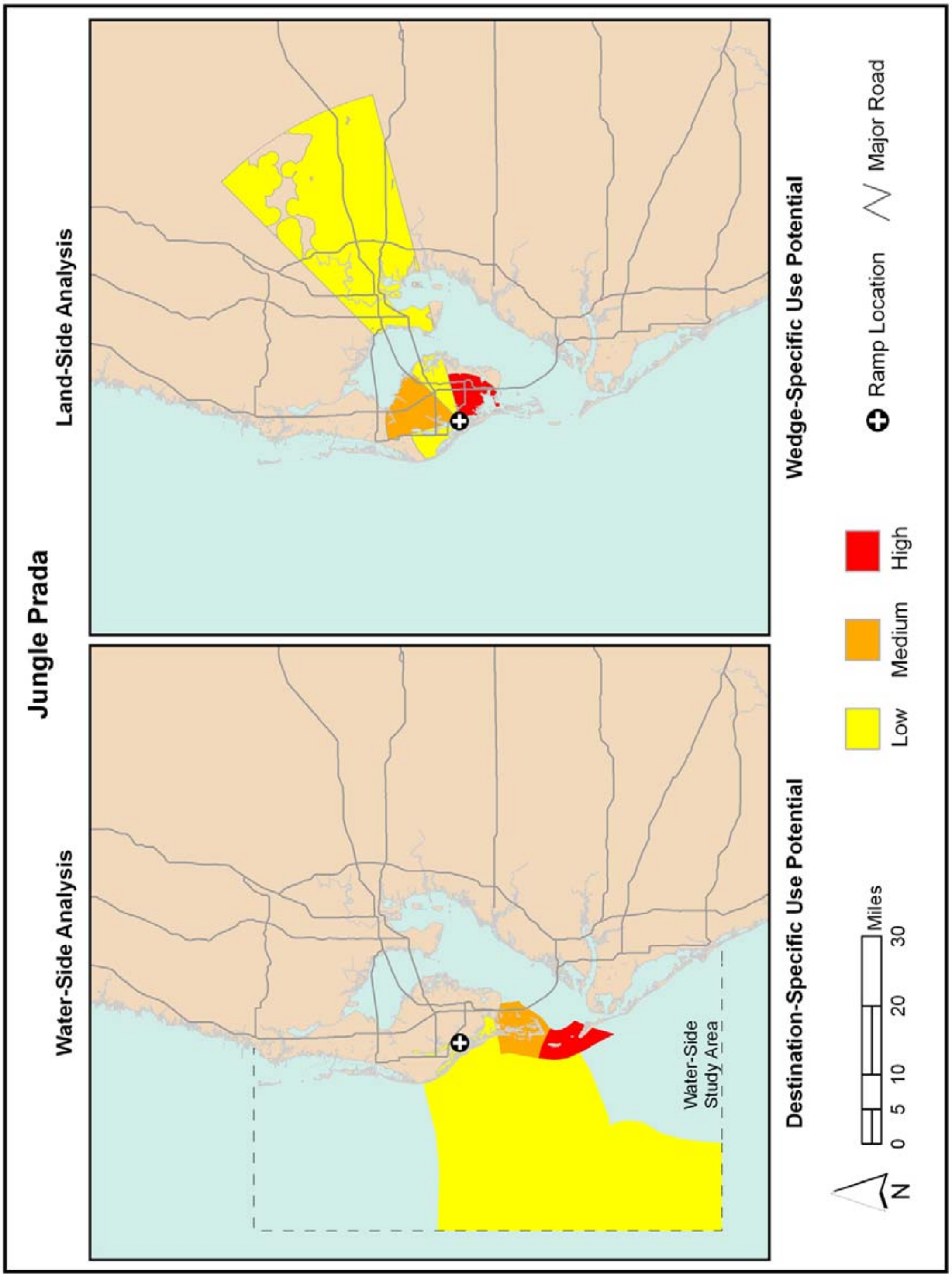
Map 3. Land and Water Use Analysis: Seminole Street.



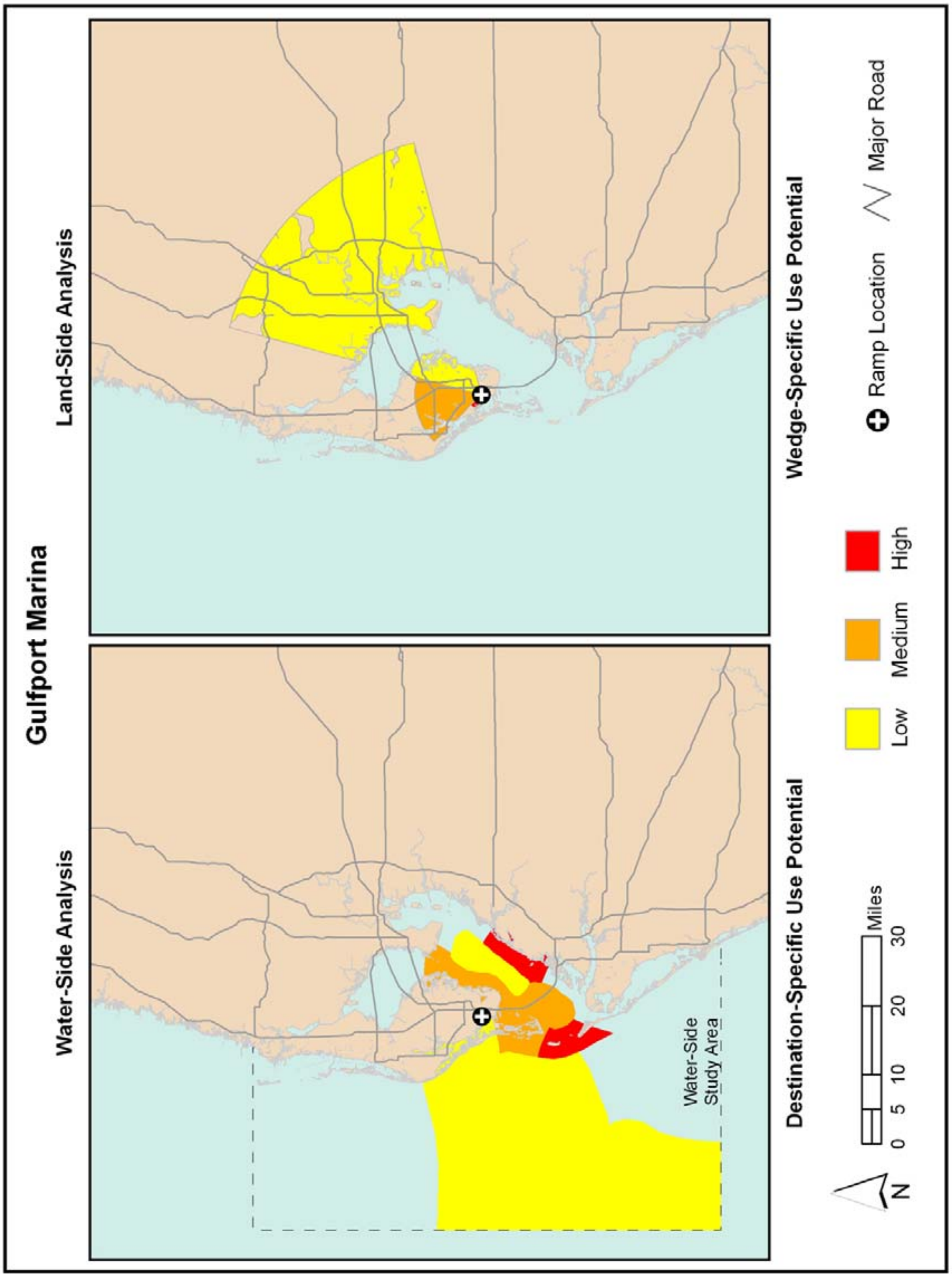
Map 4. Land and Water Use Analysis: Belleair Causeway Park.



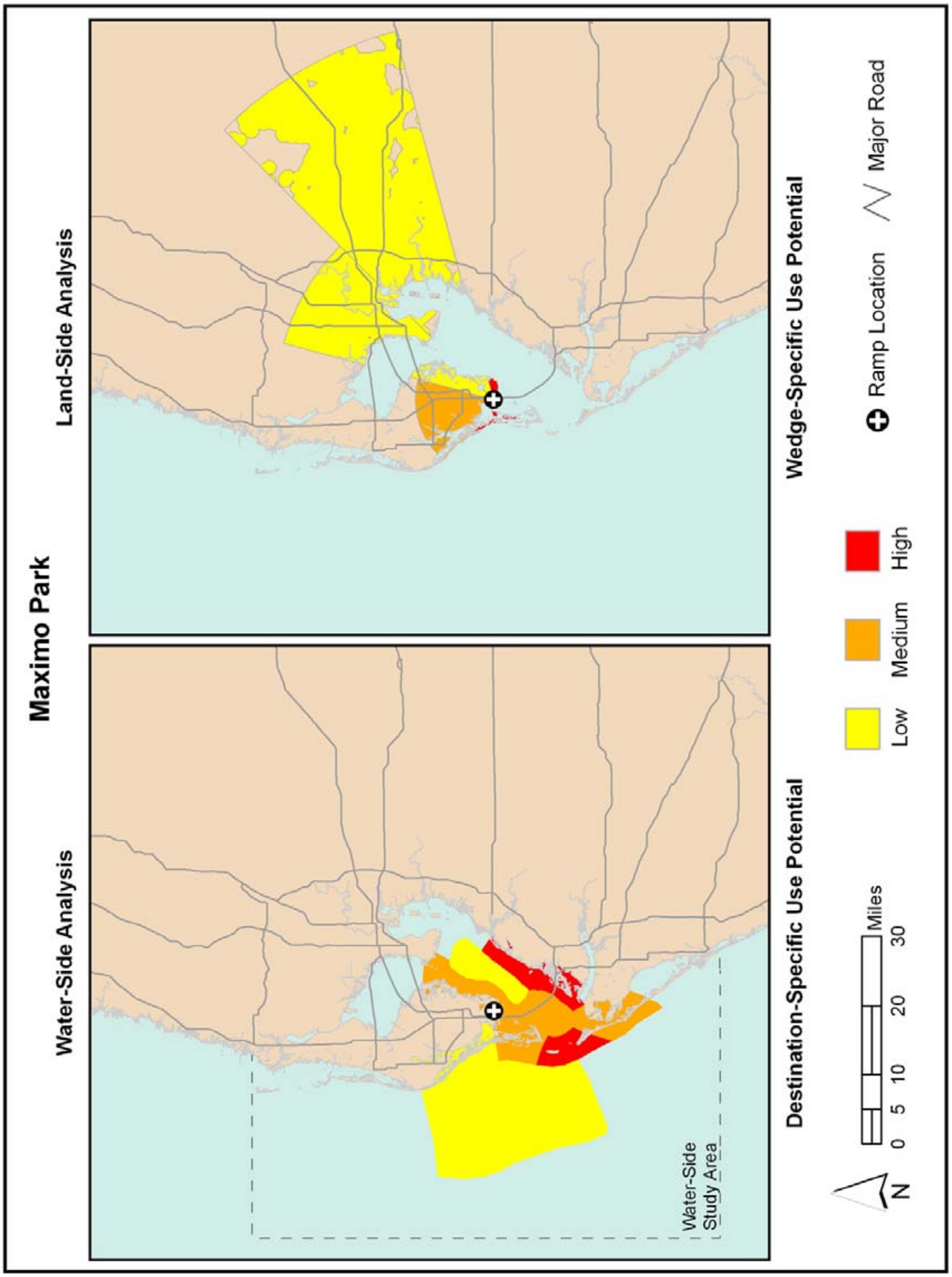
Map 5. Land and Water Use Analysis: War Veterans Memorial Park.



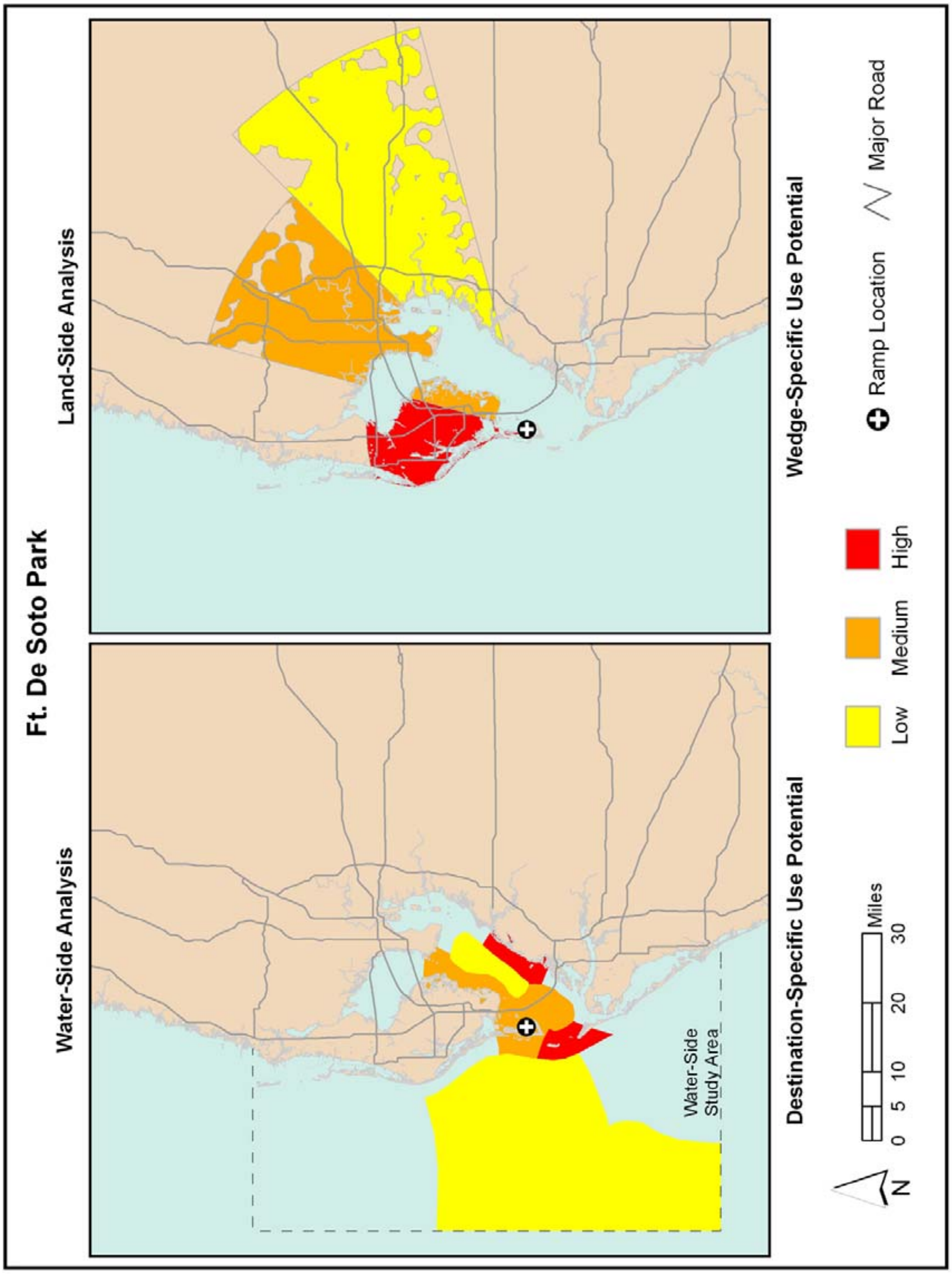
Map 6. Land and Water Use Analysis: Jungle Prada.



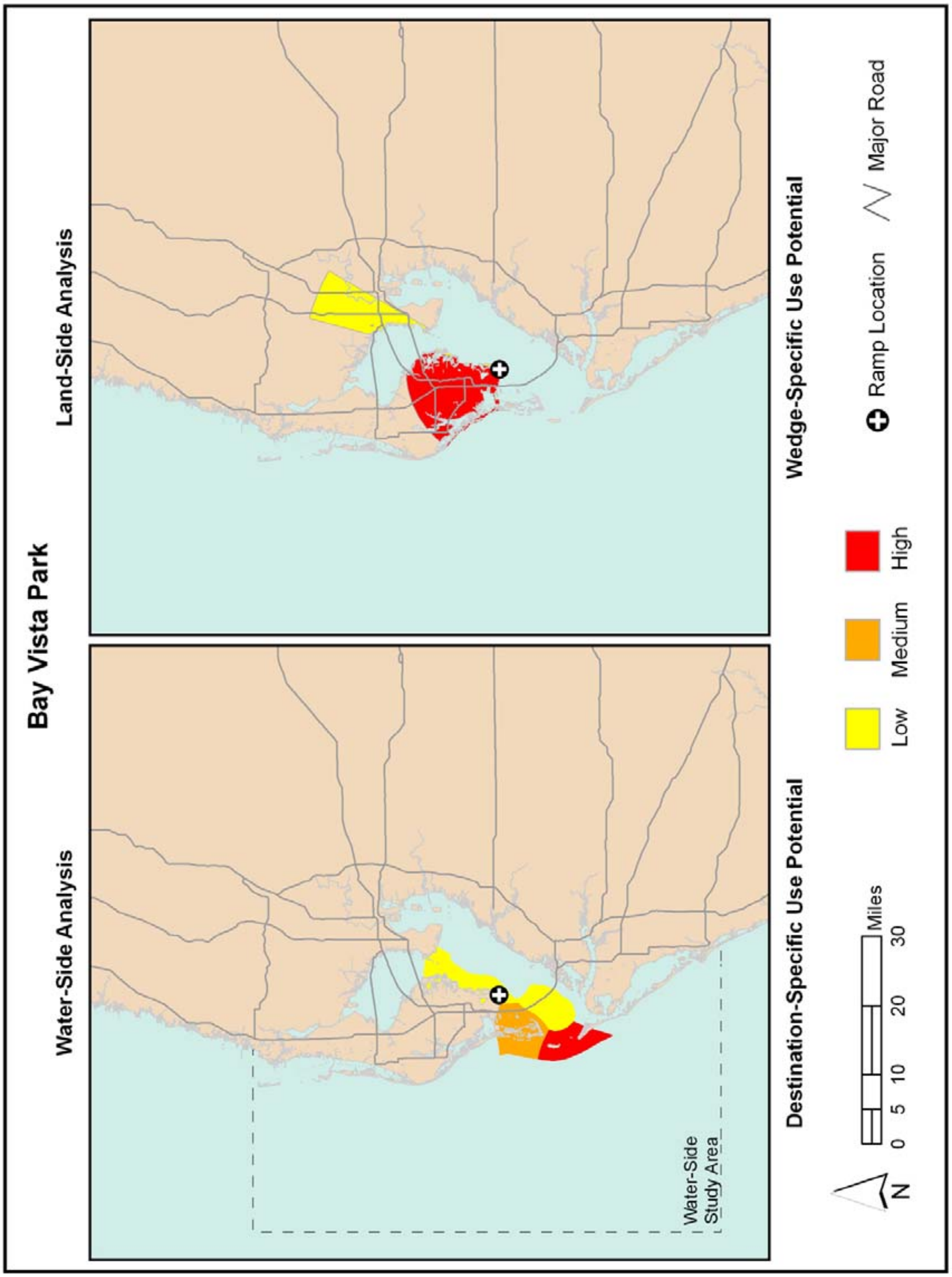
Map 7. Land and Water Use Analysis: Gulfport Marina.



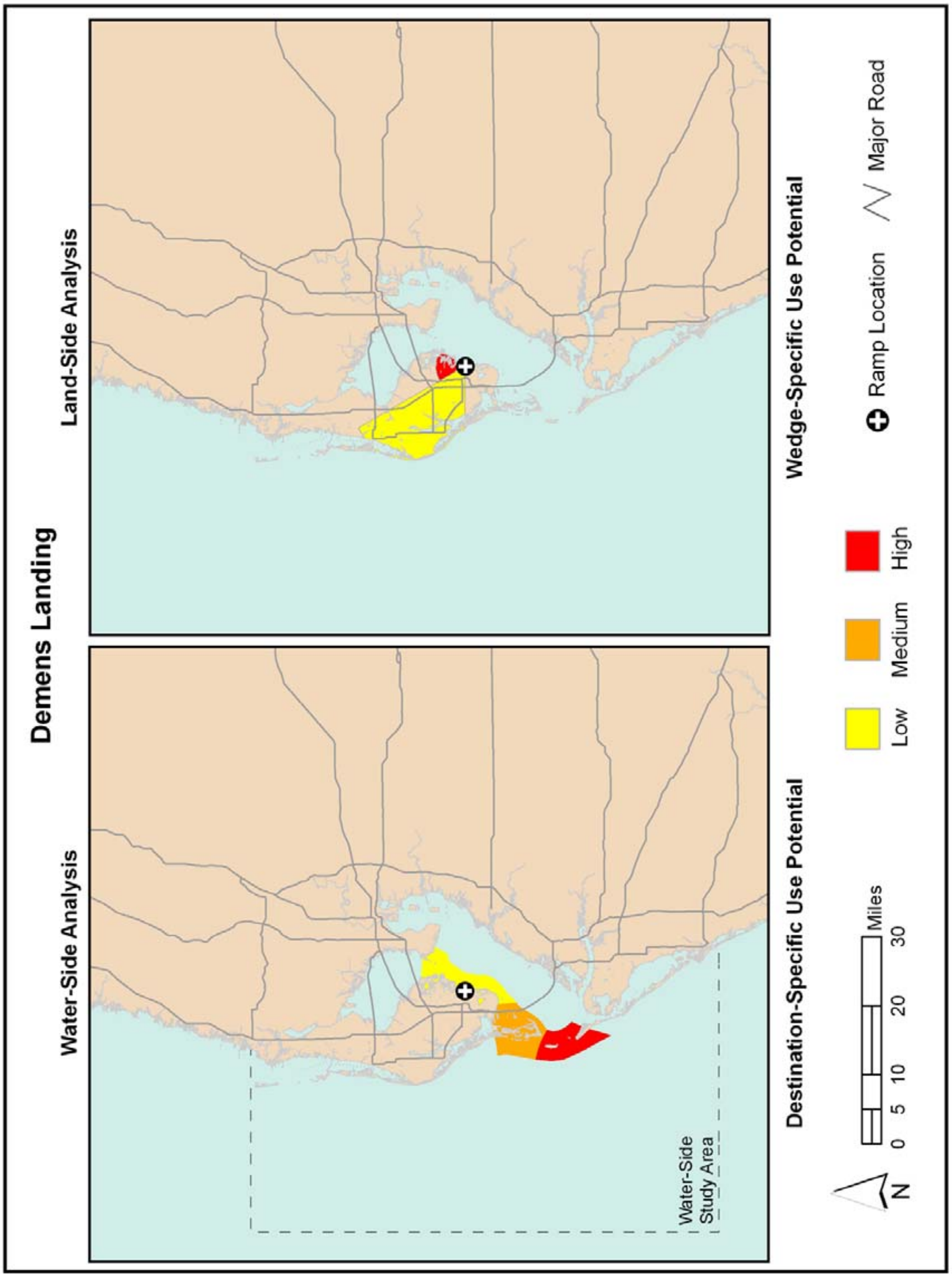
Map 8. Land and Water Use Analysis: Maximo Park.



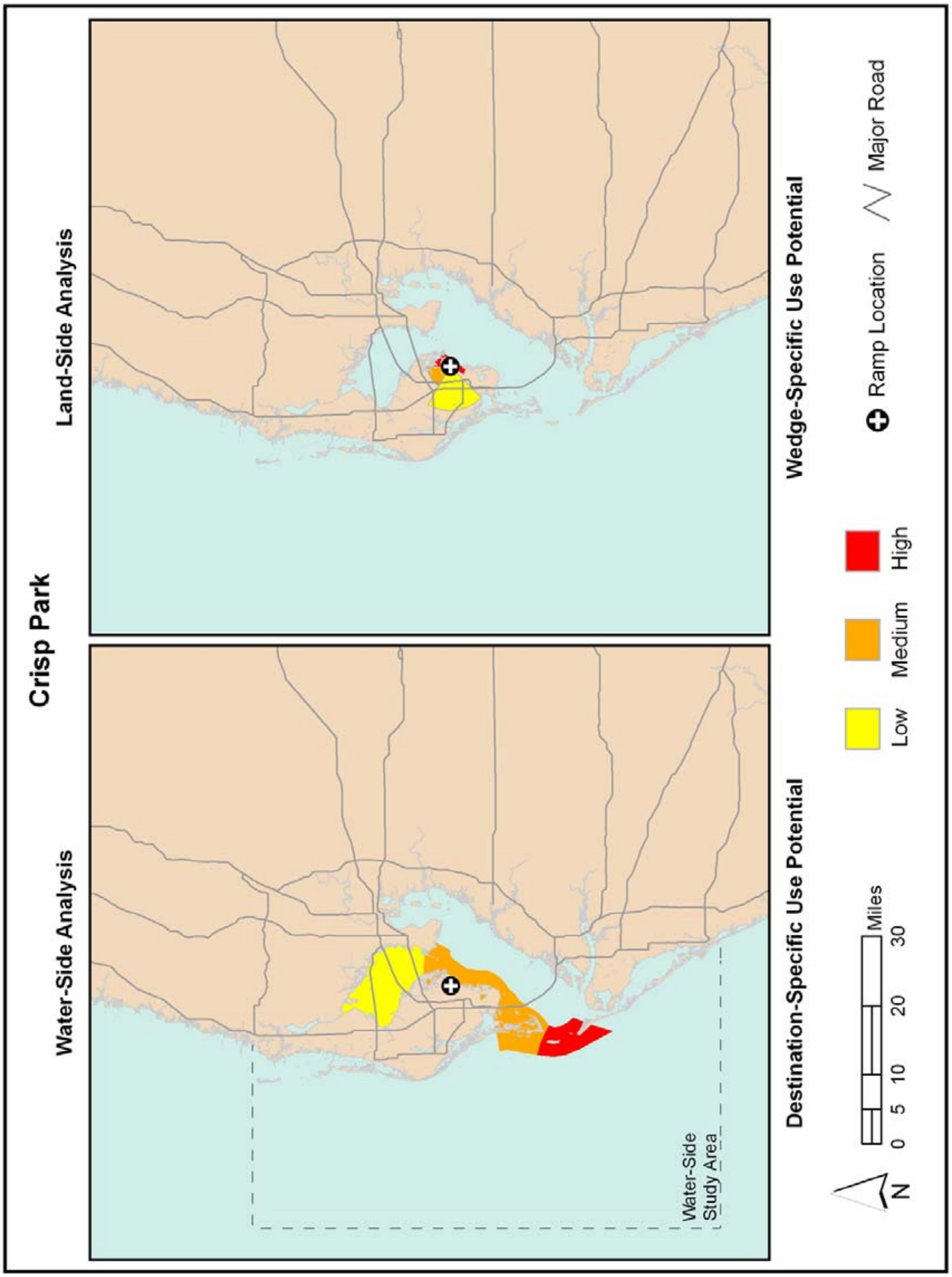
Map 9. Land and Water Use Analysis: Fort De Soto Park.



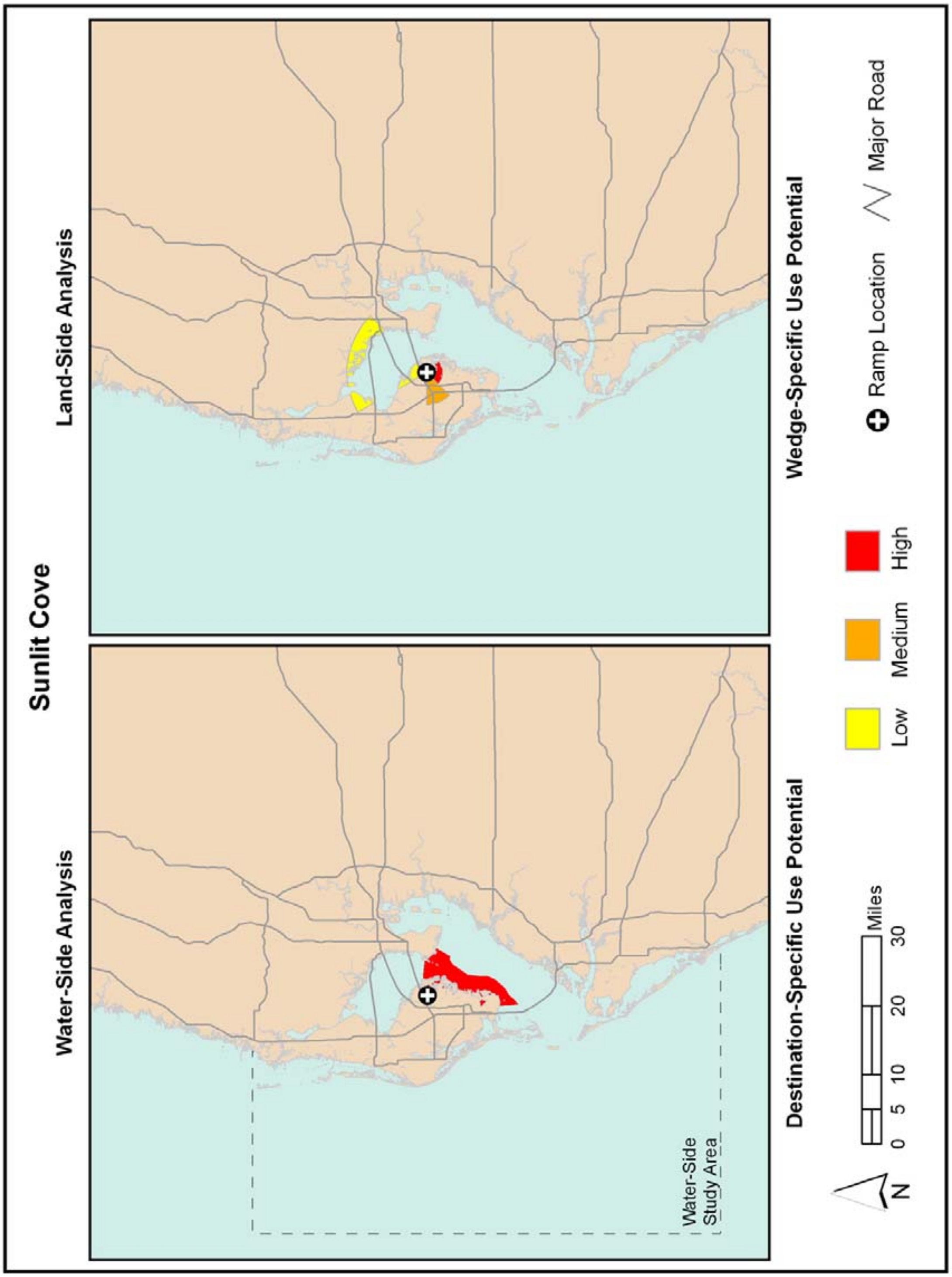
Map 10. Land and Water Use Analysis: Bay Vista Park.



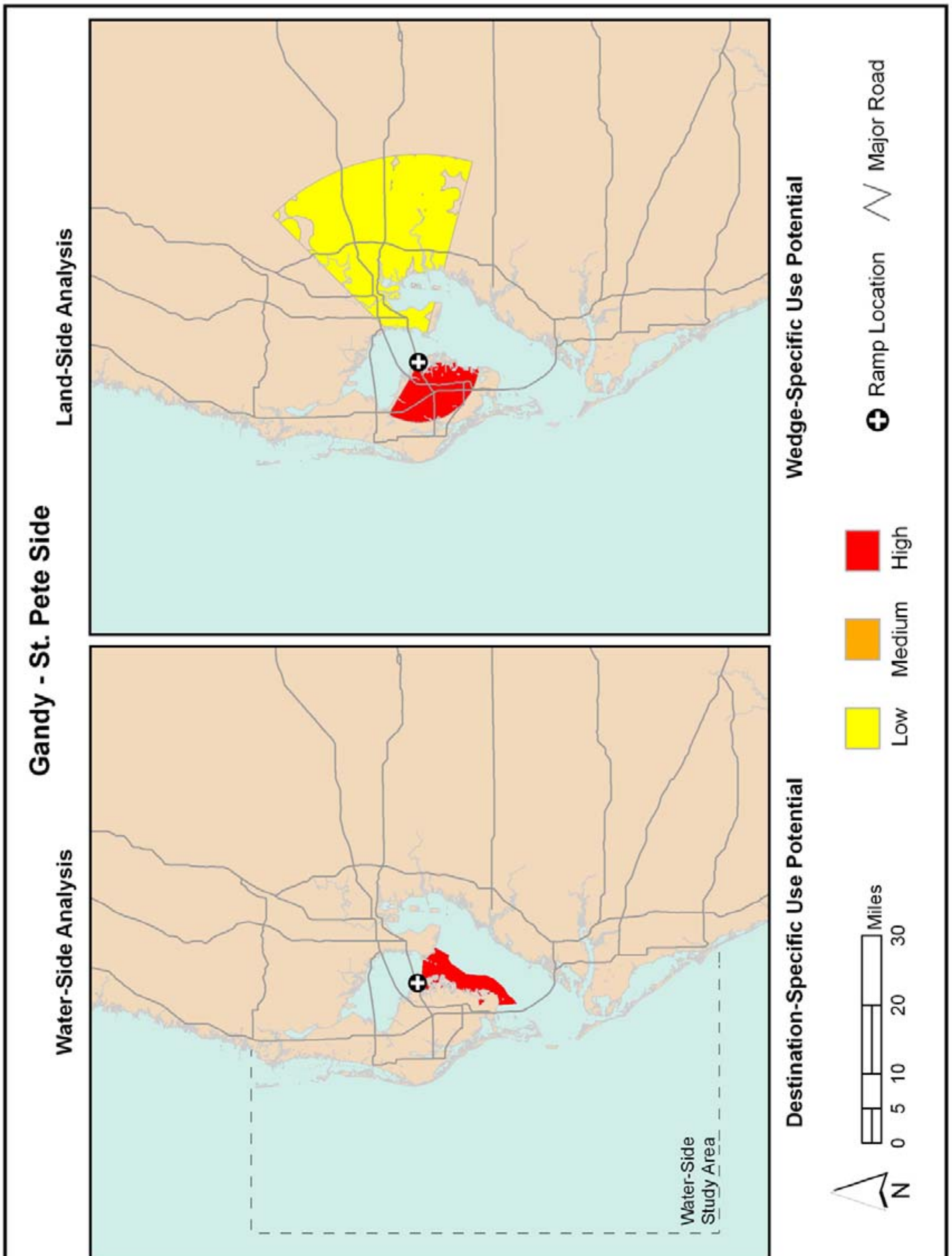
Map 11. Land and Water Use Analysis: Demens Landing.



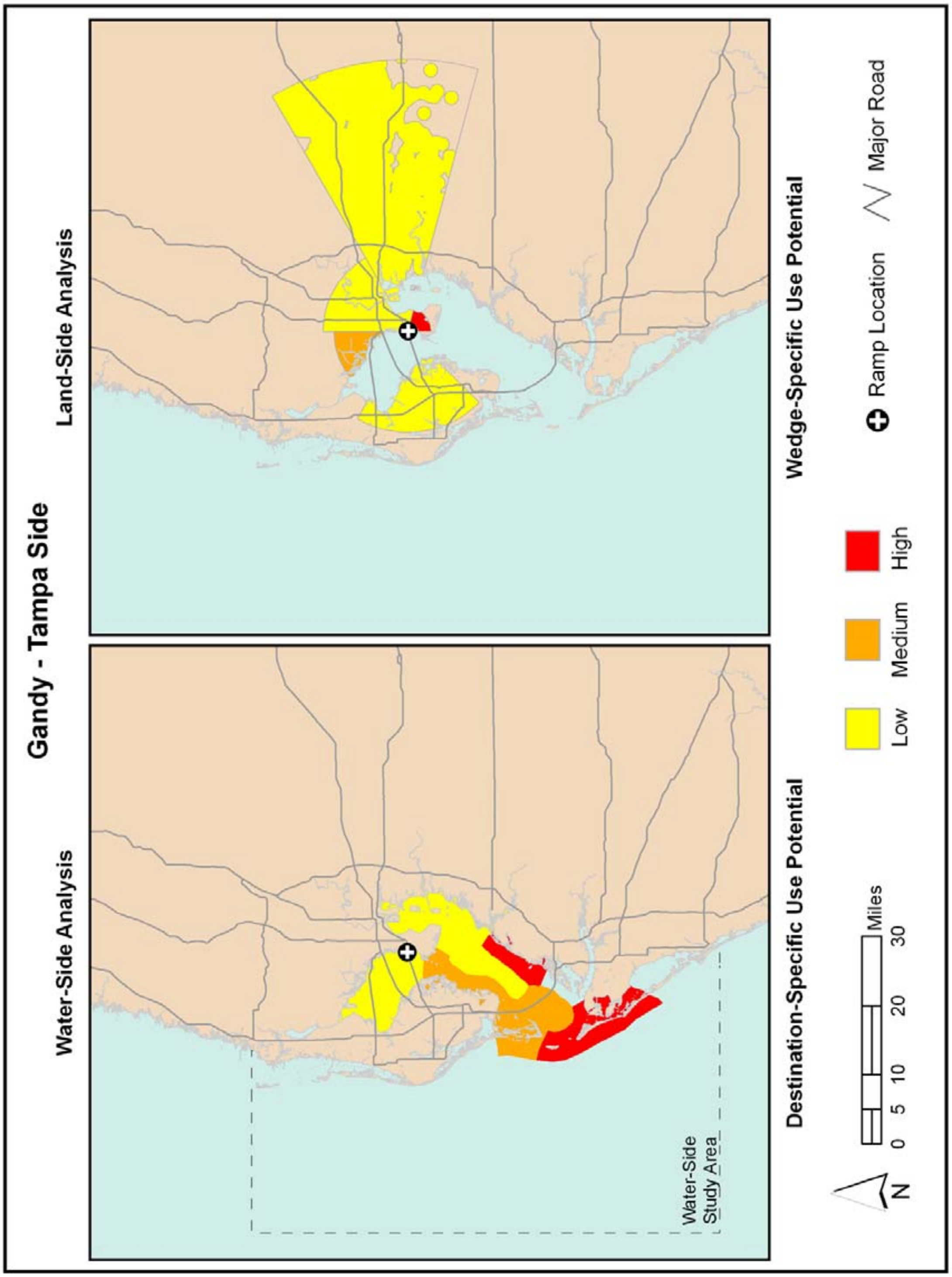
Map 12. Land and Water Use Analysis: Crisp Park.



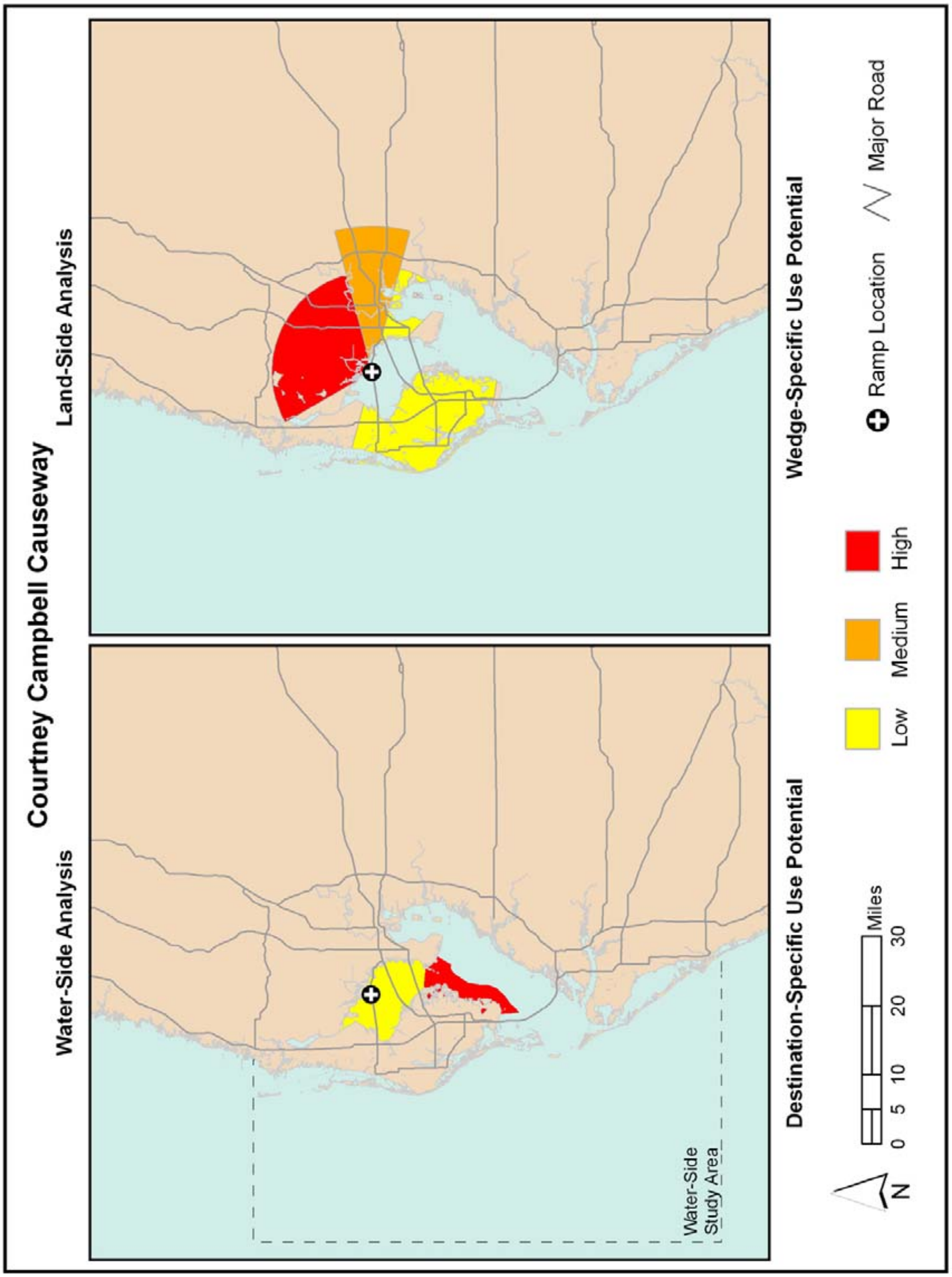
Map 13. Land and Water Use Analysis: Sunlit Cove.



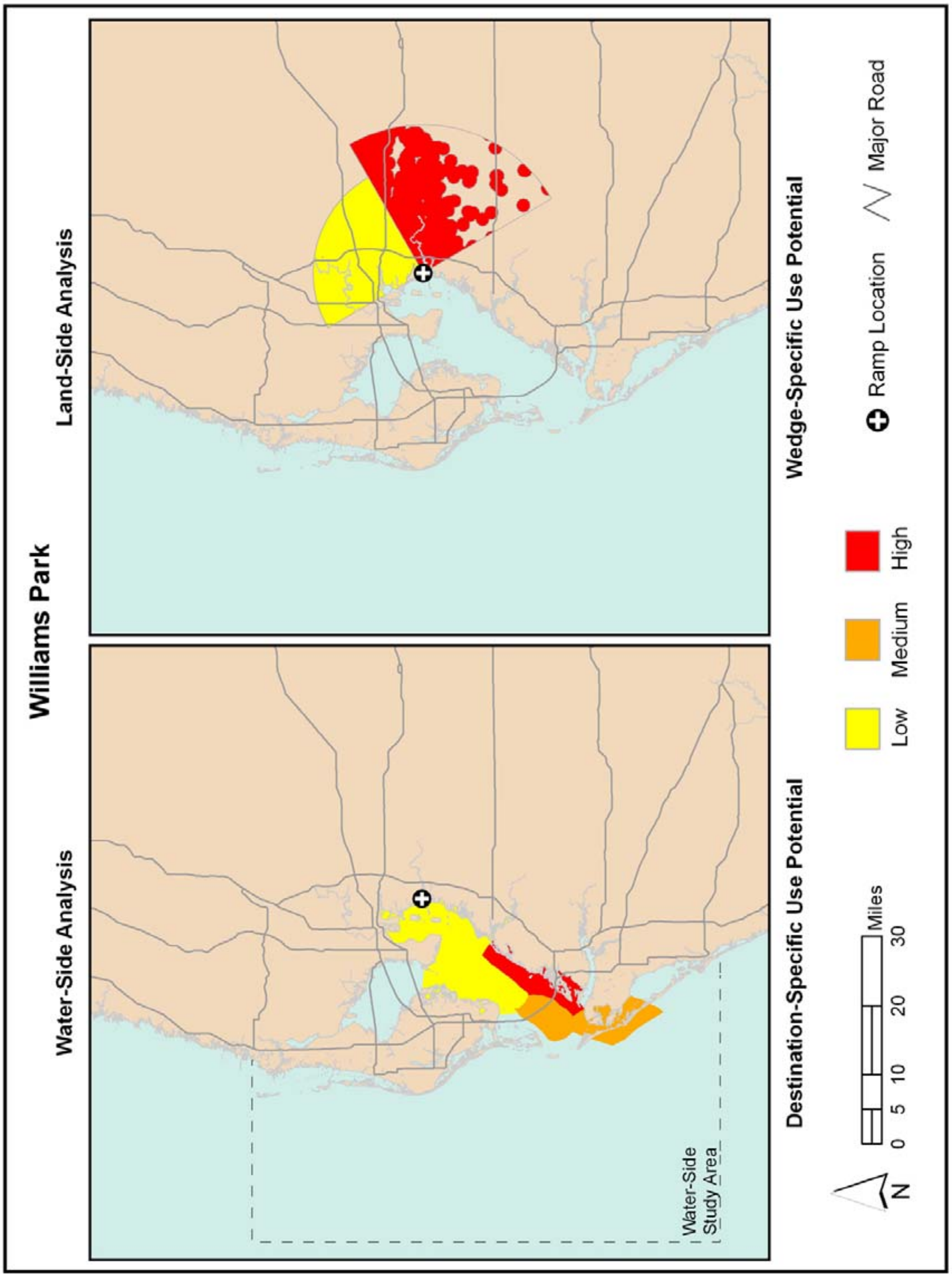
Map 14. Land and Water Use Analysis: Gandy – St. Pete Side.



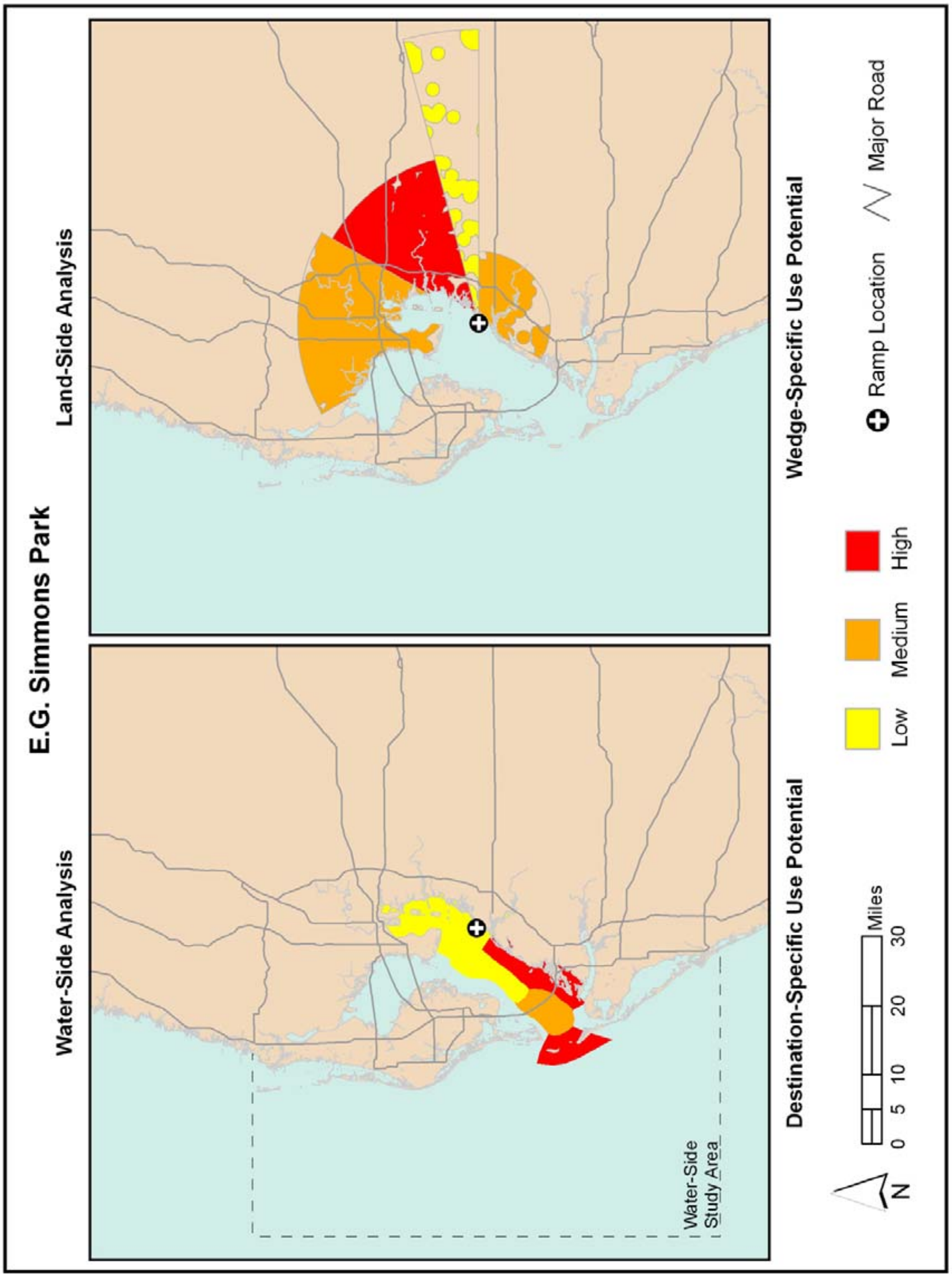
Map 15. Land and Water Use Analysis: Gandy – Tampa Side.



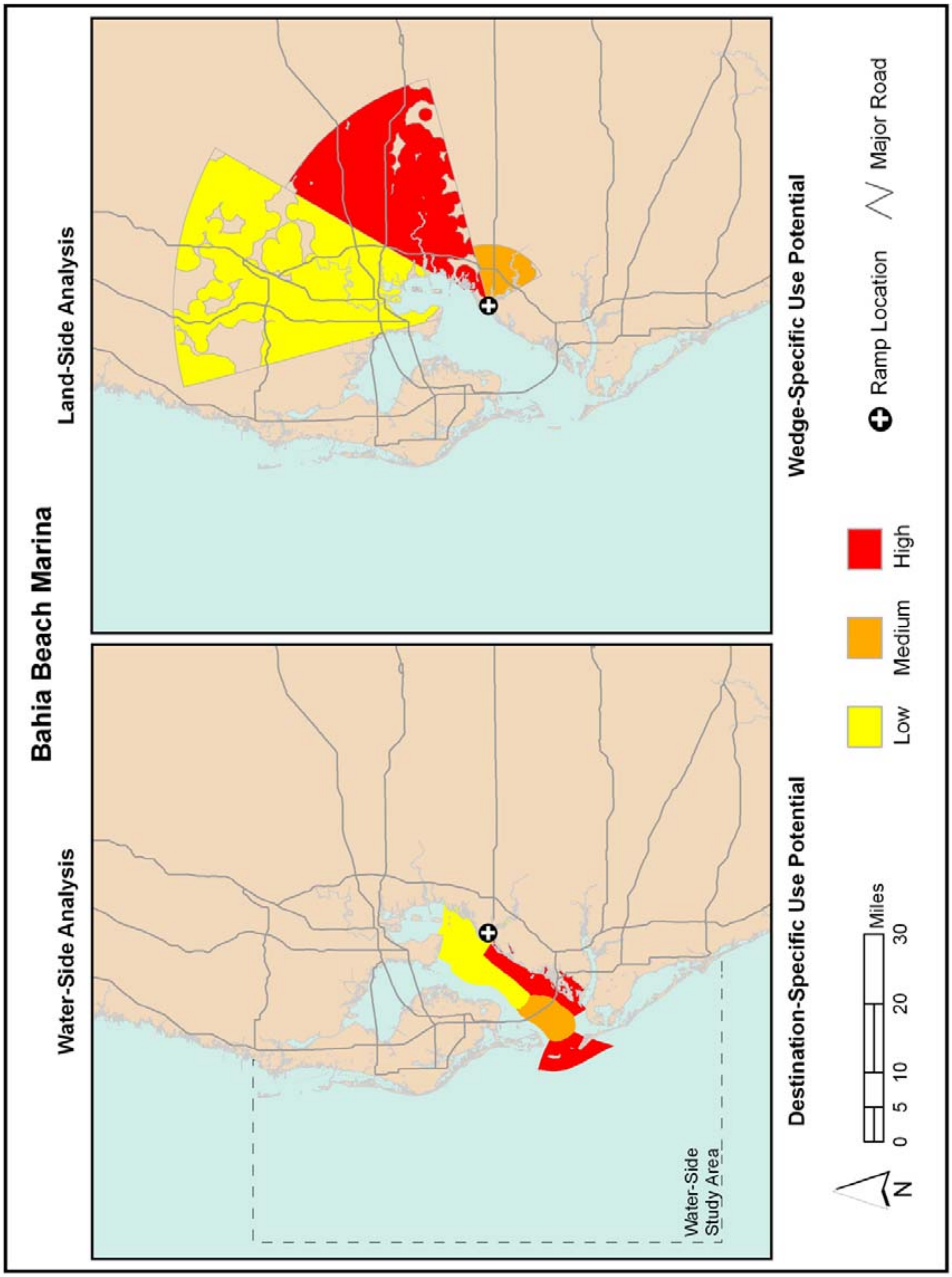
Map 16. Land and Water Use Analysis: Courtney Campbell Causeway.



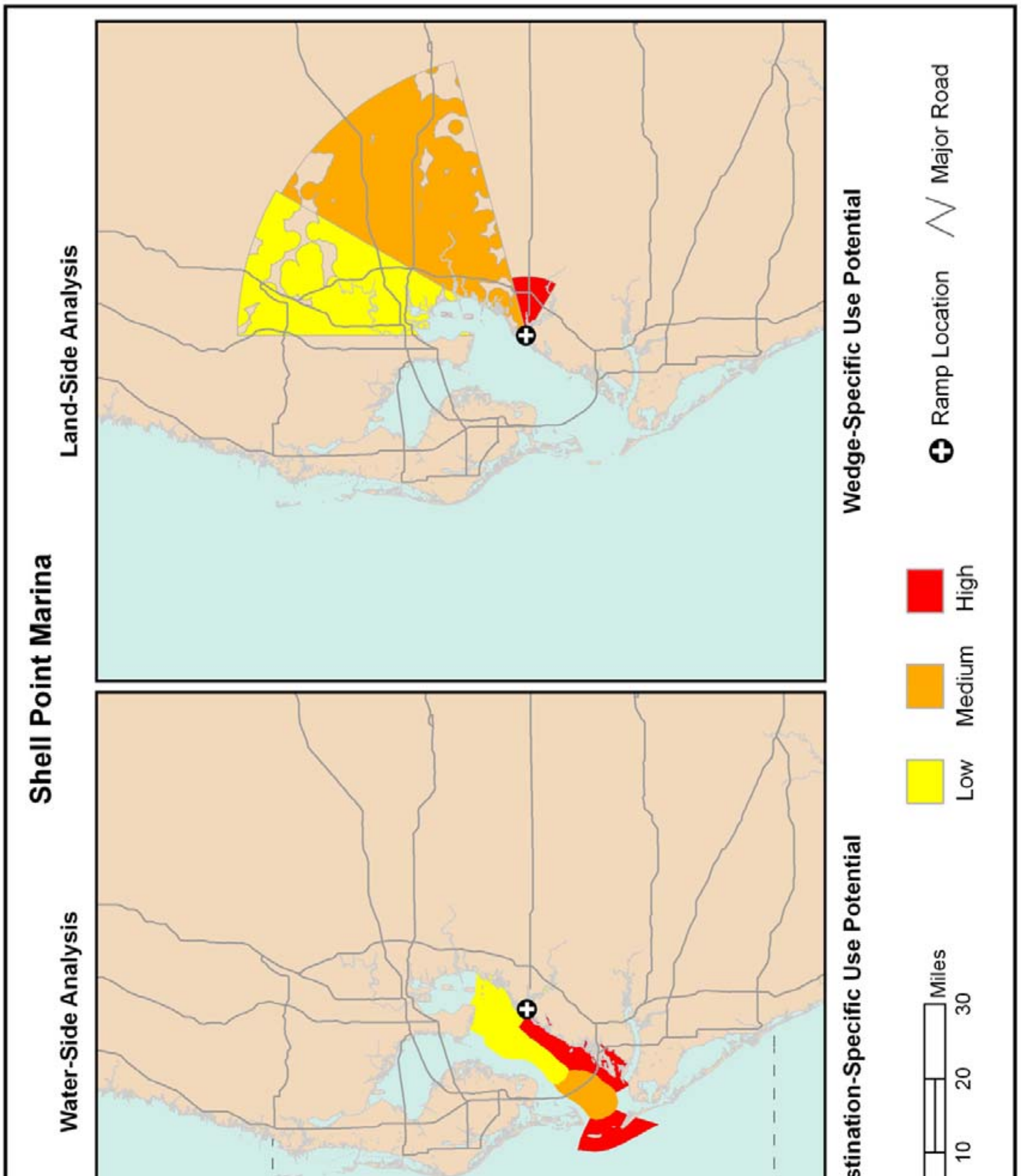
Map 17. Land and Water Use Analysis: Williams Park.



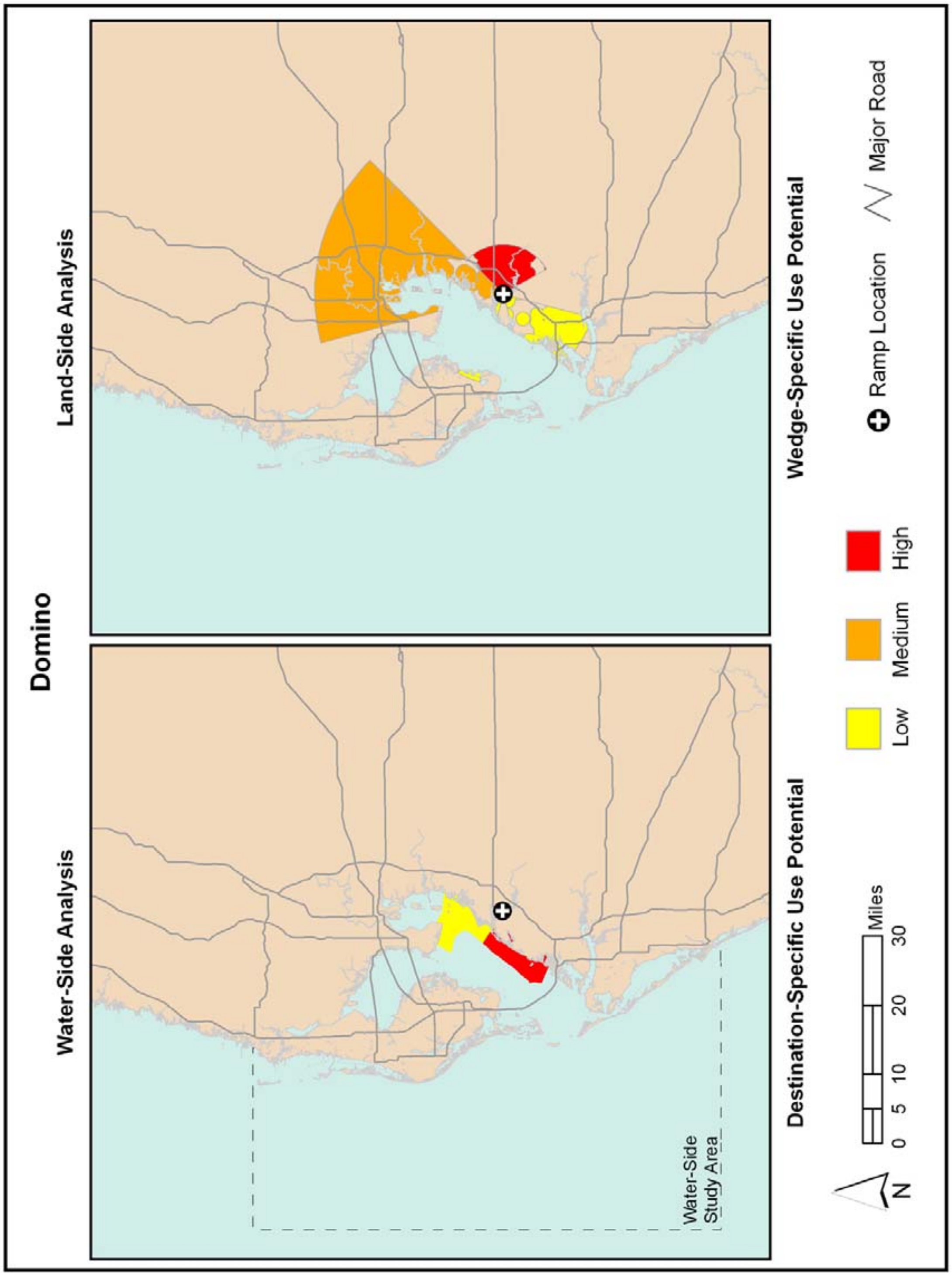
Map 18. Land and Water Use Analysis: E.G. Simmons Park.



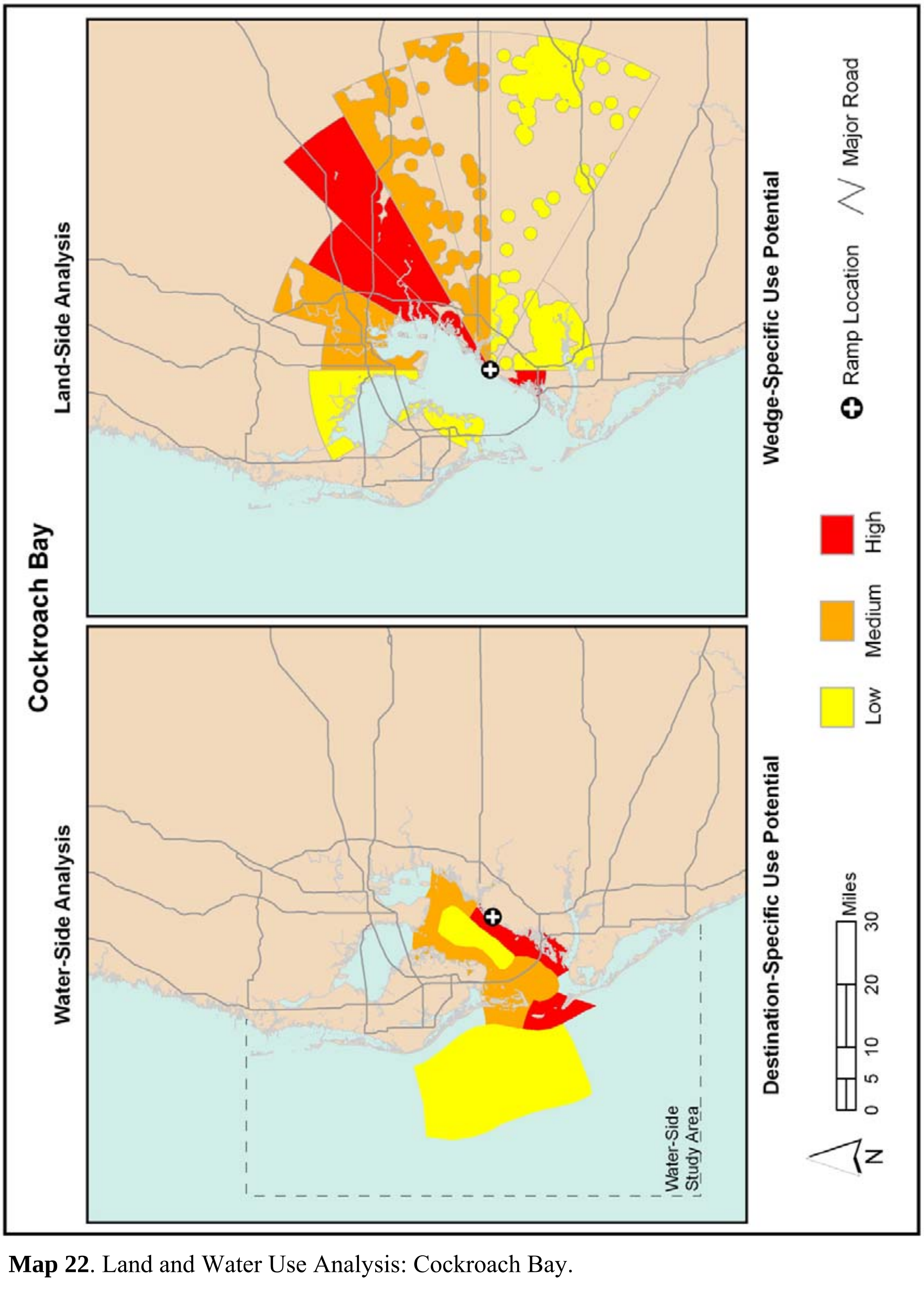
Map 19. Land and Water Use Analysis: Bahia Beach Marina.



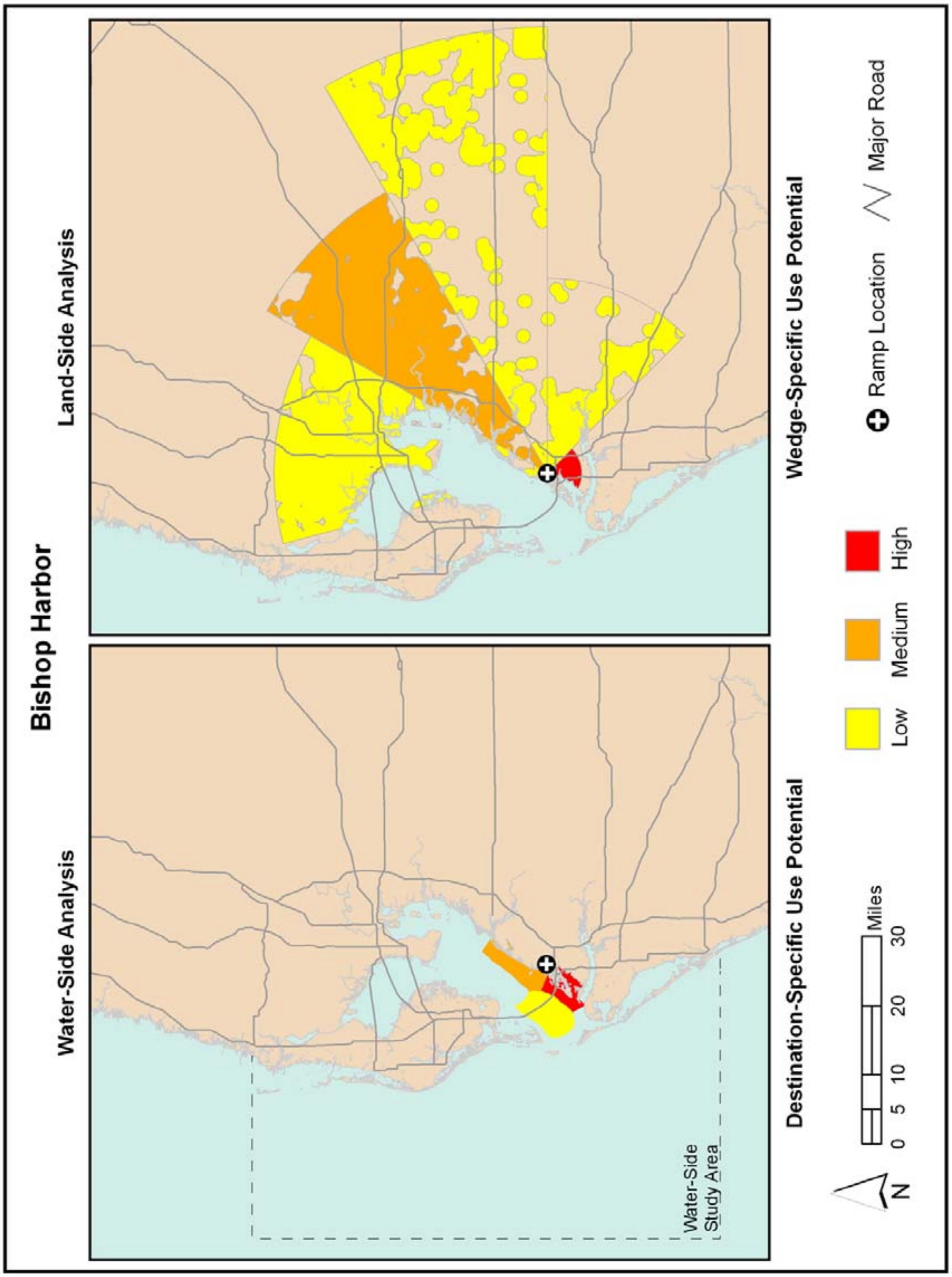
Map 20. Land and Water Use Analysis: Shell Point Marina.



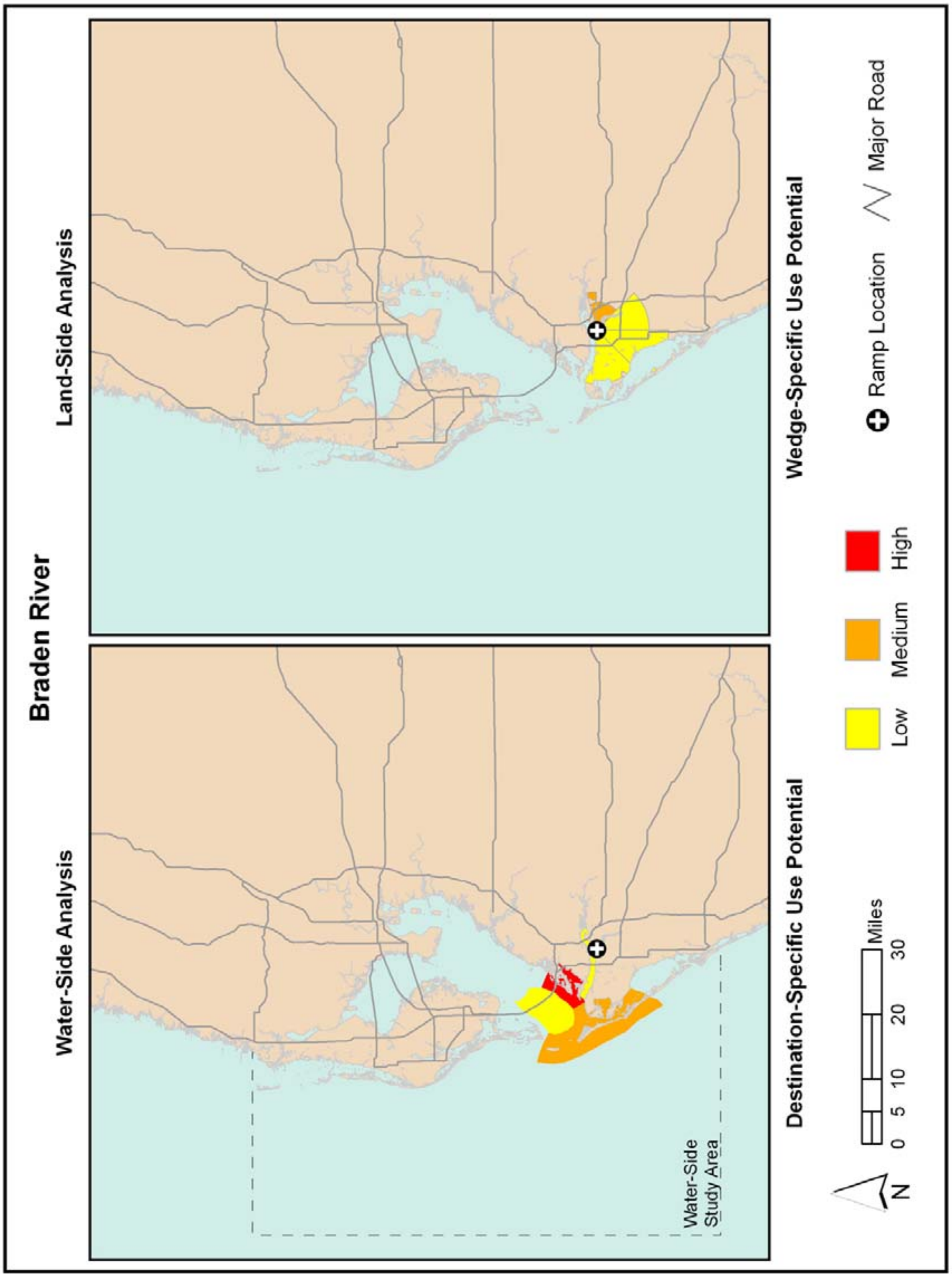
Map 21. Land and Water Use Analysis: Domino.



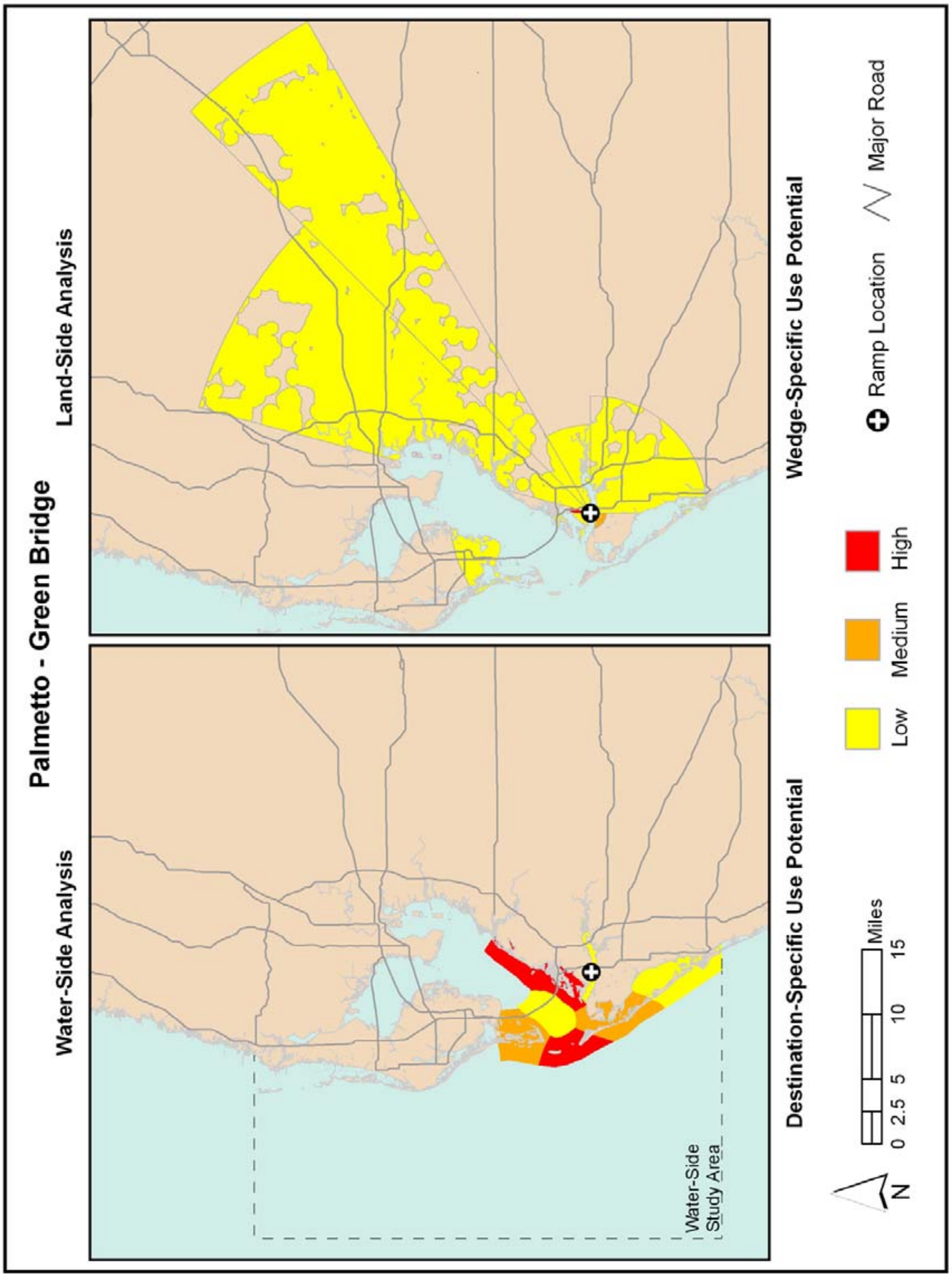
Map 22. Land and Water Use Analysis: Cockroach Bay.



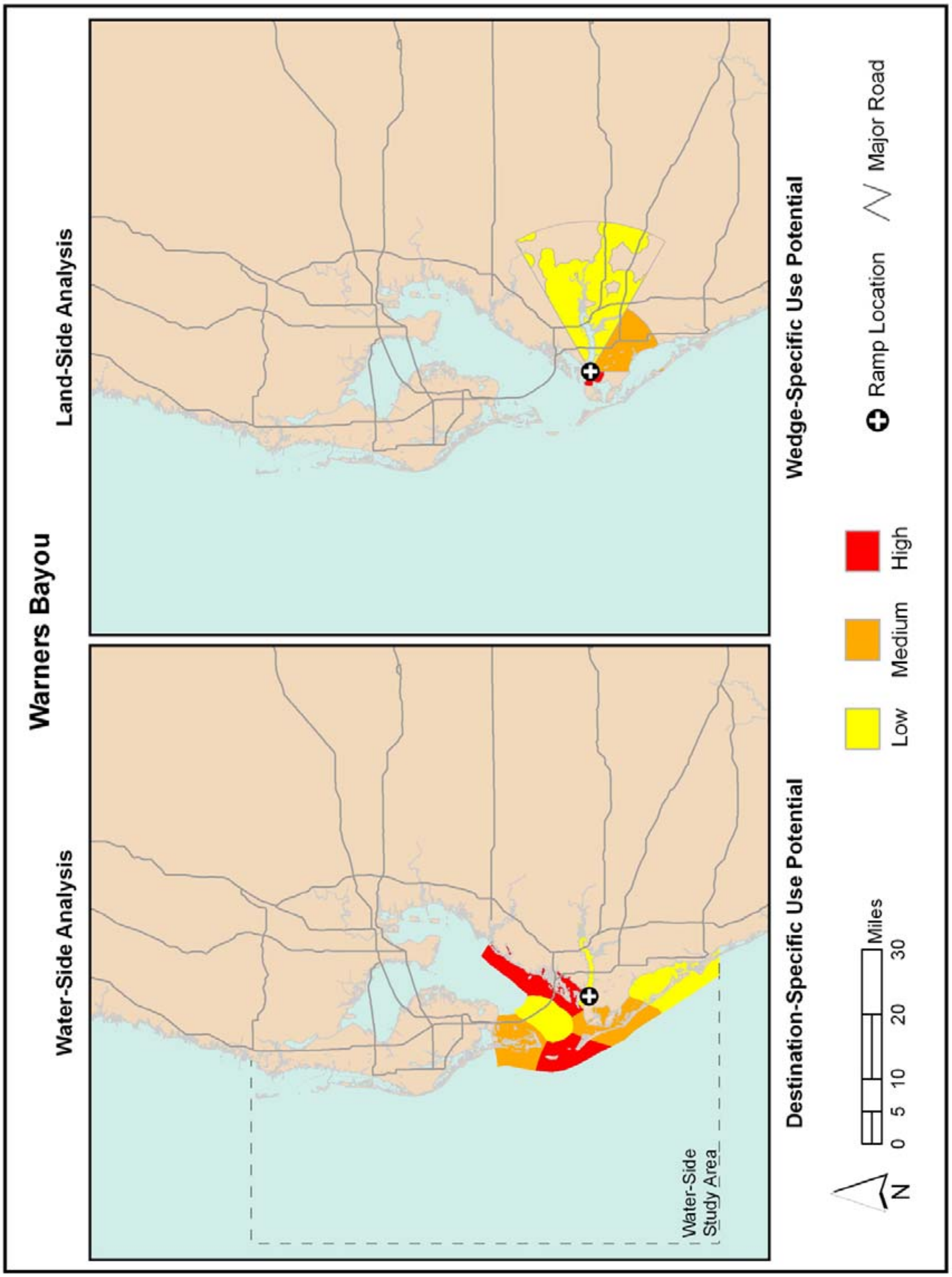
Map 23. Land and Water Use Analysis: Bishop Harbor.



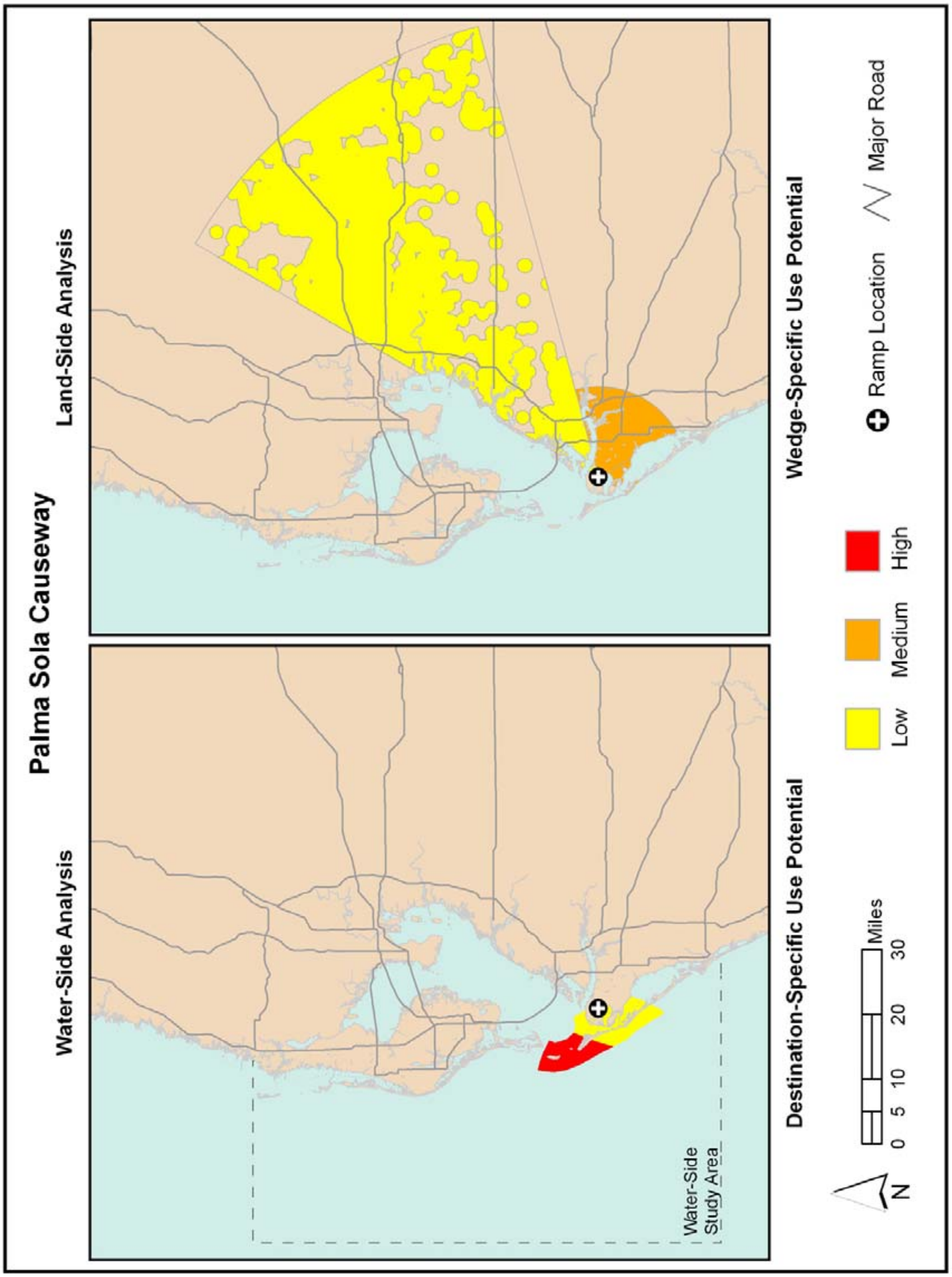
Map 24. Land and Water Use Analysis: Braden River.



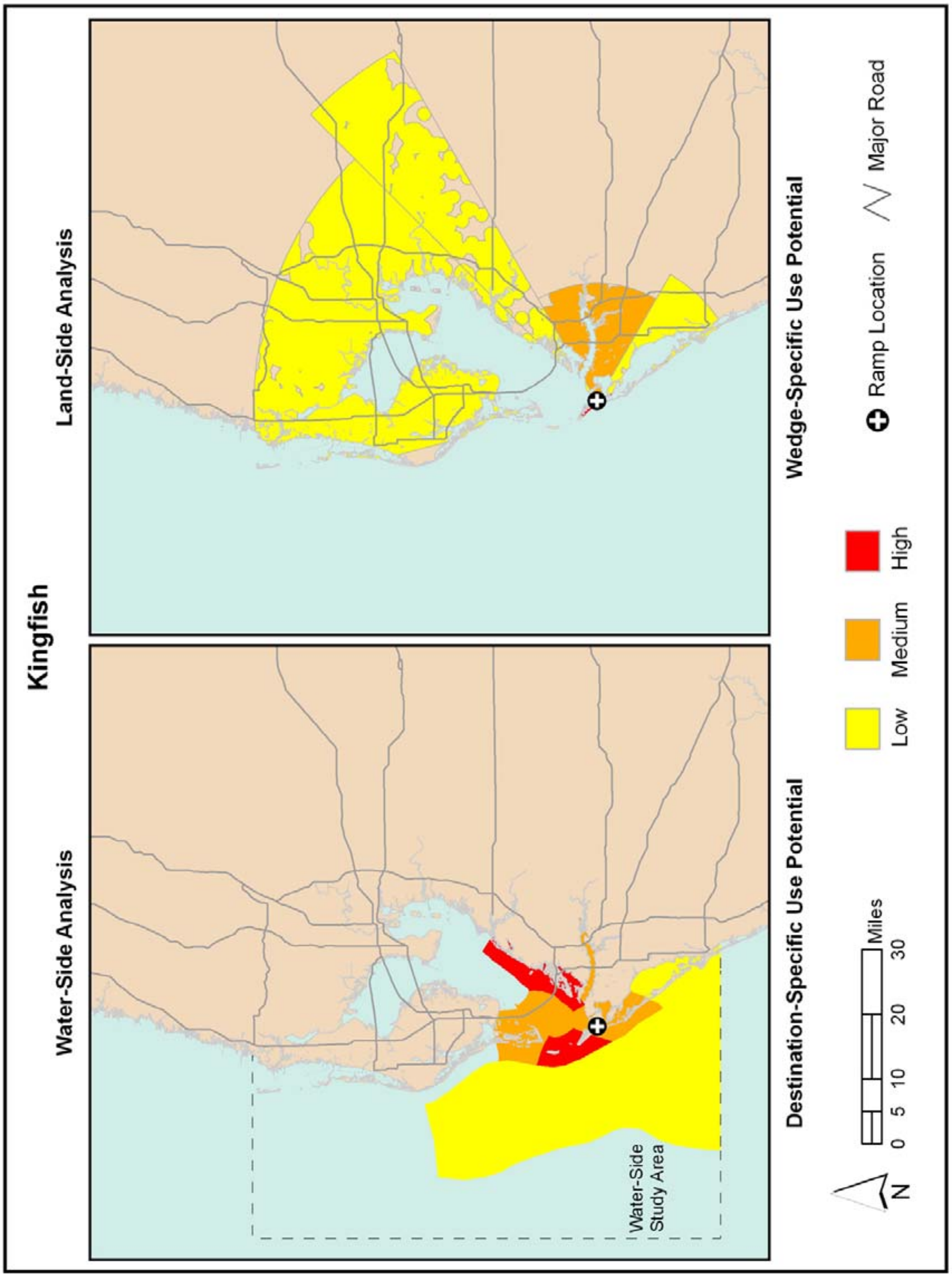
Map 25. Land and Water Use Analysis: Palmetto – Green Bridge.



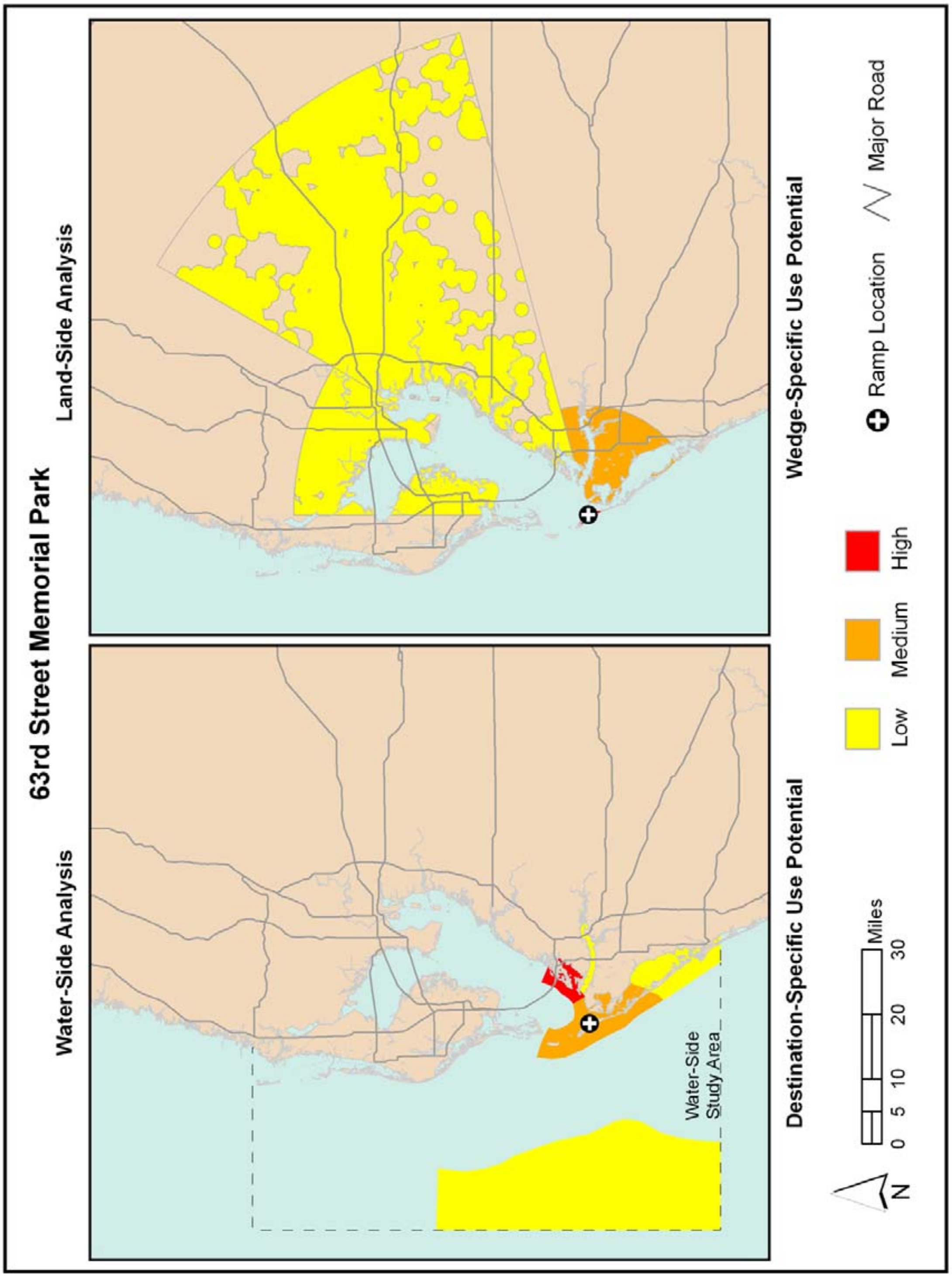
Map 26. Land and Water Use Analysis: Warners Bayou.



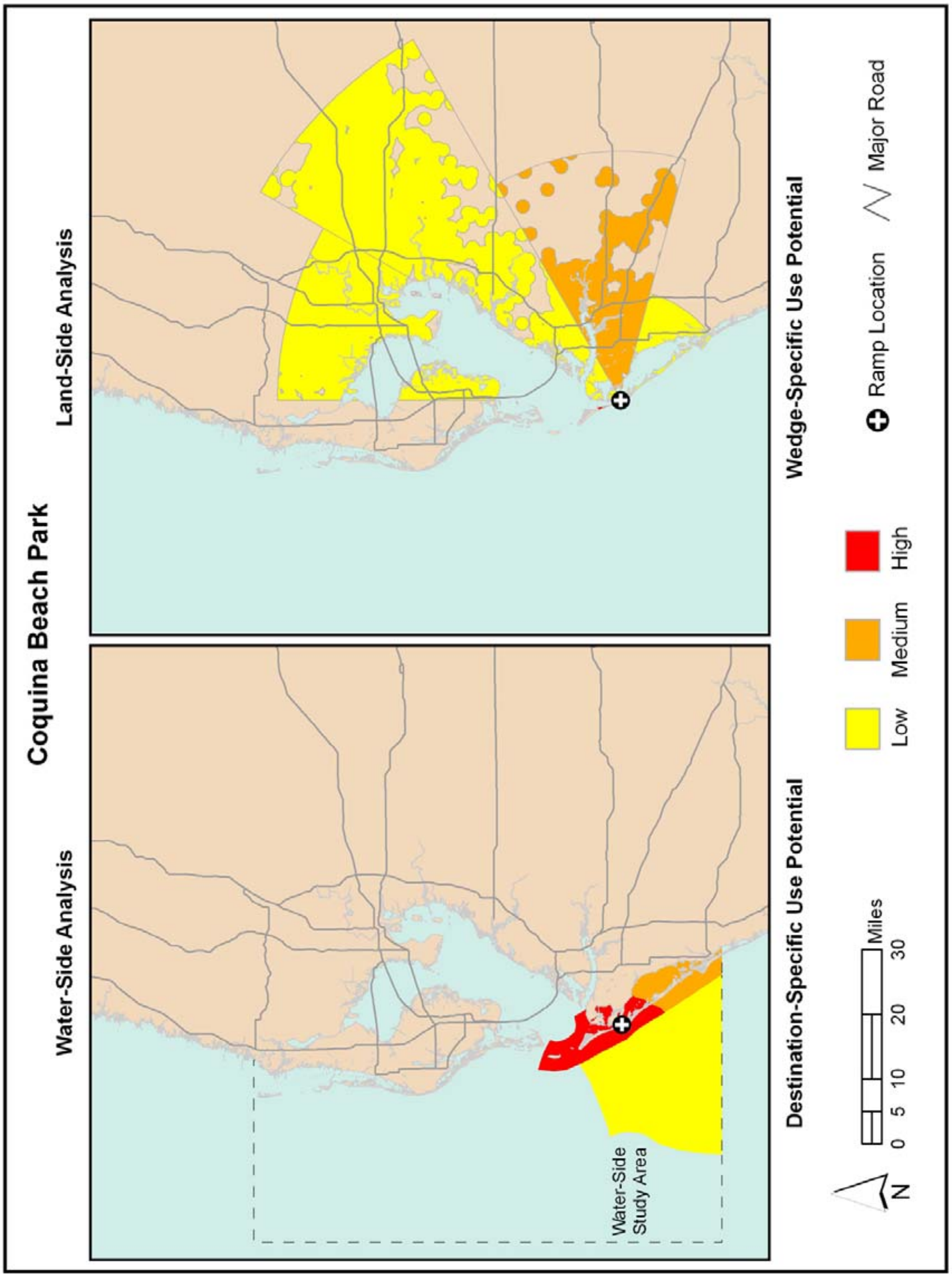
Map 27. Land and Water Use Analysis: Palma Sola Causeway.



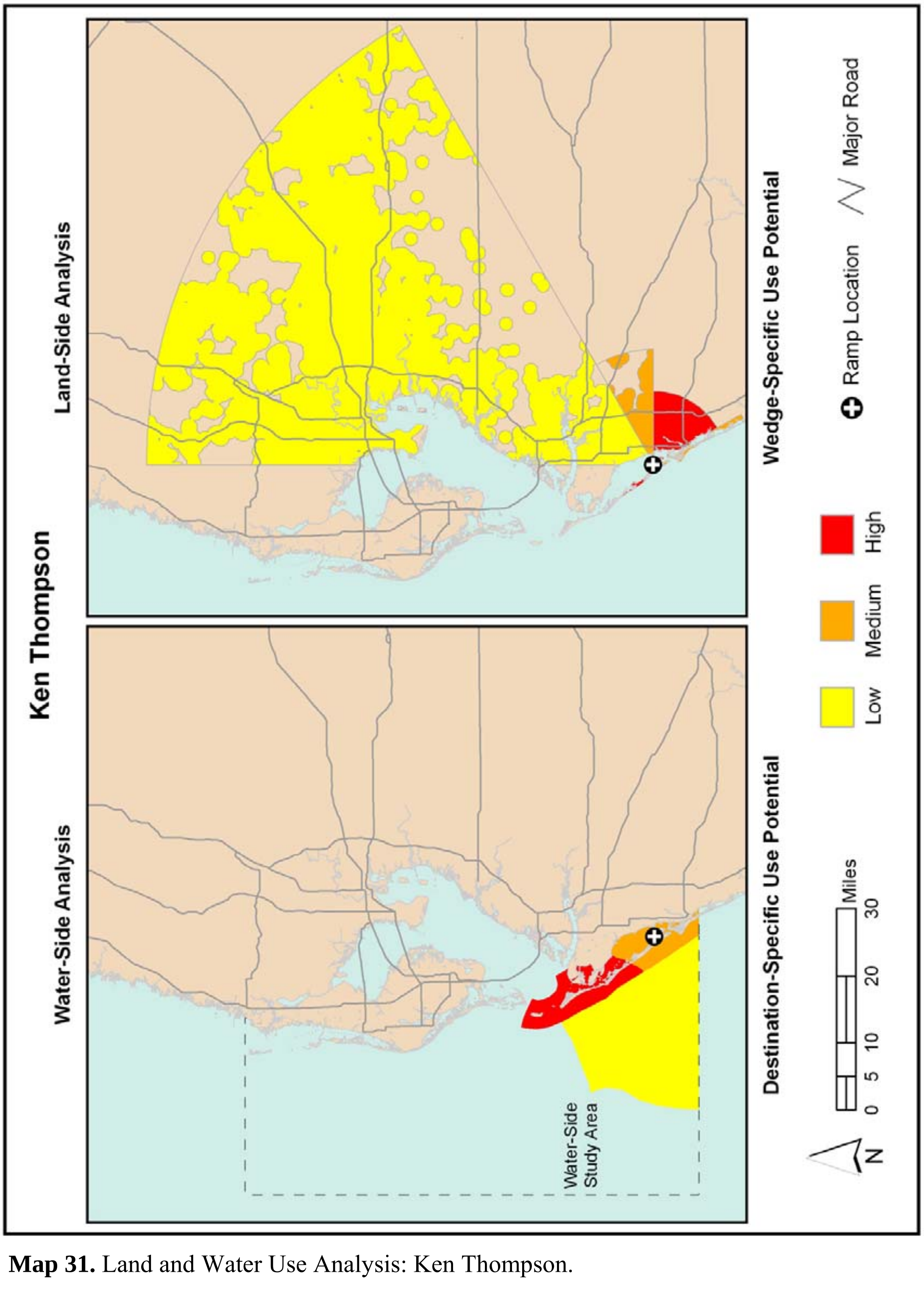
Map 28. Land and Water Use Analysis: Kingfish.



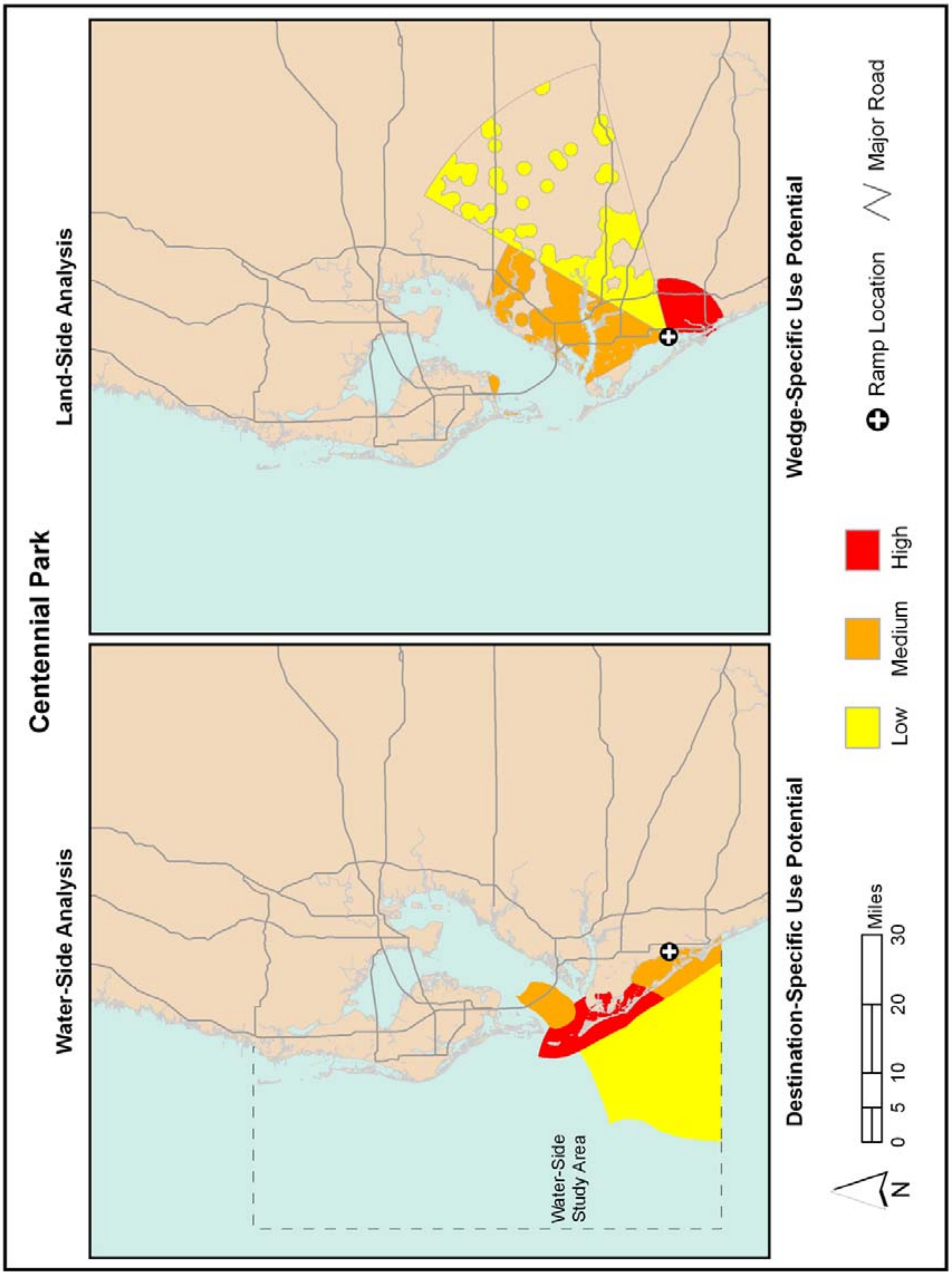
Map 29. Land and Water Use Analysis: 63rd Street Memorial Park.



Map 30. Land and Water Use Analysis: Coquina Beach.



Map 31. Land and Water Use Analysis: Ken Thompson.



Map 32. Land and Water Use Analysis: Centennial Park.

Chapter 6. USE INDICES FOR RAMPS

The following descriptive indices were developed to characterize the primary service area of ramps (PSA).

(a) Ramp Draw Potential Index
(b) Ramp Competition Index
(d) Wedge-Specific Use Potential Index

Ramp Draw Potential Index (RDPI)

A ramp draw potential index (RDPI) was developed to compare the size of a j-th primary service area associated with a given ramp to the size of the regional service area or RSA, by computing the following ratio

$$RDPI_j = \{ \sum_{i=1}^{m_j} \theta_{ij} \} / \lambda$$

where λ defines the total area associated with the regional service area (RSA). This index essentially describes the relative "reach" of a given PSA using the RSA's geographic area as a benchmark value. The greater the area of the PSA relative to the area of the RSA, the greater the geographic reach of the ramp's service area relative to the reach of a typical ramp found within the study region. This is a measure of relative spatial coverage. It can be used to identify and compare those ramps that draw use from local or regional boater populations/geographic areas.

Ramp Competition Index (RCI)

A ramp competition index (RCI) was developed to characterize substitutability vs. non-substitutability of ramps, or the competition between ramps to attract boaters from sectors within the RSA. The RCI index describes the relative number of boaters that use specific ramps from specific RSA sectors[3]. It is defined as the relative proportion of boaters launching from ramp j that are observed (i.e., VTRS mailing address was geocoded) within a specific RSA sector (see Figure 11 for RSA sectors). The index may be defined for any given ramp (j) and an r-th RSA sector (for r=1,… R=16 RSA sectors that are comprised of the n = 24 fifteen-degree pie wedges). Formally, this proportion may be expressed as

$$RCI_{rj} = o_{rj} \ / \ O_j$$

where o_{rj} is the number of boaters observed in an r-th RSA sector that launched from a j-th ramp, and O_j is the total number of boaters observed in an r-th RSA sector. This index can be used to determine which ramps are competing for boaters who reside in the same geographic area.

[3] A sector is an individual pie wedge or a combination of adjacent 15-degree pie wedges that comprise an RSA or PSA.

Wedge-Specific Use Potential (WSUP)

Each wedge within the PSA was assigned a weight to represent its relative contribution to the use of a given ramp per unit area (i.e., an index of ramp use originating from a given wedge or combination of adjacent wedges within the PSA). This weight is called the wedge specific use potential (WSUP) and was calculated as follows:

For a given ramp or Primary Service Area j, let p_{ij} denote the number of observed geocoded points/boaters in wedge i, and let θ_{ij} denote the area of wedge i that is known to contain a boating population (i.e., the estimated land-side area of a wedge as determined (1) by the spatial distribution of boaters observed using the ramp, and (2) by excluding areas where boaters do not reside, based on the geocoding of VTRS boater address information). The wedge-specific use-potential (WSUP) index may be defined as:

$$p_{ij}^* = \left\{ \left[p_{ij} / \sum_{i=1}^{m_j} p_{ij}\right] / \left[\theta_{ij} / \sum_{i=1}^{m_j} \theta_{ij}\right] \right\}$$

for i=1,… m_j wedges associated with a j-th ramp/PSA. The WSUP index was computed for each i-th wedge (i=1,…m_j) contained in each of the j=1,… k ramps/PSAs, and represents a use-intensity measure that is adjusted for area–the area adjusted proportion of users coming from a given wedge or combination of wedges (based on geocoded addresses) in the sample that were observed to use a j-th ramp. This index can be used to measure and compare the use potential derived from specific geographic areas (i.e., wedges) within each primary service area. In other words, it measures inter-wedge use variability standardized by area, by identifying where boaters are most and least likely coming from within a ramps primary service area.

Results

The extent to which ramps attract a local or more regional population of patrons is summarized by the ramp draw potential index (RDPI). A quartile analysis of RDPI values calculated for each ramp identified four RDPI breakpoints, color-coded in Table 5 according to those ramps determined to have negligible (gray), low (blue), moderate (white), and high (red) draw potential. Ramps that exhibited the greatest draw (i.e., attracted a regional patron population) include Ken Thompson, 63rd Street, Palmetto-Green Bridge, Bishop Harbor, Kingfish, Coquina Beach, Palma Sola Causeway, and Cockroach Bay. Ramps that had the lowest draw (i.e., attract a localized patron population) include Crisp Park, Sunlit Cove, Braden River, War Veterans Memorial Park, Demens Landing, and Bay Vista Park.

The degree to which individual ramps compete for spatially related boater populations (i.e., from boater populations within the same RSA wedges or sectors) is estimated by the ramp competition index (RCI). The four RCI categories were identified by a quartile analysis that ranked RCI values calculated for each ramp/RSA combination. The RCI index results are presented in Table 6 as a matrix that identifies which ramps (rows) draw or attract users from the same boater population areas, as defined geographically by RSA sectors (columns). The cells in Table 6 are color-coded according to those ramps that attracted a negligible (gray), low (blue), moderate (white), and high (red) proportion of users from specific RSA sectors. The results suggest that most ramps compete highly with four or more other ramps for patrons that reside in particular RSA sectors. For example, Anclote River, Maximo Park, Fort De Soto Park, Crisp Park, Gandy-St. Pete Side, and Courtney Campbell Causeway all attracted a high relative proportion of patrons from RSA sector 1 (refer to the first column in Table 6). There are only two instances where a ramp did not compete highly with another ramp for patrons in a particular RSA sector. The first instance is Domino in RSA sector 7; the second is 63rd Street Memorial Park in RSA sectors 13–20[4].

Table 5. Ramp Draw Potential Index.

Name	SQMiles	DPI	Quartile	Category
Anclote River	940	0.350	3	Moderate
Seminole St.	1016	0.378	3	Moderate
Belleair Beach Causeway	467	0.174	2	Low
War Veterans Memorial Park	66	0.025	1	Negligible
Jungle Prada	610	0.227	2	Low
Gulfport Marina	630	0.235	2	Low
Maximo Park	896	0.334	3	Moderate
Fort De Soto Park	1203	0.448	3	Moderate
Bay Vista Park	179	0.067	1	Negligible
Demens Landing	112	0.042	1	Negligible
Crisp Park	37	0.014	1	Negligible
Sunlit Cove	42	0.016	1	Negligible
Gandy - St. Pete Side	472	0.176	2	Low
Gandy - Tampa Side	699	0.260	3	Moderate
Courtney Campbell Causeway	498	0.185	2	Low
Williams Park	433	0.161	2	Low
E.G. Simmons Park	656	0.244	2	Low
Bahia Beach Marina	1087	0.405	3	Moderate
Shell Point Marina	827	0.308	3	Moderate
Domino	423	0.158	1	Negligible
Cockroach Bay	1249	0.465	4	High
Bishop Harbor	1572	0.585	4	High
Braden River	83	0.031	1	Negligible
Palmetto – Green Bridge	1677	0.625	4	High
Warners Bayou	201	0.075	1	Negligible
Palma Sola Causeway	1275	0.475	4	High
Kingfish	1386	0.516	4	High
63rd St. Memorial Park	1705	0.635	4	High
Coquina Beach	1378	0.513	4	High
Ken Thompson	2149	0.800	4	High
Centennial Park	482	0.180	2	Low

[4] Note that the wedge-specific-use-potential is mapped for each ramp in the previous section.

Table 6. Ramp Competition Index.

Ramp Name	Regional Service Area Sectors															
	1	2	3	4	5	6	7	8-9	10	11	12	13-20	21	22	23	24
Anclote River	0.178	0.197	0.080	0.032	0.003								0.020	0.008	0.015	0.385
Seminole St.	0.059	0.067	0.012	0.011	0.026									0.011	0.198	0.141
Belleair Beach Causeway	0.030	0.017	0.012	0.007									0.020	0.176	0.147	0.031
War Veterans Memorial Park	0.020	0.025	0.019	0.007	0.010							0.045	0.160	0.299	0.154	0.026
Jungle Prada	0.005	0.013	0.012	0.014						0.003		0.045	0.180	0.184	0.084	0.047
Gulfport Marina	0.015	0.021	0.031	0.004	0.003								0.460	0.142	0.103	0.031
Maximo Park	0.064	0.067	0.031	0.039	0.020				0.009	0.003		0.136	0.080	0.038	0.084	0.089
Fort De Soto Park	0.079	0.076	0.086	0.043	0.049			0.018		0.003		0.091	0.020	0.027	0.081	0.047
Bay Vista Park	0.020	0.042	0.019	0.004	0.003			0.018					0.020	0.034	0.015	0.010
Demens Landing	0.040			0.004	0.003									0.008	0.015	0.010
Crisp Park	0.069	0.034	0.006	0.004	0.003									0.015	0.015	0.063
Sunlit Cove	0.035	0.004												0.004	0.015	0.036
Gandy - St. Pete Side	0.035	0.017	0.049	0.011	0.010									0.011	0.015	0.021
Gandy - Tampa Side	0.163	0.139	0.148	0.032	0.010					0.003	0.010			0.019	0.018	0.021
Courtney Campbell Causeway	0.084	0.055	0.037	0.021	0.007								0.020		0.026	0.005
Williams Park		0.008	0.037	0.018	0.039							0.045		0.004	0.004	
E.G. Simmons Park	0.010	0.017	0.056	0.107	0.095	0.096	0.150		0.009	0.003						
Bahia Beach Marina	0.005	0.025	0.037	0.093	0.089	0.077	0.150		0.009							
Shell Point Marina	0.010	0.025	0.037	0.107	0.075	0.115	0.050			0.003						
Domino		0.013	0.025	0.032	0.010	0.385	0.450			0.006	0.005					
Cockroach Bay	0.010	0.017	0.136	0.142	0.118	0.154	0.050	0.018	0.019		0.005			0.008		
Bishop Harbor	0.015	0.017	0.025	0.085	0.121	0.058		0.127	0.046	0.012	0.010			0.004		
Braden River			0.006	0.004	0.007			0.182	0.259	0.078	0.019				0.004	
Palmetto – Green Bridge			0.012	0.032	0.062		0.100	0.218	0.185	0.099	0.014	0.045		0.008	0.004	0.016
Warners Bayou	0.005	0.004			0.010			0.200	0.111	0.069	0.264	0.045				
Palma Sola Causeway			0.006	0.018	0.016			0.055	0.074	0.093	0.250	0.045				0.005
Kingfish	0.005	0.029	0.006	0.039	0.062	0.058	0.050	0.091	0.120	0.078	0.183	0.136	0.020			0.010
63rd St. Memorial Park	0.020	0.029	0.037	0.039	0.036	0.019			0.037	0.045	0.067	0.273			0.004	
Coquina Beach	0.015	0.038	0.031	0.046	0.102	0.038		0.036	0.037	0.063	0.130	0.091			0.004	
Ken Thompson		0.004	0.006	0.004	0.003			0.018	0.065	0.250	0.019					0.005
Centennial Park	0.010			0.004	0.007			0.018	0.019	0.187	0.024					

Quartile Categories: Negligible (Gray); Low (Blue); Moderate (White); High (Red).

Chapter 7. USE INDICES FOR DESTINATION REGIONS

A series of descriptive indices were developed to describe the distribution and concentration of on-water boating destinations within the n=20 specific destination regions (SDR). The indices are described below.

(a) Destination Draw Potential Index.
(b) Destination Use Concentration Index
(c) Destination-Specific Use Potential Index

Destination Draw Potential Index (DDPI)

The destination draw potential index (DDPI) compares use within a given SDR to the overall use observed in all 20 SDRs (Figure 10). It is defined as the total number of boater destinations from the sample observed in a given SDR (p_r) divided by the total number of boater destinations from the sample observed in all SDRs. The index may be expressed as

$$DDPI_r = p_r \,/\, [\, \sum_{r=1}^{R} p_r \,].$$

The DDPI index is computed for each of r=1,… R=20 specific destination regions. The DDPI can be used to identify those SDRs that received the greatest relative proportion of overall ramp use, and those that attracted proportionately few ramp users.

Destination Use Concentration Index (DUCI)

The destination use concentration index (DUCI) describes the number of boaters that use various SDR's from a given ramp. It is defined as the proportion of boaters launching from ramp j that reported destinations within an SDR. The index may be defined for any given ramp (j) and an r-th SDR (for r=1,… R=20 destination regions). Formally, this ratio may be expressed as

$$DUCI_{rj} = p_{rj} \,/\, P_j \,,$$

where p_{rj} is the number of boaters in the sample that reported destinations in an r-th SDR that originated from a j-th ramp, and P_j is the total number of boaters in the sample that launched from ramp j. This index identifies the degree to which a ramp disperses boating use among destination regions.

Destination-Specific Use-Potential (DSUP)

The destination-specific use-potential (DSUP) index is defined as the destination use concentration (DUCI) for a given ramp, divided by the ratio of the area associated with an individual SDR (ϕ_r) in comparison to the area associated with all SDRs in the study region (i.e., the sum of all the ϕ_r values). Essentially, it is the water-side equivalent of the WSUP index. The DSUP may be defined, for an r-th destination region and a j-th ramp/PSA, as

$$DSUP_{rj} = DUCI_{rj} \;/\; [\, \phi_r \,/\, \sum_{r=1} \phi_r \,]$$

where,

$$DUCI_{rj} = p_{rj} \;/\; P_j \,,$$

and p_{rj} is the number of boaters from the sample that reported destinations in an r-th SDR that originated from a j-th ramp, and P_j is the total number of boaters from the sample that launched from ramp j.

The DSUP index characterizes the impact that a j-th ramp/PSA has on a specific destination region. DSUP indices were calculated to describe the relative use contribution that each ramp/ PSA has on each of the R=20 SDR, adjusting for the size (i.e., area in square miles) of the SDRs. This index measures the extent to which destination zones are absorbing boating use from ramps standardized by the area of the destination zones. This index controls for area because destination zones vary considerably in size.

Note that if the relative values of the $DDPI_{rj}$, $DUCI_{rj}$, and $DSUP_{rj}$ indices are all large for a given j-th ramp/PSA and a given destination region r, then it can be said that that ramp/PSA has a great impact on the overall use of that specific destination region.

Results

This section presents the results of a descriptive analysis that ranked and compared ramp use that is absorbed by SDR (i.e., draw potential, use concentration, destination specific use potential). The destination draw potential index (DDPI) analysis identified those SDR that attracted the lowest or greatest proportion of boaters from area ramps (Table 7; Figure 12). The DDPI, is based on a quartile analysis and is color-coded according to those SDR that exhibited negligible (gray), low (blue), moderate (white), and high (red) draw potential. Specific destination regions determined to have the highest draw potential include SDR 12, 13, 15, 16, and 17; those that experienced negligible draw potential include SDR 1, 2, 3, 7, 9, 18, and 19. Low to moderate draw potential was calculated for SDR 4, 5, 6, 8, 9, 10, 11, 14, and 20 (Figure 12).

Table 7. Specific Destination Region Draw Potential Index.

SDR*	DPI	Quartile	Category
1	0.018	1	Negligible
2	0.019	1	Negligible
3	0.019	1	Negligible
4	0.020	2	Low
5	0.051	3	Moderate
6	0.040	3	Moderate
7	0.018	1	Negligible
8	0.032	2	Low
9	0.053	3	Moderate
10	0.038	2	Low
11	0.025	2	Low
12	0.109	4	High
13	0.084	4	High
14	0.058	3	Moderate
15	0.109	4	High
16	0.082	4	High
17	0.115	4	High
18	0.017	1	Negligible
19	0.016	1	Negligible
20	0.046	3	Moderate

* SDR are defined in Figure 10. SDR draw potential is mapped in Figure 12.

Destination use concentration and destination specific use potential results are shown as matrices with ramps presented in rows and SDR in columns. The destination use concentration index (DUCI) measures the degree to which individual ramps concentrate use within SDR. The DUCI, highlighted in Table 8, is color-coded according to quartiles that identify those ramp/SDR combinations that direct/receive negligible (gray), low (blue), moderate (white), and high (red) use concentration. For example, some ramps (e.g., Gulfport Marina, Williams Park, E.G. Simmons) distributed use across many SDR, while others concentrated use within one or several SDR (e.g., Gandy-St. Pete Side, Sunlit Cove, Bishop Harbor, Ken Thompson, Palma Sola Causeway).

The destination-specific use-potential (DSUP) index is the DUCI index, adjusted for the relative area of the SDR. The DSUP values highlighted in Table 11 are color-coded according to quartiles that identify those SDR that receive negligible (gray), low (blue), moderate (white), and high (red) relative use intensity from individual ramps. For example, SDR 18 (Figure 10)–the Manatee River–experiences a high relative density of use from the Braden River, Palmetto–Green Bridge, and Warners Bayou ramps; SDR 20 receives a high relative density of use from the Centennial Park, moderate relative density from the Ken Thompson, and low relative density from the Kingfish ramp.

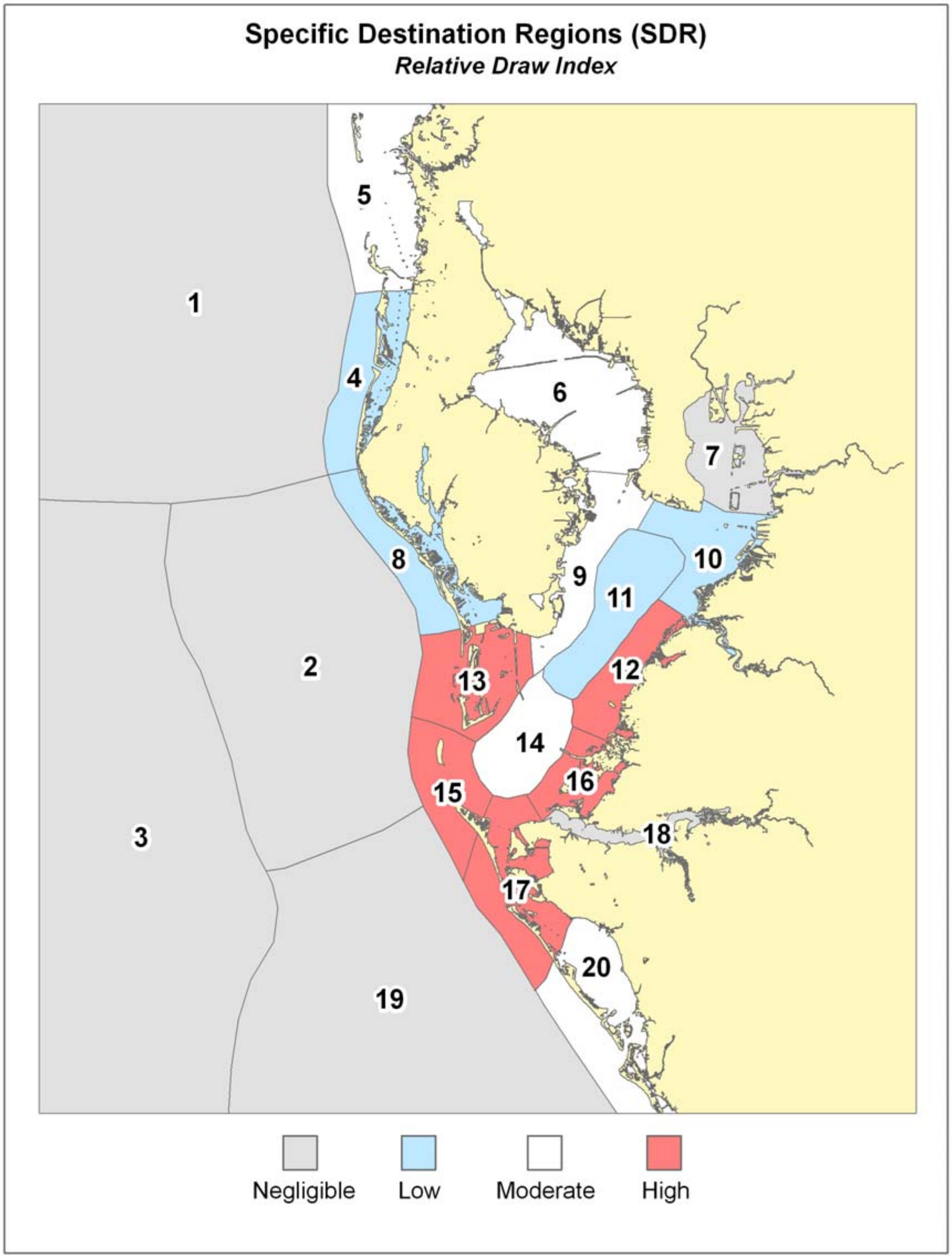


Figure 12. Specific Destination Region Draw Potential Index Mapped.

Table 8. Specific Destination Region Use Concentration Index.

Ramp Name	Specific Destination Regions (SDR)																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Anclote River	0.15			0.05	0.8															
Seminole St.	0.254			0.254	0.451								0.042							
Belleair Beach Causeway	0.19			0.328	0.483															
War Veterans Memorial Park	0.027	0.306	0.081	0.036				0.324					0.117		0.108					
Jungle Prada		0.296	0.056					0.315					0.278		0.056					
Gulfport Marina		0.045	0.08					0.182	0.045		0.068	0.034	0.25	0.114	0.182					
Maximo Park		0.093						0.02	0.033		0.026	0.026	0.404	0.152	0.166	0.04	0.04			
Fort De Soto Park		0.183	0.095						0.024		0.024	0.018	0.302	0.112	0.243					
Bay Vista Park									0.238				0.286	0.333	0.143					
Demens Landing									0.375				0.375		0.25					
Crisp Park						0.147			0.676				0.088		0.088					
Sunlit Cove									1.00											
Gandy - St. Pete Side									1.00											
Gandy - Tampa Side						0.387	0.033		0.307	0.047	0.04	0.027	0.047	0.04	0.047		0.027			
Courtney Campbell Causeway						0.879			0.121											
Williams Park							0.306		0.059	0.318	0.094	0.071		0.047		0.059	0.047			
E.G. Simmons Park							0.073			0.195	0.134	0.402		0.073	0.049	0.073				
Bahia Beach Marina										0.089	0.089	0.571		0.125	0.071	0.054				
Shell Point Marina										0.24	0.038		0.5	0.077	0.096	0.048				
Domino										0.444		0.556								
Cockroach Bay		0.02							0.046	0.034	0.081	0.55	0.027	0.094	0.04	0.114				
Bishop Harbor												0.489		0.085		0.426				
Braden River														0.125	0.313	0.208	0.208	0.146		
Palmetto – Green Bridge												0.043	0.043	0.043	0.128	0.372	0.16	0.181		0.032
Warners Bayou												0.045		0.105	0.12	0.496	0.165	0.068		
Palma Sola Causeway															0.211		0.789			
Kingfish		0.037										0.018	0.024	0.03	0.177	0.091	0.512	0.018	0.024	0.067
63rd St. Memorial Park			0.041												0.243	0.176	0.419	0.041		0.081
Coquina Beach															0.235		0.576		0.129	0.059
Ken Thompson															0.086		0.241		0.069	0.603
Centennial Park														0.031	0.051		0.235		0.163	0.52

Quartile Categories: Negligible (Gray); Low (Blue); Moderate (White); High (Red

Table 9. Destination Specific Use Potential Index.

Ramp Name	Specific Destination Regions (SDR)																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Anclote River	1.185			4.878	17.498															
Seminole St.	1.778			21.951				0.720					0.792		0.531					0.376
Belleair Beach Causeway	1.086			23.171									0.264							
War Veterans Memorial Park	0.296	2.058	0.880	4.878				25.929					3.434		3.186					
Jungle Prada		0.968	0.293	1.220				12.244					3.962	0.466	0.797					
Gulfport Marina		0.242	0.685	2.439				11.524	1.825		5.175	0.942	5.811	4.661	4.249		0.189			
Maximo Park		0.847		1.220		0.305		2.161	2.282		3.450	1.255	16.114	10.720	6.638	3.820	1.132	4.492		
Fort De Soto Park	0.099	1.876	1.565	1.220		0.305		1.441	1.825		3.450	0.942	13.472	8.855	10.887	0.637	0.377	4.492		0.753
Bay Vista Park		0.121							2.282		0.863	0.314	1.585	3.262	0.797					
Demens Landing									1.369		0.863		0.792	0.466	0.531					
Crisp Park						1.523	1.476	1.441	10.497			0.628	0.792		0.797		0.189			
Sunlit Cove									5.933											
Gandy - St. Pete Side						0.609			4.564											
Gandy - Tampa Side						17.667	7.379		20.993	4.754	5.175	1.255	1.849	2.796	1.859	1.273	0.755			
Courtney Campbell Causeway						8.833	2.952		1.825	1.358					0.266					
Williams Park		0.121	0.098			0.609	38.371		2.282	18.336	6.900	1.883	0.528	1.864	0.531	3.183	0.755			
E.G. Simmons Park							8.855		0.456	10.866	9.488	10.358	0.528	2.796	1.062	3.820				
Bahia Beach Marina		0.121	0.098				2.952	0.720	0.456	3.396	4.313	10.044	0.264	3.262	1.062	1.910	0.189			0.376
Shell Point Marina							2.952		0.456	16.978	3.450	16.321	0.264	3.729	2.655	3.183	0.377			
Domino										5.433		3.139		0.466	0.531					
Cockroach Bay		0.182							2.738	3.396	10.350	25.738	1.057	6.525	1.593	10.823	0.189			
Bishop Harbor												7.219	0.264	1.864	0.531	12.732				
Braden River													0.528	2.796	3.983	6.366	1.886	31.447		
Palmetto – Green Bridge		0.061	0.098									1.255	1.057	1.864	3.186	22.282	2.830	76.370	0.357	1.129
Warners Bayou		0.061										1.883	0.264	6.525	4.249	42.017	4.150	40.431		
Palma Sola Causeway															1.062		2.830	4.492		
Kingfish		0.363	0.098									0.942	1.057	2.330	7.700	9.549	15.846	13.477	0.713	4.141
63rd St. Memorial Park		0.121	0.293									0.628			4.780	8.276	5.848	13.477	0.357	2.259
Coquina Beach		0.121	0.196										0.264	0.466	5.311		9.244		1.961	1.882
Ken Thompson															1.328		2.641		0.713	13.175
Centennial Park			0.196						0.456					1.398	1.328		4.339		2.853	19.198

Quartile Categories: Negligible (Gray); Low (Blue); Moderate (White); High (Red).

Chapter 8. CELL-BASED PRIMARY SERVICE AREA OPTIMIZATION

Introduction

This chapter presents a cell-based spatial filtering analysis to (1) estimate ramp patronage; (2) optimize pie-wedge derived Primary Service Area (PSA) boundaries; and (3) generate estimates of spatial launch-demand for the Cockroach Bay ramp. Ramp patron information has been documented for a one-year period (2002 – 2003) for the Cockroach Bay ramp that assured a large sample size of patrons, making it an ideal case study for advancing the pie-wedge derived market area delineation application.

The pie-wedge casting approach documented in this report provides a theoretical and statistical framework to estimate threshold travel distances to (1) delineate a ramp's PSA, and (2) expose directional variability in a ramp's draw potential within a ramp's PSA. The wedge specific use potential (WSUP) index highlights "inter-wedge" variability in ramp use: how use is distributed across the wedges that comprise the PSA. However, the intensity of ramp use does not necessarily conform to pie-wedge boundaries, since external demand clusters may be found at locations that lie just outside the PSA boundary (a spillover demand that may not fully or adequately be captured by the distance-decay function) or in pockets or enclaves that are well beyond the estimated average threshold distances.

Clusters of ramp patrons located beyond the wedge-based PSA boundary might comprise an important part of a ramp's market area and, therefore, should be evaluated. If a significant demand cluster is found to exist just outside the PSA, the PSA's outer boundary may be extended to encompass that cluster. This would involve annexing the cluster. It is also conceivable to delineate a portion of a PSA that is disconnected; such as cases involving influential demand clusters or enclaves located at a distance that is substantially beyond a PSA's demarcated boundary. In cases involving discontinuities in demand, a separate and isolated segment of the PSA may also be identified in a localized area or enclave that is non-adjacent and disconnected from that portion of the PSA that is in close proximity to the ramp itself.

In some instances, estimated threshold distances for wedges that define the outer boundaries of the PSA can be overstated due to the combined impact of a small sample size and the presence of one or more distant outliers that draw the wedge outward. In light of these concerns, the size, shape, and geographic reach of a ramp's PSA along a given direction may be optimized[5] to account for distortions in the wedge-based PSA boundaries that may arise due to fringe or external demand clusters, small samples size, and/or the presence of outliers.

Estimating Ramp Patronage

To estimate spatial variability in use and demand and to optimize PSA boundaries a 2.5-square-mile grid was superimposed over the state of Florida. First, a GIS point-in-polygon operation calculated the number of observed ramp patron geocoded addresses that fell within each j-th 2.5-

[5] Optimizing refers to finding the best representative geographic depiction of the predominant service area.

square-mile grid cell. Proportionate use was then calculated for each j-th cell of a k-th ramp–where k = Cockroach Bay–by taking the total number of sample points (i.e., observed ramp patron geocoded addresses) that fell within that cell and dividing it by the total number of vessels registered to boat owners (i.e., VTRS records) that also geocoded within that cell.

Second, use estimates were derived for 2.5-square-mile cells that contained VTRS records but no observed ramp patrons. This was accomplished by taking the local average of proportionate use in neighboring cells, defined as those cells that share a common border with the cell in question. The estimated local proportionate use average $u_{j(k)}$ calculated for each cell that did not contain a ramp patron observation was then multiplied by the number of VTRS records geocoded to that cell to obtain a "patron-count estimate," rounded to the nearest integer value (Figure 13).

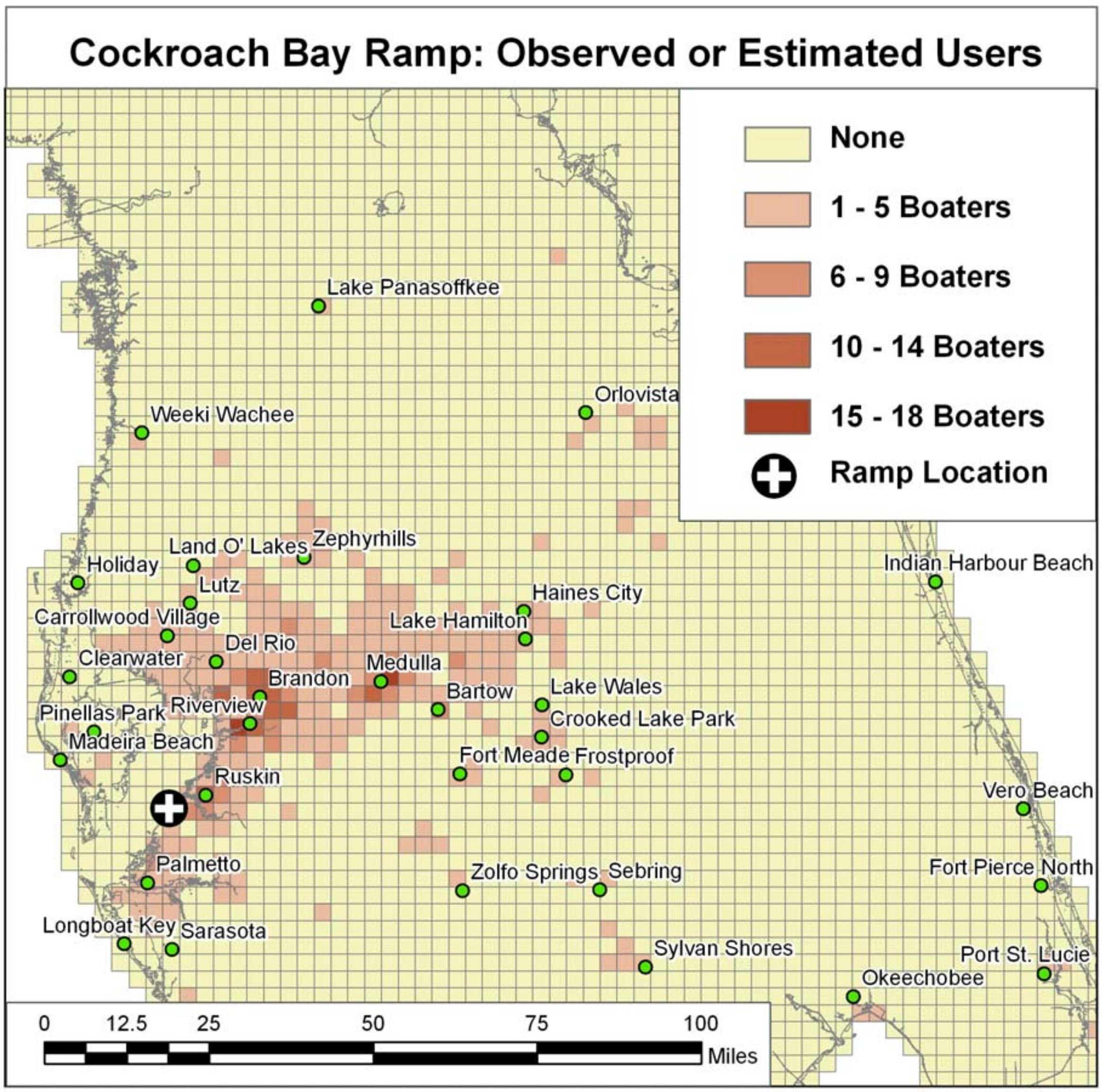


Figure 13. Spatial Distribution of Observed or Estimated Ramp Patrons.

The use probability $p_{j(k)}$ of a k-th ramp user $u_{j(k)}$ coming from a given cell was then calculated by dividing a cell's observed or patron-count estimate by the sum of patron-count estimates for the $j=1\ldots m_k$ cells within the wedge-derived PSA:

$$p_{j(k)} = [\, u_{j(k)} * VTRS_j \,] \;/\; [\, \sum_{j=1}^{m_k} u_{j(k)} * VTRS_j \,] .$$

Use probability values define the likelihood that ramp patronage comes from a given grid cell (or geographic location) within the PSA based on observed or estimated use counts. Use probability values are used later to derive estimates of launch demand. Note that division by the sum of patron-counts for all cells contained within the PSA will ensure that the use probability estimates of a k-th ramp will sum to one:

$$\sum_{j}^{m_k} p_{j(k)} = 1 .$$

Optimizing the PSA Boundary

A cell-based spatial-filter approach was developed to fine-tune the market area boundary that may have been over- or under-estimated within some wedges due to outlying sample observations and/or small sample bias. Observed and estimated patronage use-counts within the wedge-derived PSA for Cockroach Bay were compared to those outside the PSA. This involved calculating the average observed or estimated ramp patronage totals for all cells within and outside the PSA. A 3x3 floating spatial filter (composed of nine cells) was centered about each of the 288 cells that comprised the PSA and all cells located outside the PSA that contained at least one observed or estimated patron. An average patron count for each 3x3 floating "window" was calculated by dividing the total number of observed or estimated patron counts within the window cast about the target cell by nine. The average patron estimates for all cells within the PSA were then used to compute the average use-estimate for each floating 3x3 window and a 95% confidence interval associated with that average use-estimate.

The average use-estimate for cells comprising the Cockroach Bay PSA was found to be 1.79 patrons, with a standard deviation of 2.28 patrons, and a range of 10.33 patrons. The 95% confidence interval for the average patron count was 1.52 to 2.05. The lower limit of the 95% confidence interval was then used as the cut-off point to identify those cells within and outside the PSA where the estimated patron count exceeded the average. For example, any cell internal or external to the PSA with an average 3x3 floating window use count that was equal to or greater than 1.52 users qualified as a significant contributor to ramp patronage. The analysis for Cockroach Bay revealed several cells/clusters of cells located on the fringe of the PSA that qualified as significant contributors to ramp patronage. These cells can be thought of as having a spatial concentration of boaters that use the Cockroach Bay ramp, one that is not dissimilar from the average patronage found within the PSA (Figure 14).

A similar logic was employed to eliminate cells within the PSA that did not significantly contribute to Cockroach Bay ramp use; cells with an average patron count that was below the 1.52

patron threshold value. Though some cells (or clusters of cells) may have low average use values by themselves, they may collectively contribute to a significant overall demand for the ramp within the PSA. Nonetheless, a strong argument can be made for their elimination if these cells (or clusters of cells) are associated with portions of the PSA whose outer boundary is likely to have been distorted due to the effects of small sample size within a wedge, absence of VTRS boats, or the presence of outliers. For example, the pie wedge at 4:00 (Figure 14) is a prime example of overshoot due to the small number of overall users and clumps of distant outliers in the towns of Sebring, Sylvan Shores, Okeechobee and Port St. Lucie (as visible in Figure 13). Note that Pinellas county users are also filtered out through the optimization process (Figure 14).

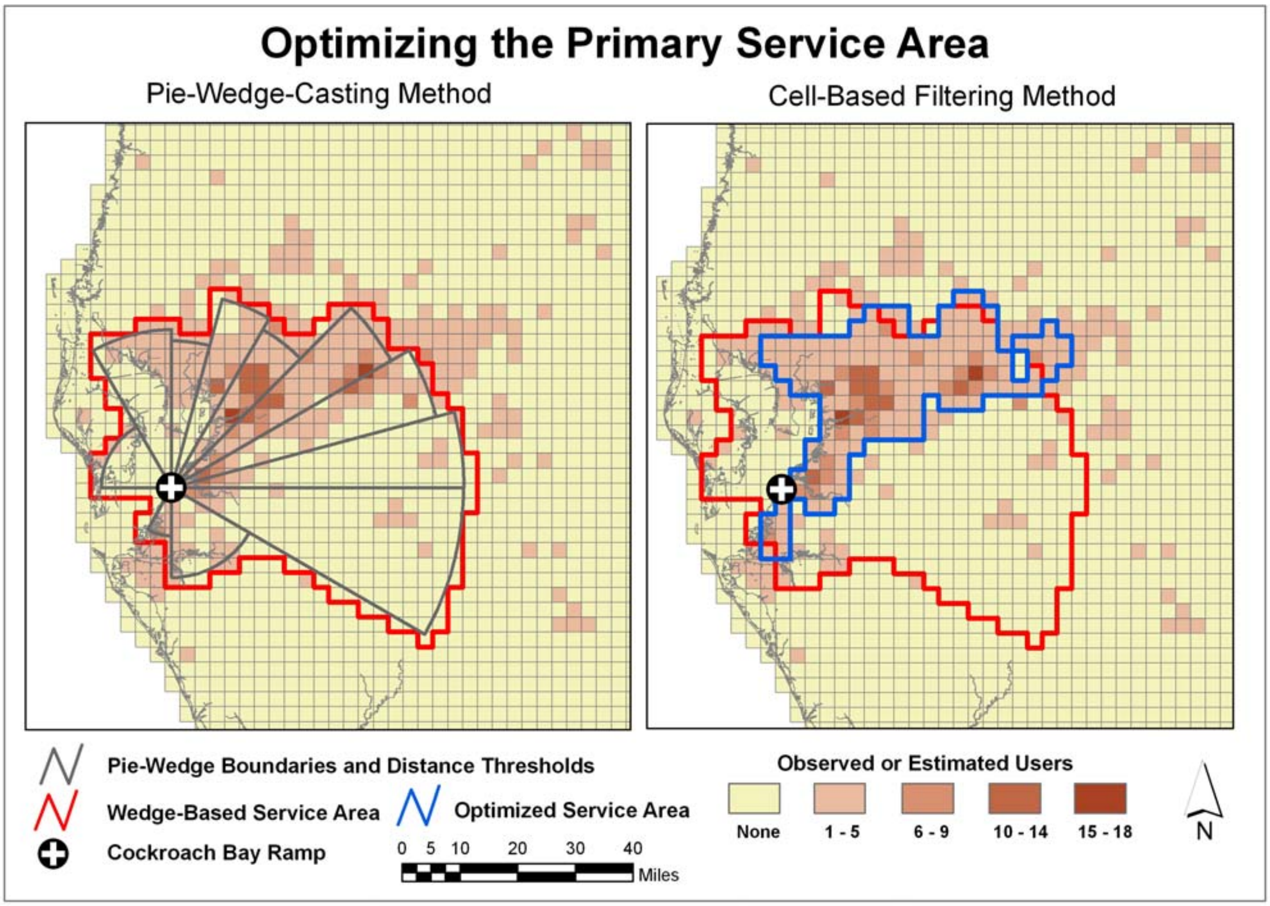


Figure 14. Comparison of Pie-Wedge and Optimized PSA Delineation Results.

Estimating Launch Demand

Use probability values generated for cells that comprise the "optimized" PSA can be used to estimate Cockroach Bay launch demand over the course of a boating year. Suppose that B_w represents the average number of launches from a given ramp on typical weekend day (***w***) and B_{nw} represents the average number of launches from the same ramp on typical non-weekend day (***nw***). The estimated total number of launches (B^*_T) from that ramp during a given year-long boating period may thus be defined as

$$B^*_T = [\, B_w \cdot \boldsymbol{w} \,] + [\, B_{nw} \cdot \boldsymbol{nw}],$$

where ***w*** is the total number of weekend days and ***nw*** is the total number of non-weekend days in the year. The spatial distribution of launch demand may be found by apportioning the total number of launches B^*_T of a specific ramp across various 2.5 square mile cells that comprise the PSA based on estimated use probabilities. In other words, an estimate of launch demand originating from a particular j-th cell (using a k-th ramp) may be obtained by multiplying B^*_T by the estimated use probability values. This is a way of allocating demand over various locations based on estimated use probability. Hence, a 2.5 square-mile cell-specific estimate of demand ($D_{j(k)}$) may be formally expressed as

$$D_{j(k)} = B^*_T \cdot p_{j(k)}.$$

Weekend and weekday launch estimates for Cockroach Bay were determined from an inventory of vessel trailers observed on n = 158 randomly selected dates spanning the period of December 2002–December 2003. Field surveys reflected those times when trailer counts were likely to be at their maximum (e.g. around 12 noon). It was estimated that 47.1 boats on average were launched during a typical weekend day based on a sample of n=45 weekend days. The 95% confidence interval for the average number of weekend boats launched is 41.2 to 52.9. The observed median number of boats launched on a weekend was 50.

It was estimated that 19.9 boats on average were launched on a typical weekday based on a sample of n=113 weekdays. The 95% confidence interval for the average number of weekday boat launches is 18.0 to 21.8. The observed median number of boat launches for a typical weekday was 19. Using the median values, the total number of weekend launches was estimated to be 5,200 (104 weekend days), and the total number of weekday launches was estimated to be 4,959 (261 weekdays) over the course of the year. Weekday and weekend estimates summed to 10,159 vessels launched from the Cockroach bay ramp. Since the primary service area (PSA) contains approximately 80% of the market area the estimated total demand within the PSA for a given year is .80 x 10,159 = 8,127 (rounding to the nearest integer value). The estimated yearly launch demand for individual 2.5 square mile cells that fall within the wedge derived and optimized Cockroach Bay PSA is calculated by multiplying use probability values by 8,127 (Figure 15).

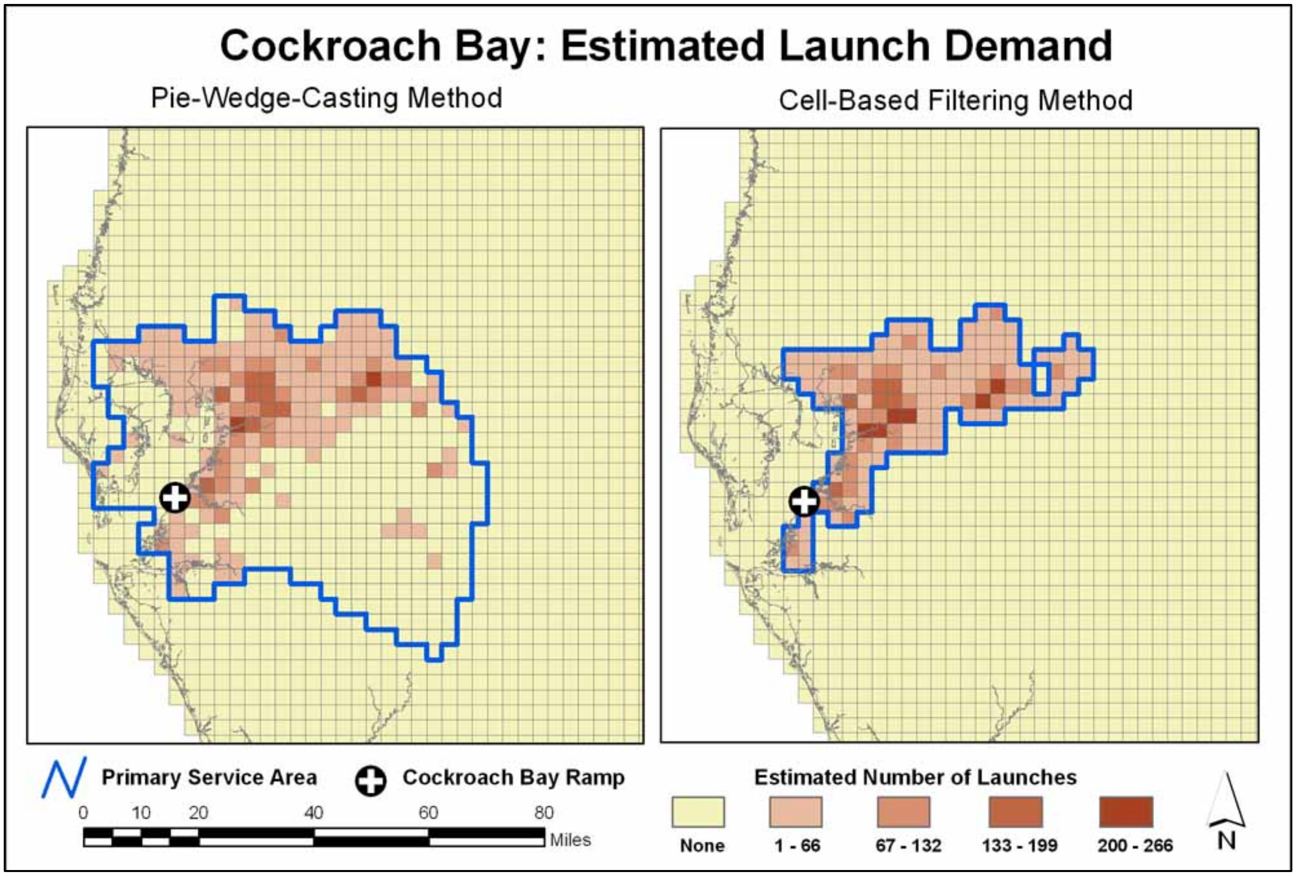


Figure 15. Estimated Launch Demand Within Primary Service Areas.

Chapter 9. SUMMARY AND CONCLUSIONS

A statistical based methodology for estimating the regional and primary service areas for boat ramps is presented along with the delineation of land-side market areas for boaters that use public access ramps in the Tampa and Sarasota Bay region. The analysis employed a pie wedge-casting method to identify:

(a) inland areas from which ramp users originate based on a sample of boaters that are known to have launched from specific ramps;

(b) wedge-specific threshold distances (i.e., the distance from a ramp that best represents the outermost confines of the predominant market/service area for a given ramp); and

(c) variability in the spatial distribution of boater origins in terms of direction-specific distance-decay properties that are observed in the mapped point distributions of ramp users within their predominant market/service areas.

Delineation of a regional service area (RSA) and ramp-specific primary service areas (PSAs) were used to:

(a) determine and differentiate the burden placed on existing ramps from a local and regional standpoint as defined by a draw potential index;

(b) measure the extent to which there is local and/or regional competition between ramps in terms of overlapping or non-overlapping service areas and the extent of the geographic coverage of PSAs as defined by a competition index;

(c) identify those locations where boaters are likely to come from, given the geographic properties of the PSAs and the distribution of users and user density; and

(d) highlight the variability of use intensity within each PSA standardizing by area as defined by a wedge-specific use potential index.

In addition, a K-means cluster analysis was used to determine near-shore and offshore boundaries of specific on-water destination regions or SDRs. A series of water-side indices were developed to:

(a) identify those SDR that received the greatest relative proportion of overall ramp use, and those areas that attracted proportionately few ramp users as defined by a draw potential index;

(b) identify the degree to which ramps disperse boating use among destination zones as defined by a use concentration index; and

(c) measure the extent to which destination zones absorb ramp users standardized by the area of the destination zones as defined by a destination specific use potential index.

Lastly, a cell-based spatial filtering method was developed and implemented for the Cockroach Bay ramp to:

(a) estimate ramp patronage,

(b) optimize the wedge-derived primary service area boundary; and

(c) estimate spatial launch demand within the primary service area.

The wedge-casting method developed and implemented in this study offers several distinct advantages over commercial market delineation GIS functions. First, the delineation of market area boundaries accounts for directional variability in the degree to which wedges or sectors extend out from a given ramp, as based on a statistical analysis of ramp use attenuation with increasing distance (and not simply as a function of point density). Second, statistics such as threshold distances are generated for each wedge or combination of wedges, providing a means to evaluate and compare spatial variations in the estimated market areas and boundaries and the geographic coverage of market segments within the PSAs.

A negative-exponential regression model was successfully employed to delineate PSA market area boundaries for wedges and/or combinations of wedges (i.e. sectors) when the sample size was large—when the number of observations was, on average, 30 or greater. For cases when the model was ineffective due to a small sample size, an alternative methodology was employed and conservative estimates of wedge-specific distance thresholds were calculated based on ordinal scale data (i.e., utilizing median values and/or the upper-bounds of the confidence intervals about the median value). This approach attempted to minimize the effects of outlying or extreme observations. While some existing GIS algorithms offer density kernel and wedge-casting options, they typically are less flexible, also require minimum sample sizes, are not as effective in determining threshold distances or directional variability of thresholds, and do not retain the boundaries of individual sectors that comprise the PSA.

The wedge-casting method, negative exponential model, and use potential indices developed in this study provide ways to account for the complications of the uneven distribution of ramp patrons, and more importantly, to measure the variability in ramp use intensity across space and with respect to different directions. Isotropic surfaces (i.e., featureless plains), equal mobility over space, and the equal distribution of user density reflect idealized conditions that produce circular market areas. The complexities found in reality—such as (1) uneven patron density or variability in the geographic distribution of users or potential users; (2) variability in accessibility over space or across directions; and/or (3) constraints and barriers, be they physical or infrastructural—warp a circular market area to one that spans gaps (e.g., water), one that shows variability across space, and one that varies in terms of its reach with respect to direction. For example, retail market or service areas typically warp around transportation networks, areas of high patron concentration, or where spatial variation in accessibility to a given point of reference (e.g., store, ramp) is known to exist. These complexities are particularly true for a coastal application where a wedge can extend outward from a ramp, over water, or beyond a bay. The extension of a wedge across a water gap is an indication that the reach extends beyond the local area—that there is a significant number of users of a particular ramp that are drawn from across a bay. Water gaps do not affect the estimation of the distance-decay estimations (i.e., negative exponential model, median distance, median UCL) which provide a statistical estimate of how use intensity declines with increasing distance in a given direction. Water gap or not, there still is some threshold distance beyond which use intensity falls below the lower limit of the confidence interval of mean use intensity.

The process applied to optimize the wedge-derived primary service area and to estimate launch demand reflects a two-stage procedure. First, a PSA boundary was demarcated based on statistical procedures that estimated threshold distances for pie wedges cast about a given ramp. Second, the wedge-derived PSA was optimized (for the Cockroach Bay ramp) by evaluating and comparing average use estimates for 2.5 square mile grid cells that fell inside the PSA to cells that fell outside the PSA. The pie wedge-casting approach implemented in this study is considered to be a necessary precursor to the cell-based filtering analysis, which allows for optimization of the PSA. Advantages of the two-stage procedure include the following:

(a) It is a gravity model application that utilizes a distance-decay function to measure / quantify the degree to which ramp use declines with increasing distance from a ramp. These parameters can later be used to build a model for both prediction and forecasting based on observed patron travel patterns.

(b) It is firmly grounded in spatial interaction and consumer travel-behavioral theories; and allows for the assessment of (a) the distance-minimizing behavior of consumers in a geographic market. In addition, the empirical results and the identification of a Primary Service Area typically meet the requirements established by Applebaum (1966). Hence, the method of identifying initial market boundary thresholds is theoretically defensible.

(c) The use of regression analysis allows for the statistical evaluation of the estimated distance-decay parameters associated with each pie wedge and the overall significance of the model. When the model did not produce significant results, an alternative statistical method was used (based on median values). Hence, the method is statistically defensible.

(d) The wedge-casting approach allows for alternative functional forms to be tested (i.e., negative exponential function, inverse power function, linear and log-linear functions) to find a best-fit function.

(e) The use of pie-wedges allows for an assessment of directional-specific distance-decay parameters, to reveal differences in patronage over various directions within a ramp's Primary Service Area (PSA).

(f) Having identified the PSA (i.e., the service market boundary), patron use estimates for grid cells within the PSA can be compared to grid cells outside the PSA to optimize the PSA. This allows for the inclusion of some areas that are just outside the boundary of the wedge-derived PSA as it is initially estimated. It also provides a statistical basis by which some areas within the PSA may be eliminated -- those areas where use intensity falls below the average use intensity within the PSA as a whole.

Effective implementation of the two-stage method for delineating and refining a ramp's PSA require that a fairly large sample size be drawn from the boating population that uses a given ramp (typically n > 500 observations). The larger the sample size, the better the estimation of threshold distances and the initial demarcation of the PSA boundary (stage one). A large sample size increases the likelihood that the observed point pattern generated from the sample is "representative" of the underlying geographic distribution of ramp use within the statistical population. Moreover, large and geographically representative samples (1) reduce the likelihood of over- or under-shooting service boundaries when estimating threshold distances during stage one; and (2) limit the impact of geographic outlier(s) on the estimation process. Note, however, that distortions in wedge-derived market boundaries that may arise from the presence of outliers do not necessarily pose a serious problem, as the final demarcation of the service area boundary is subject to "optimization" during stage two. Recall that the optimization process allows for the augmentation or retraction of the service area boundary; by comparing use intensity within the PSA to use intensity in areas outside the PSA; including areas where spatial demand is significantly equal to or greater than that which is observed in the PSA, or eliminating areas where spatial demand is significantly less than that which is observed in the PSA.

The two-stage procedure requires knowledge of the location of registered vessel owners (i.e., geocoded VTRS records), which are used as a benchmark for standardizing the data and estimating use probabilities. The two-stage method provides a solid framework for market boundary demarcation and refinement of a ramp's primary service area based on comparative use intensities by geographic area.

Research Opportunities

Service area delineation and the ramp use analyses can be improved with long-term ramp monitoring to increase sample sizes. Longitudinal data would also be useful to generate use profiles. Use profiling would include the analysis of the characteristics of boats/boaters using specific ramps and the propensity of boaters to vary their ramp use seasonally. Future research should also examine the impact of the physical properties of individual ramps such as launch capacity, available parking and facilities, and ease of access as defined in terms of a ramp's location within the broader study region and its accessibility within the context of the regional transportation network. Further exploration is also warranted into the use of the VTRS database as a tool to assess the degree to which boaters are likely to use specific ramps based on the geographic distribution of boaters in relation to the location of substitutable ramps (Swett, Sidman, and Fik, 2004). Such a study would be useful to uncover ramp preferences, the degree to which boaters using specific public ramps are distances minimizers, and the extent to which they are aware of ramp launching alternatives or substitutes within the region. The identification of the factors responsible for poor VTRS trailer tag matching is also recommended.

The cell-based filtering method for PSA optimization that was tested for the Cockroach Bay ramp should be applied to the remaining Tampa and Sarasota Bay ramps investigated as part of this study. Currently, there is no simple way to spatially compare use potential indices generated for each wedge cast about a ramp to those generated for other ramps. This is due to the fact that ramp wedges all have different points of origin and distance threshold boundaries. Thus, they do not share the same geographic areas of overlap. A major benefit derived from the optimization stage is that ramp patron estimates and use potential are standardized spatially for each ramp over a 2.5 square mile grid within a Geographic Information System. In this way, use demand between ramps can be directly compared, spatially. In addition, the grid-based system is flexible in that data for additional ramps can be easily incorporated. Each cell in the GIS grid-based system would have linked table attributes that identify use estimates, use proportions, and demand estimates for each ramp. It is further recommended that a similar grid-based system be developed for the water-side use profile to ensure that land and water-side service area analyses are spatially and methodologically consistent.

The cell-based filtering method can also be expanded to forecast demand given changes (i.e., projected growth) in the number registered vessel owners across cells within the optimized PSA. For example, for a given ramp, cell-specific estimates of spatial demand (the dependent variable) can be regressed against geocoded VTRS (V_j) record counts per j-th cell, the distance (d_{jk}) from a j-th cell to a k-th ramp, and the cells location coordinates (x,y):

$$D_{j(k)} = \beta_0 + \beta_1 (V_j) + \beta_2 (d_{jk}) + \beta_3 (V_j \cdot d_{jk}) + \beta_4 (x_j) + \beta_5 (y_j) + \ldots + \varepsilon_{jk} ,$$

for the j = 1,…. m_k cells that comprise the ramp's service area, where ε_{jk} is a random, independent, and normally distributed error structure.

The parameter estimate for β_1 represents the scaled proportion of registered vessel owners from the VTRS that use the ramp from a typical cell taking into account the attenuating effects of distance and the likely interaction between the number of registered boat owners geocoded to that cell and distance from the cell to the ramp. Moreover, the estimate of β_2 provides a measure of the ramp-specific distance-decay parameter (where the E [β_2] < 0) which reveals (in general) how use intensity by cell declines with increasing distance from the ramp. Note that this specification controls for the uneven distribution of registered vessel owners within cells at varying distances from the ramp as captured by the interaction effect embodied in the estimated parameter β_3 as associated with the interaction variable ($V_j \cdot d_{jk}$). The additional beta parameters account for the effects of location.

The cell-based regression approach offers a potentially useful tool for forecasting demand; in particular, how the spatial distribution of demand may change in response to changes in the number of registered boat owners per cell (i.e., growth in vessel registrations). Lifestyle segmentation profile (LSP) demographic information might also be incorporated into forecasting models to further characterize and distinguish boating populations within PSA's. As such, predictive models can blend higher resolution geographic data developed in this study with demographic information currently being used by economists to forecast regional demand, to increase the spatial resolution of those demand forecasts. Nevertheless, the spatial/geographic approach developed and applied in this study to define land and water-side service areas for ramps is consistent with the results of a previous boater survey in Tampa and Sarasota Bay, which found that geographic distance was overwhelmingly the primary reason reported for ramp and water-based destination choice among boaters (Sidman, Fik, and Sargent, 2004).

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Appendices

Appendix A. GIS Wedge-Casting, Distance, and Use Intensity Procedures

<u>Datasets</u>

RampCircle_Template: This shapefile (Albers meters) will be created by in step one below. Once created, it will be used as the template for creating pie wedges for each of the study are ramps (via a copy and move operation). This shapefile is a template and it should not be altered.

A. Boat_Ramps: This shapefile contains the positions (Albers meters) and characteristics of all study area ramps.
B. FL_Grid_Sub: This shapefile (Albers meters) contains 513 grid cells. They are grid cells that contain 1 or more geocoded "boats" and that are within 180 miles of the study area. (150 miles defines the outer boundary that was determined by calculating the overall ramp service area (TF). The maximum distance between any two study area ramps is 60 miles. Therefore half this distance was added to the overall outer boundary in order to select grid cells that may contribute to the service area of an individual ramp.
C. Geocodes_Mail2: This shapefile (Albers meters) contains 3089 geocoded addresses that were obtained from the FMRI/FSG ramp intersect and mail surveys.
D. RampName_Count: This MS Excel spreadsheet contains the names of 32 ramps in the study area and the number of geocoded points that pertain to each ramp. (There are a total of 3089 points and individual ramp totals range from 2 to 216 points.)
E. Ramps_DeltaXY: This MS Excel spreadsheet contains delta X and Y coordinates (Albers meters) that define the distance from each of the 32 study area ramp to the centroid point that Charles calculated for all ramps. These coordinates will be used in step 2 below when constructing pie wedges for each of the ramps (a copy and move operation). The spreadsheet also contains the X and Y coordinates (Albers meters) for each of the 32 ramps.

<u>Generating wedges</u>

1. Creation of the RampCircle_Template:
    a. In ArcView use the "Radiating Lines" extension to create a circle that has a 150-mile radius, a center point equal to that of the centroid of all ramps (Y=410718.3, X=533055.92), and 24 pie wedges each with a 15 degree angle.
    b. Enclose the pie wedges by creating a circumference (use the DF method)
    c. Create polygon topology for the circle.
    d. Add the following fields to the circle's polygon attribute table:
        i. Label (Type: short; Length: 2; Precision: 2; Scale: 0)
        ii. Angle (Type: string; Length: 10; Precision: 0; Scale: 0)
    e. For each wedge, populate the Angle field. Start with the first wedge that lies immediately east of the north point of the circle (0 degrees) and then proceed in a clockwise direction. The wedges should be labeled as follows: 1st wedge: 00-15, 2nd wedge: 15-30, 3rd wedge: 30-45, …, 24th wedge: 345-360.
    f. For each wedge, populate the Label field. Start with the first wedge that lies immediately east of the north point of the circle (0 degrees) and then proceed in a

clockwise direction. The wedges should be labeled as follows: 1st wedge: 1, 2nd wedge: 2, 3rd wedge: 3, …, 24th wedge: 24.

Generating polygirds (i.e., wedges broken into two mile square grids)

The following steps were completed for each ramp in succession:

2. Move the pie wedges so that they are centered over the current ramp (within ArcMap).
    a. Within ArcMap make a copy of the shapefile named RampCircle_Template. Name the new shapefile using the ramp identification number (e.g., R22_Wedges).
    b. Start editing the new wedge shapefile.
    c. Add the Boat_Ramps shapefile to the view. (This shapefile will be used to check that the center of the wedges has been moved to the correct ramp.)
    d. Select all 24 of the wedges pertaining to the new shapefile. Make sure that no other features (or layers) are selected within the view. (Use selectable layers to limit your selection to RampCircle_Template features.)
    e. From the dropdown editor menu select "Move."
    f. Paste the appropriate delta X and delta Y values from the "Ramps_DeltaXY" spreadsheet (contained in the last two columns) into the ArcMap dialog box. Press enter after entering both values in the dialog box.
    g. Zoom into the center of the ramp wedges.
    h. Turn off the ramp wedge layer and use the identity tool to query the underlying ramp point to make sure that the move was executed properly.
3. Intersect the pie wedge shapefile created in step 2 above (e.g., R22_Wedges) with the 513 grid cells contained in the FL_Grid_Sub shapefile using the GeoProcessing Wizard within ArcMap. Give the resulting file a name that corresponds to the ramp that is currently being analyzed. (Note, turn off editing, if still on, or put the resulting shapefile in a different directory.)
    a. Add the FL_Grid_Sub shapefile to the map document (to the view).
    b. Select the geoprocessing wizard under "Tools" on the menu bar.
    c. Select the option to intersect two layers
    d. The layer to intersect is the FL_Grid_Sub shapefile.
    e. The polygon overlay layer is the ramp pie wedge shapefile (e.g., R22_Wedges).
    f. Give the output a recognizable name (e.g., R22_GridPie).

Calculating distance from each wedge polygrid centroid to the ramp

4. Use Xtools (under the "Tools" on the menu bar) to add X and Y coordinates (Albers meters) to the output shapefile created in step 2 above (e.g., to R22_GridPie).
    a. Tools->Xtools->Table Operations->"Add X,Y coordinates"
    b. Open the attribute table and check to see of the X_Centroid and Y_centroid fields and values were added.
5. Open the attribute table of the shapefile created in step 3 (e.g., R22_GridPie) above and:
    i. Calculate the values of the RampX and RampY attributes equal to the corresponding X and Y coordinate values contained in the MS Excel spreadsheet named Ramp_DeltaXY.

j. Open field calculator for the attribute Dist_Miles and load the expression titled "PTheoremMI" and run it (the filename is PTheoremMI.cal). Close the table upon completion.
k. For the first few ramps, check the distance between the ramp center point and some grid cells to make sure the calculated value is correct.

<u>Counting ramp patron addresses in the wedge polygrids</u>

6. Count the number of data points in each grid cell/pie wedge.
    a. Add the Geocodes_Mail2 shapefile to the map document.
    b. Select only those points in the Geocodes_Mail2 shapefile that pertain to the current ramp (Use the attribute M_NAME to select the pertinent ramp).
        i. On menu bar: Select->Select by Attributes
        ii. Layer=Geocodes_Mail2
        iii. Method=Create new selection
        iv. M_Name=the ramp name
    c. Export the selected points as a separate shapefile (named after the ramp).
        i. Right click on the layer name (Geocodes_Mail2)
        ii. Choose: Data->Export Data
        iii. Give the ouput shapefile a unique name (e.g., R22_points).
        iv. Say yes to add output shapefile to the map document
    d. Operationalize a spatial join (select join from the property menu of the current ramps gridpie shapefile: e.g., R22_GridPie).
        i. Right click over the layer name in the legend
        ii. Select "Joins and Relates" and then "Join"
        iii. Select: "Join data from another layer based on a spatial location"
        iv. Option 1: Choose the ramp points shapefile (e.g., R22_points) as the join layer.
        v. Option 2: Leave all options unchecked
        vi. Option 3: Give the output shapefile a unique name that corresponds to the ramp (e.g., R22_Join).
7. Using MS Excel, open the DBF file of the resulting shapefile in MS Excel and save it as an Excel Spreadsheet (R22_join.xls).
8. Sort the records in the Excel spreadsheet in ascending order by the Count_ field (last column).
9. Select all records with a Null or zero value contained in the Count_ field and delete them.
10. As a check: Sum up the Count_ field and compare it to the quantity of points for the ramp (RampName_Count). The values should be comparable, but not necessarily exact. Delete the sum.
11. Resort the spreadsheet on the label field (ascending).
12. Save the Spreadsheet for regression analysis.

Appendix B. Wedge-Casting Model Results and Distance Thresholds

Anclote River

wedge_degrees	model_distance	median_distance	median_distance_UCL	model_significant	cells	points
0_45	64.60	16.13	28.03	Yes	19	32
45_75	31.39	13.70	32.02	Yes	17	31
75_90	52.77	22.20	35.03	Yes	24	38
90_120	27.07	20.23	27.07	No	37	54
120_150	23.57	15.15	23.57	No	24	34
150_195	27.11	15.73	27.11	No	14	19

Seminole Street Causeway

wedge_degrees	model_distance	median_distance	median_distance_UCL	model_significant	cells	points
0_60	41.90	9.24	15.93	Yes	31	49
60_75	45.90	19.41	84.84	Yes	15	22
75_90	54.58	19.06	54.58	No	12	25
90_105	56.10	31.95	56.10	No	12	13
105_180	10.11	5.29	10.11	No	14	25

Belleair Beach Causeway

wedge_degrees	model_distance	median_distance	median_distance_UCL	model_significant	cells	points
0_60	23.02	12.64	23.02	No	13	17
60_90	30.23	7.65	36.49	Yes	17	34
90_150	15.73	6.72	10.51	Yes	20	38
150_315	6.04	3.07	6.04	No	12	30

War Veterans Memorial Park

wedge_degrees	model_distance	median_distance	median_distance_UCL	model_significant	cells	points
0_45	57.74	6.42	35.45	Yes	15	42
45_75	45.75	12.29	55.72	Yes	12	23
75_135	32.59	5.37	28.44	Yes	16	43
135_165	4.61	4.61	na	No	3	4
270_330	6.30	2.97	6.30	No	11	30
330_360	11.79	4.52	11.79	No	9	14

Jungle Prada

wedge_degrees	model_distance	median_distance	median_distance_UCL	model_significant	cells	points
345_45	10.69	4.66	10.69	No	20	38
45_75	48.79	18.04	48.79	No	15	18
75_165	6.94	2.85	6.94	No	21	41
300_345	7.33	7.33	na	No	6	8

Gulfport Marina

wedge_degrees	model_distance	median_distance	median_distance_UCL	model_significant	cells	points
15-75	37.73	21.32	37.73	No	24	24
255-315	na	2.14	na	No	10	27
315-15	12.96	5.95	9.63	Yes	14	59

Maximo Park

wedge_degrees	model_distance	median_distance	median_distance_UCL	model_significant	cells	points
15_45	31.36	26.16	31.36	No	18	35
45_75	55.06	38.35	55.06	No	25	28
75_300	5.82	2.67	5.82	No	9	13
300_15	11.28	9.14	11.28	No	22	38

Fort De Soto Park

wedge_degrees	model_distance	median_distance	median_distance_UCL	model_significant	cells	points
330_15	27.49	15.57	23.24	Yes	24	36
15_45	67.79	29.47	47.85	Yes	35	57
45_75	60.32	50.99	60.32	No	27	31

Bay Vista Park

wedge_degrees	model_distance	median_distance	median_distance_UCL	model_significant	cells	points
15_30	28.49	28.49	na	No	7	10
270_15	13.57	8.73	13.57	No	21	24

Demens Landing

wedge_degrees	model_distance	median_distance	median_distance_UCL	model_significant	cells	points
330_30	4.27	4.27	na	No	9	11
270_330	17.90	6.59	17.90	No	8	9

Crisp Park

wedge_degrees	model_distance	median_distance	median_distance_UCL	model_significant	cells	points
0_210	20.90	2.30	20.90	No	14	17
225_300	6.36	3.90	6.36	No	11	16
300_360	3.22	3.22	na	No	6	12

Sunlit Cove

wedge_degrees	model_distance	median_distance	median_distance_UCL	model_significant	cells	points
330_45	11.52	11.52	na	No	7	8
135_255	2.34	2.34	na	No	4	6
225_270	4.65	4.65	na	No	6	7

Gandy - St. Pete Side

wedge_degrees	model_distance	median_distance	median_distance_UCL	model_significant	cells	points
45_105	29.97	20.47	29.97	No	17	17
180_300	8.76	5.30	8.76	No	15	17

Gandy – Tampa Side

wedge_degrees	model_distance	median_distance	median_distance_UCL	model_significant	cells	points
0_60	16.56	12.23	16.56	No	20	42
60_105	39.23	16.89	39.23	No	11	12
105_180	3.36	3.36	na	No	10	17
225_300	14.59	14.59	na	No	4	5
300_360	41.95	10.68	41.95	No	13	36

Courtney Campbell Causeway

wedge_degrees	model_distance	median_distance	median_distance_UCL	model_significant	cells	points
330_75	14.54	10.08	14.54	No	25	31
75_105	21.06	18.84	21.06	No	8	11
105_135	15.47	15.47	na	No	3	4
180_285	18.00	9.07	18.00	No	10	9

Williams Park

wedge_degrees	model_distance	median_distance	median_distance_UCL	model_significant	cells	points
330_60	15.92	11.70	15.92	No	10	10
60_150	21.42	21.42	na	No	3	14

E.G. Simmons Park

wedge_degrees	model_distance	median_distance	median_distance_UCL	model_significant	cells	points
330_30	26.23	18.74	26.23	No	12	16
30_75	24.51	19.84	24.51	No	38	58
75_90	42.44	42.44	42.44	No	2	3
90_210	10.37	10.37	na	No	7	8

Bahia Beach Marina

wedge_degrees	model_distance	median_distance	median_distance_UCL	model_significant	cells	points
345_30	45.60	25.36	45.60	No	14	15
30_75	33.98	24.85	33.98	No	41	53
75_150	na	8.85	na	No	7	7

Shell Point Marina

wedge_degrees	model_distance	median_distance	median_distance_UCL	model_significant	cells	points
00_30	39.04	19.60	39.04	No	14	15
30_75	38.24	29.31	38.24	No	41	52
75_120	8.02	8.02	na	No	6	7

Domino

wedge_degrees	model_distance	median_distance	median_distance_UCL	model_significant	cells	points
345_45	35.70	17.85	27.33	Yes	20	29
45_150	7.21	4.29	7.21	No	12	17
195_255; 285_300	13.17	13.17	na	No	5	5

Cockroach Bay

wedge_degrees	model_distance	median_distance	median_distance_UCL	model_significant	cells	points
1	25.22	25.22	33.64	No	18	21
2	38.99	25.44	33.60	Yes	25	37
3	31.38	26.36	31.63	Yes	41	100
4	43.76	33.68	40.49	Yes	76	182
5	47.32	34.08	42.72	Yes	48	84
6	50.51	15.84	55.90	Yes	19	33
7_8	50.41	8.2	65.90	Yes	13	17
9_10_11_12	11.38	11.38	15.43	No	15	7
13_14	8.26	8.26	16.16	No	12	12
19_20_21_22	12.11	12.11	na	No	7	3
23_24	23.58	23.58	27.17	No	14	8

Bishop Harbor

wedge_degrees	model_distance	median_distance	median_distance_UCL	model_significant	cells	points
345_30	39.57	34.75	39.57	No	12	13
30_60	46.86	39.43	46.86	No	40	61
60_90	64.48	60.48	64.48	No	11	14
90_135	28.12	28.12	na	No	6	8
135_210	4.95	4.95	na	No	7	11

Braden River

wedge_degrees	model_distance	median_distance	median_distance_UCL	model_significant	cells	points
45_75	1.22	1.22	na	No	4	4
75_90	5.52	5.52	na	No	5	13
90_135	19.89	4.04	19.89	No	9	16
135_180	34.40	7.60	34.40	No	11	16
180_225	10.36	4.34	10.36	No	10	12
225_285	7.76	3.48	7.76	No	9	11

Palmetto - Green Bridge

wedge_degrees	model_distance	median_distance	median_distance_UCL	model_significant	cells	points
0_45	96.53	36.06	56.42	Yes	2	6
45_90	64.68	47.09	64.68	No	19	32
90_180	16.89	10.79	16.89	No	18	26
180_285	2.29	2.29	na	No	5	6
285_360	20.43	20.43	na	No	12	19

Warners Bayou

wedge_degrees	model_distance	median_distance	median_distance_UCL	model_significant	cells	points
60_120	21.71	11.59	21.71	No	14	27
120_180	15.35	5.61	10.55	Yes	20	49
180_300	3.99	2.07	3.99	No	15	31

Palma Sola Causeway

wedge_degrees	model_distance	median_distance	median_distance_UCL	model_significant	cells	points
30_75	67.37	38.67	67.37	No	18	22
75_150	13.06	8.17	13.06	No	35	85
150_210	17.28	6.25	17.28	No	8	8
255_360	1.00	1.00	na	No	4	6

Kingfish

wedge_degrees	model_distance	median_distance	median_distance_UCL	model_significant	cells	points
345_45	49.57	42.32	49.57	No	21	22
45_60	58.62	54.55	58.62	No	22	26
60_120	17.11	11.56	17.11	No	41	84
120_150	21.21	18.86	21.21	No	8	10
150_345	3.05	3.05	na	No	4	7

63rd Street Memorial Park

wedge_degrees	model_distance	median_distance	median_distance_UCL	model_significant	cells	points
0_30	47.25	42.66	47.25	No	12	19
30_75	72.10	58.53	72.10	No	24	28
75_150	15.79	11.63	15.79	No	30	41
150_330	1.85	1.85	na	No	5	10

Coquina Beach

wedge_degrees	model_distance	median_distance	median_distance_UCL	model_significant	cells	points
0_30	49.75	40.74	49.75	No	18	20
30_60	60.25	53.31	60.25	No	46	66
60_105	36.06	10.82	36.06	No	23	48
105_150	15.99	15.99	na	No	5	6
330_360	3.58	3.58	na	No	6	9

Ken Thompson

wedge_degrees	model_distance	median_distance	median_distance_UCL	model_significant	cells	points
0_60	75.62	11.47	75.62	No	20	27
60_90	42.70	8.48	17.17	Yes	11	23
90_150	10.96	7.12	10.96	No	21	64
150_180	15.00	15.00	na	No	6	6
300_330	6.56	6.56	na	No	2	3

Centennial Park

wedge_degrees	model_distance	median_distance	median_distance_UCL	model_significant	cells	points
330_30	26.78	8.47	26.78	No	15	16
30_75	40.87	11.36	40.87	No	16	17
75_180	8.50	4.97	8.50	No	24	54

Note: Shaded cells represent threshold distances used to delineate primary service areas.

Appendix C. GIS Procedure for Delineating Service Areas

The following steps were completed for each wedge, for each ramp, in succession:

1. Buffer the ramp location by the model distance calculated for each wedge or combination of wedges cast about the ramp (see Appendix B for model distances).
    a. Select Tools
    b. Select Buffer wizard
        i. Select feature layer to buffer (i.e., the shapefile containing the ramp location)
        ii. Set distance units to miles
        iii. Set specified distance equal to the model threshold distance (when significant) or to the median, or median UCL for the first wedge – which ever value includes 80 percent of the ramp patron data points within the wedge.
        iv. Save output buffer file (buffer1) and repeat steps i through iv for the other wedges.
2. Intersect the buffer shapefiles generated for each wedge by the RampCircle_Template (Appendix A, Step 1). This step generates wedge sectors within each buffer shapefile.
    a. Select ArcToolbox
    b. From the dropdown menu select Analysis, then Overlay, then Intersect options
        i. Select feature layers to intersect (i.e., RampCircle_Template; buffer1)
        ii. Save output intersected buffer1 file as wedge_buffer1
        iii. Repeat steps i through ii for the other buffer files created in step 1.

The intersect command stamps buffer1 with all 15-degree wedge radii (0 to 360 degrees) from the RampCircle_Template. The next step isolates the one wedge or combination of wedges in wedge_buffer1 that correspond(s) to the distance threshold used to generate buffer1.shp (step 1 b).

3. Select the pie wedge or wedge combinations in wedge_buffer1 that correspond(s) to the buffer1 distance threshold and save as a new shapefile. Repeat for other wedges. Merge wedges if applicable. Union all sectors into one shapefile.

    a. Set Selectable Layers
        i. Be sure to only check buff_1_intersect.shp
        ii. Select the Features button to select the wedge(s) that correspond(s) to buffer1 distance threshold.
        iii. Make a new shapefile of the selected wedge(s) (sector1.shp)
    b. Right click on the buff_1_intersect.shp theme in the display window and choose the Data and Data Export option sequence.
        i. Place the sector1.shp into the f:/boating/ramps/psa/sectors directory
        ii. Repeat for other wedges.
    c. Merge wedges if applicable (if multiple adjacent wedges have the same distance threshold)
        i. Select Editor button
        ii. Select Start Editing option

    iii. Select Merge option to merge wedges into a common sector; repeat for all wedge combinations.
  d. Union the sectors and Clip to shoreline
    i. Select ArcToolbox
    ii. From the dropdown menu select Analysis, then Overlay, then Union options
    iii. Select feature layers to Union (i.e., merged sectors)
    iv. Save output intersected buffer1 file as ramp_sectors.shp
  e. Clip ramp_sectors with the Florida shoreline
    i. Select ArcToolbox
    ii. From the dropdown menu select Analysis, then Extract, then Clip options
    iii. Select feature layers to Clip (i.e., ramp_sectors.shp; florida24.shp).
    iv. Save output file as ramp_sectors_clip.shp. Repeat for other ramps.

4. Eliminate areas of sectors that do not contain VTRS boats.
  a. Buffer geocoded VTRS points (VTRS_Points.shp) by 150 feet.
    i. Invoke Buffer wizard
    ii. Select shapefile to buffer (VTRS_Points.shp)
    iii. Select output shapefile (VTRS_150_Buffer.shp)
  b. Eliminate areas of ramp_sectors_clip.shp that do not contain vessels
    i. Select ArcToolbox
    ii. Select shapefile to buffer (VTRS_Points.shp)
    iii. Select output shapefile (VTRS_150_Buffer.shp)
    iv. Select ArcToolbox
    v. Erase VTRS_150 Buffer.shp areas from ramp_sectors_clip.shp

5. Calculate area and calculate square miles for each sector in ramp_sectors_clip.shp).
  a. Use XTOOLS extension to calculate acres for each sector
  b. Calculate square miles for each wedge
    i. Add a field to the ramp_sectors_clip.shp table theme
    ii. Right click on the theme and select Options
    iii. Select the Add Field options.
    iv. Field (window) field name = SQMILES;
    v. Select Double Precision (precision = 9; scale = 2)
    vi. Right click on SQMILES to invoke the calculate wizard and calculate SQMILES = Acres / 640

6. Use Data Export option to save the final PSA shapefile as ramp1_PSA.shp. Repeat step for each ramp.