

## ASSESSMENT OF MANATEE MONITORING PROGRAMS IN TAMPA BAY

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### ABSTRACT

Manatee monitoring programs for Tampa Bay, coordinated by scientific staff at the Florida Department of Environmental Protection's Florida Marine Research Institute in St. Petersburg, were reviewed to examine the status of individual projects along with the adequacy and availability of data for management purposes. Evaluations of data and recommendations for program changes were solicited from management staff using a confidential questionnaire. In comparison to other regions of the state, manatee data for the Tampa Bay area were rated highest for completeness and availability. Ideas to improve access to additional data and to shorten the time between data acquisition and availability were included in responses. A CD-ROM containing manatee GIS data including statewide mortality locations and aerial survey results along with habitat base maps was tested and demonstrated to resource managers as part of the assessment project.

### INTRODUCTION

Endangered Florida manatees, *Trichechus manatus latirostris*, are year round residents in the Tampa Bay area. Programs to monitor the Tampa Bay manatee population are coordinated by staff of the Marine Mammals Program (MMP) at the Florida Department of Environmental Protection's (FDEP) Marine Research Institute (FMRI) in St. Petersburg. Since its inception in Fiscal Year (FY) 1984-85, the MMP staff has grown from four initial members: a program manager, a sign contract manager, a research biologist, and a secretary. The management portion of the MMP moved to FDEP headquarters in Tallahassee during 1990, leaving the research staff program in St. Petersburg and at regional field laboratories located in Port Charlotte, Tequesta, Melbourne, and Jacksonville. In FY 1995-96, a total of 16 program staff are located in the Tampa Bay area at the main FMRI laboratory at Bayboro Harbor (seven FTE biologists, two OPS research staff, and three support staff) and at the FMRI Marine Mammal Pathobiology Laboratory on the campus of Eckerd College (three FTE biologists and one OPS research staff). An additional four FTE biologists and four OPS research staff are stationed at the field laboratories.

Manatee monitoring programs are organized into five projects: population monitoring; mortality and rescue; ecology and migration; life history and biology; and the manatee geographic information system. This report reviews the progress of each project in monitoring Tampa Bay area manatees. The review of each program includes:

- Evaluation of the current project status including data analyses and reports;
- Adequacy of data for management purposes and comparison to other areas of Florida;
- Recommendations for program changes.

Research project leaders were asked to complete a questionnaire about existing manatee data sets. The questionnaire also solicited recommendations for both research projects and management

activities. Other manatee research and management personnel outside of the FMRI program were also asked to complete the questionnaire.

In addition to the reviews of research projects, this report includes a CD-ROM entitled "Florida Atlas of Marine Resources, Version 1.0." The disk includes GIS data files that contain spatially referenced manatee mortality and aerial survey data prepared by Marine Mammals Program GIS staff along with environmental data sets accumulated by staff from the Coastal and Marine Resource Assessment (CAMRA) section at FMRI. Also included are text files and meta-data files (data about the data sets) to explain the basic concepts required for use of the data sets. The GIS files are stored as Arc/Info export files. A copy of Arc/Info, ArcView, or other software that can read these export files is not provided on the CD-ROM.

## **PROJECT REVIEWS**

### **Population Monitoring,**

Aerial surveys are an important source of manatee distribution data (Ward and Weigle, 1993; Ackerman, 1995). Over the last ten years, researchers have surveyed most of Florida's shoreline from small, high-winged planes at an altitude of 150-230 meters and a speed of 100-130 kilometers per hour. Several aerial survey methods have been used to study manatees: distribution or extended-area surveys, intensive search, unit-recount techniques, and statewide surveys conducted during the winter. Detailed descriptions of these manatee aerial survey techniques can be found in Packard (1985) and Ackerman (1995).

Distribution surveys are an important method for acquiring information on manatee spatial and temporal distribution, relative abundance in geographic regions of special concern, and use of habitat types. Distribution surveys cover a large area, are conducted repeatedly, and are designed to include likely manatee habitats such as coastal areas, estuaries, major rivers, tributaries, and fresh and saltwater canals (Ackerman, 1995). Counts within a given study area provide valid seasonal minimum estimates of the numbers of manatees in the study area and in the zones within the study area. However, effort and visibility biases can vary within surveys, among surveys, and among study areas, making comparisons of numbers difficult among areas.

In a typical distribution survey, prescribed routes are flown at two-week intervals over one or more years (O'Shea and Kochman, 1990; Ackerman, 1995). One or two experienced observers conduct each survey. When manatees are seen, observers circle the immediate area until an accurate count is recorded. Observers continue along the defined flight path after circling ends. The primary, or most experienced, observer records sightings on paper maps copied from NOAA 1:40,000 navigation charts or USGS 1:24,000 topographic maps. The total number of animals in the group is recorded, including the number of calves. Those animals closely associated with an adult and no more than one-half the adult's length are recorded as calves (Irvine and Campbell, 1978). Manatee

behavior is recorded as either feeding, traveling, resting, or cavorting. Survey data are entered into a computer database and locations are digitized using a geographic information system (GIS).

Synoptic surveys of all manatee wintering habitats in Florida and southeast Georgia are conducted following cold front passages when the animals are aggregated at warm springs and thermal discharges from power plants and industries. Biologists conduct surveys at altitudes of 150 m over two days; the east coast is covered first followed by flights over the west coast. These surveys are useful in determining a minimum manatee population estimate.

**Distribution survey status.** Extended-area aerial surveys of Tampa Bay's near shore waters were conducted between November 1987 and May 1994 by marine mammal biologists from Eckerd College and the FDEP. Eighty-eight surveys were conducted from small, high-winged airplanes flying at a height of 150 m and a speed of 130 km/hr. Each survey required two airplanes flying simultaneously, one covering each side of the bay. The flights were designed to maximize the manatee counts by concentrating on shallow near shore waters where manatees and their primary food source, sea grasses, are usually located. Flight paths were parallel to the shoreline, and the airplane circled when manatees or dolphins were spotted until a reliable estimate of the number of animals was obtained. Deeper waters in the middle of the bay were not surveyed.

Data collected for each sighting included location, species, number of adults and calves, and behavior. All data were recorded on copies of navigation charts and entered into the FDEP's Marine Resources Geographic Information System (MRGIS) for spatial analysis. Verification maps of aerial survey data were given to observers for validation. Once data were verified, maps were created showing the distribution of manatees during winter (December through February) and non-winter seasons. A fixed-area, flexible shaped filter was applied to the data to determine areas of Tampa Bay that had high density of manatee sightings. Density distribution maps for Tampa Bay winter and summer manatee aerial surveys are included in Appendix A (Figures 1 and 2). A full description of the filter analysis technique is included on the CD-ROM.

Winter distribution of manatees in the bay was centered around the Tampa Electric Company's (TECO) power plant discharge at Apollo Beach and the Florida Power Corporation's power plant discharge in St. Petersburg. During periods between the passage of cold fronts, manatees leave the power plants to feed on nearby sea grass meadows. From 1987 to 1994, the number of manatees using Tampa Bay during the winter months of December through February showed a statistically significant increasing trend. The mean number of manatees counted during the winter surveys rose from 49 in 1987-88 to 128 in 1993-94. The maximum count of 190 manatees occurred on January 24, 1994. The location showing the largest increase in counts was the discharge area at the TECO plant in Apollo Beach. A winter no-entry zone for watercraft was implemented at the discharge area in 1986. In 1989, the zone was upgraded to a year-round no-entry zone because of the increasing use by manatees.

Regression analysis of manatee counts by year during the months of April through October revealed that there was no significant increasing or decreasing trend in the number of manatees counted during the non-winter survey periods. Apparently, many of the animals that use the bay as a winter refuge migrate to other habitats north and south of Tampa Bay in summer. Manatees that continue to use the bay during warm months disperse to favored habitats throughout the bay. Spatial analysis of the aerial survey data revealed that areas showing medium to high use by manatees included McKay Bay, Apollo Beach near the TECO power plant, Simmons Park in Ruskin, the mouth of the Little Manatee River, Terra Ceia Bay and the adjoining lower Manatee River, Braden River, Anna Maria Sound, Weedon Island, Safety Harbor, Rocky Point, and Culbreath Bayou. Data for all surveys has been entered and verified in the Manatee GIS. A publication on the 1987-1994 distribution surveys has been submitted for publication in a refereed journal.

Additional Tampa Bay aerial surveys are currently flown once a month. A new series of surveys began in January 1995 as a cooperative effort by FMRI and John Reynolds at Eckerd College with partial funding from the Save the Manatee Club. The standard aerial survey methodology described above is used and data are incorporated in the GIS on a regular basis.

**Synoptic survey status.** The first statewide synoptic surveys of all manatee wintering habitats in Florida and southeast Georgia were conducted in January and February of 1991. The survey on January 23 and 24 produced a count of 1,268 manatees. During the second survey on February 17 and 18, a count of 1,465 manatees occurred; 104 manatees were located in the Tampa Bay area. In 1992, biologists from 14 state, federal, and private cooperating agencies conducted surveys on January 17 and 18. A new record count of 1,856 manatees was tallied; 126 manatees were counted in Tampa Bay. No synoptic surveys were flown in 1993 or 1994. Weather conditions were not considered suitable for statewide counts during those two winters. Two synoptic surveys were flown in 1995. A total of 1,443 manatees was counted statewide on January 21 and 22; 94 manatees were located in Tampa Bay. With very good weather conditions on February 6 and 7, a count of 1,822 manatees was recorded. Tampa Bay provided shelter for 113 manatees during that survey. In 1996, biologists flew another two statewide surveys during the very cold conditions that occurred this winter. A new high count of 2274 manatees was made on January 9 and 10. Surveys flown on February 17 and 18 produced another record high count of 2639 manatees; Tampa Bay was used by 136 animals.

Yearly summaries of synoptic survey results are included in the Fiscal Year annual Reports to the Legislature prepared by the MMP at FMRI and the FDEP Bureau of Protected Species Management. Synoptic survey results for the first three survey dates have been entered into the Manatee GIS. Results for all synoptic surveys are summarized in Table 1.

Table 1. Summary of manatee synoptic survey results.

Date	Survey total	Tampa Bay	Percent of Total
23-24 Jan 1991	1268	109	8.60
17-18 Feb 1991	1465	104	7.10
17-18 Jan 1992	1856	126	6.79
21-22 Jan 1995	1443	94	6.51
06-07 Feb 1995	1822	113	6.20
09-10 Jan 1996	2274	132	5.80
18-19 Feb 1996	2639	136	5.15

### **Manatee Mortality and Rescues**

A manatee mortality network was established in 1974 by U.S. Fish and Wildlife Service and the University of Miami to collect data on the cause of death for every dead manatee reported in the southeastern United States. The FDEP assumed responsibility for the program within Florida in 1985, initially using FDEP staff, manatee scientists at the University of Miami, and veterinarians at Sea World to conduct necropsies. Field staff were gradually hired by the FDEP to replace contracted services, and a pathobiologist was hired by the FDEP in 1989 to oversee the entire necropsy and rescue program. A Marine Mammal Pathobiology Laboratory (MMPL) was built on the campus of Eckerd College in St. Petersburg with funds from a USFWS Endangered Species Grant, and was occupied by FDEP staff in 1993. FDEP field staff use cooled enclosed trailers to transport manatee carcasses that are not badly decomposed to the MMPL. Staff of the MMPL also coordinate manatee rescues statewide.

Carcasses recovered by FDEP Manatee Mortality Program staff are designated with a three letter prefix (MNE, MEC, MSE, MSW, MNW) corresponding to the region within the state where the carcass was recovered. This is followed by the year designation followed by the sequential number of the carcass recovered for that year. Therefore MSE9504 is the fourth carcass recovered in the southeast region of Florida during 1995. Animals that are injured and captured alive are brought to rehabilitation centers. If they die within 12 months of their capture, they are included in the mortality data set. Their identification numbers will appear different and will correspond to the rehabilitation facilities' numbering systems.

Mortality is divided into the following categories: watercraft-related (DCODE = 1), flood gate/canal lock (DCODE = 2), other human related (DCODE = 3), perinatal (DCODE = 4), cold stress (DCODE = 5), other natural (DCODE = 6), undetermined (DCODE = 8, 9), verified not

recovered (DCODE = 7). Examples of other human related mortalities include: animals drowned in nets, entangled in ropes, or stuck in drainage culverts. Occasionally, animals are speared or shot. Perinatal manatees (newborns) are those less than 150 cm in total length that die from causes other than human-related activities. If a perinatal manatee was killed by a human-related activity, the mortality would be classified by that cause and not as a perinatal mortality. Animals succumb to prolonged exposure to cold temperatures. Cold stress is actually a form of natural mortality that, since 1986, has been classified separately. Natural mortalities result from infectious processes and anomalies. Manatee carcasses too decomposed to accurately determine a cause of death are categorized as undetermined. Occasionally, carcasses are reported by reliable sources but are lost before they are recovered; these animals are categorized as verified but not recovered.

Each case becomes a database record that includes 105 fields containing information like identification codes, geographic location, cause of death, carcass condition, date reported, length, sex, county, and body morphometrics. Latitude and longitude coordinates of manatee mortalities are generated into an ARC/INFO point coverage. Verification of all coordinates is accomplished using detailed textual descriptions of the carcass locations, Florida Marine Patrol reports, and phone calls to citizens who reported the dead animal, when necessary. Staff who recover carcasses mark the mortality locations on navigation charts or USGS topographic maps, calculate coordinates and provide written descriptions to facilitate verification of points by GIS personnel. Most of the mortality data incorporated into GIS are relatively straight forward. The location information is where the carcass was recovered and may not be the location at the time of death. The amount of drift of the carcass after death is not known so the recovery location is considered the most reliable data available. In Appendix A, GIS maps depict manatee carcass recovery sites in Tampa Bay from 1974 to 1995 for watercraft collisions (Figure 3), perinatal deaths (Figure 4), and natural causes (Figure 5).

From 1985 through 1995, 117 manatee deaths were verified in Hillsborough, Manatee, and Pinellas counties (Table 2). Twenty two deaths caused by collisions with watercraft comprised 19 percent of the total. Perinatal manatees, those animals less than 1.5 m long and still dependent on their mothers, constitute the largest class of manatee deaths (32% of the total) in Tampa Bay. Nearly half of the perinatal mortalities result from natural causes (predominantly bacterial infections); the remaining animals are too decomposed to determine a cause of death. It is plausible to assume, however, that stress factors such as boat strikes or near misses, early separation from or abandonment by mothers due to human disturbances, and mortality of mothers with calves can play a contributing role in some of the perinatal deaths. The "Other Natural" category (20% of all deaths) includes animals that died as a result of natural phenomena such as infections, cold-related stress, and advanced age. The "Undetermined" category (21%) includes juveniles and adults that are generally too decomposed for the MMPL staff to determine a specific cause of death.

Table 2. Causes and numbers of manatee deaths reported in the Tampa Bay area from 1985 to 1995. Data from the Florida Department of Environmental Protection, Marine Mammal Program.

CAUSE OF DEATH	YEAR DEATH REPORTED											TOTAL
	85	86	87	88	89	90	91	92	93	94	95	
Watercraft	3	2	0	1	3	1	3	4	0	5	5	22
Gate/Lock	0	2	0	0	0	0	0	0	0	0	0	2
Other Human	0	0	0	1	1	0	0	0	0	0	0	2
Perinatal	2	2	4	4	3	5	8	3	1	2	4	38
Other Natural	1	0	1	1	2	3	1	1	5	5	3	23
Undetermined	2	3	0	0	0	5	2	1	2	4	6	25
<b>TOTAL</b>	<b>8</b>	<b>9</b>	<b>5</b>	<b>7</b>	<b>9</b>	<b>14</b>	<b>14</b>	<b>9</b>	<b>8</b>	<b>16</b>	<b>18</b>	<b>117</b>

Each month, a report is distributed that provides information on the most recent month's deaths and rescues. The GIS mortality coverage and SAS mortality data base are both verified updated, and provided to the FDEP management staff at the Bureau of Protected Species Management. Two recent publications analyzed manatee mortality due to watercraft (Wright et al., 1995) and reviewed statewide mortality trends (Ackerman et al., 1995).

### Rescue and Rehabilitation

Staff at the FDEP MMPL are responsible for coordinating the rescue of injured manatees statewide in cooperation with the USFWS Manatee Coordinator in Jacksonville. A manatee-rescue boat was designed by MMPL staff to deploy a 120 m net with a 9 m drop so that injured animals can be captured in most situations encountered. Injured manatees rescued in Tampa Bay are usually transported to either of two manatee rehabilitation facilities: Sea World in Orlando or the Lowry Park Zoo in Tampa. Sea World has participated in manatee rehabilitation since the 1970s. The Lowry Park manatee hospital was completed and began taking injured animals in mid-1991.

The goal of the rescue and rehabilitation process is to treat the animals and then release them back into the wild population. In 1990, Sea World successfully treated and then reintroduced into the wild a juvenile male who had become entangled with a crab trap in the Palm River in Tampa. In August 1992, he was tagged during the west coast telemetry project discussed below and continues to range over the entire bay area from northern Sarasota Bay to the Hillsborough River and Old Tampa Bay. Between 1990 and 1993, six manatees were rescued in the Tampa Bay area by FDEP staff. Two animals were assisted and released on site. Four others were transported to the

rehabilitation facilities for additional treatment; two died within days. The two surviving manatees, both females, were fitted with satellite transmitters and released near the location of their capture. One female, released from Lowry Park Zoo into the Braden River in June 1993, is using habitats from Tampa Bay to Charlotte Harbor; her movements continue to be monitored by satellite telemetry and field observations. The other female was released from Sea World in July 1991 at the west end of the Gandy Bridge in St. Petersburg, but she lost her transmitter in October 1991. Her carcass was recovered in Boca Ciega Bay during December 1993; cause of death was determined to be a massive systemic infection.

## **Ecology and Migration**

Staff of the FMRI Marine Mammals Research Project have used satellite and radio transmitters on manatees, primarily in Tampa Bay, since February 1991 to determine habitat utilization patterns, to delineate long-range migratory routes and short-term movements, and to accumulate observational data on individual manatees. The FMRI west coast telemetry project is scheduled to conclude in 1996 following a nine month pilot project and five full years of field work. The tagging process involves capturing manatees (usually at a power plant in winter), fastening a belt around the narrow part of the tail stock, and attaching a floating transmitter housing to the belt by using a four-foot semi-rigid nylon tether. The capture and tagging are conducted under authority granted by US Fish and Wildlife Service Permit Number PRT-773494.

The signal from a satellite transmitter is processed by the Service Argos receivers on NOAA's TIROS weather satellites, giving location coordinates along with the date and time of the location, water temperature, and animal activity. Data are delivered to FMRI daily via the Internet or are downloaded by staff in St. Petersburg after a satellite pass when it is necessary to get a location later in the day. Research teams working in the field use the satellite locations to determine general areas where manatees are located; the location accuracy varies from 150m to 1km. Field crews use the VHF radio signals from the tag to locate a tagged manatee either using a boat or from the shore. Staff members can then observe the manatee and record its behavior and movements or perform necessary maintenance by switching out the tag housing.

By following the movements of individual manatees in fresh-water, brackish-water, and saltwater habitats, valuable information is obtained about manatee behavior and preferred habitat. From the start of the project through the end of 1995, 54 manatees were tagged and tracked, including 23 males and 31 females. Fifteen of these animals, four males and 11 females, had been in rehabilitation programs. Wild manatees tagged in Tampa Bay ranged as far south as the Ten Thousand Islands in Everglades National Park and north of the Suwannee River before returning to the Tampa Bay power plants in the winter.

Analysis of the telemetry-derived location data using the Marine Resources Geographic Information System (GIS) has been initiated. Locations obtained by the satellites and visual observation are entered into the GIS, scanned for errors, and verified. Some satellite locations fall



on land; those points that are within a one standard deviation tolerance distance are moved to water and the rest are eliminated from analyses. A customized software routine was developed that uses the GRID module of the ARC/INFO GIS to connect sequential locations using a model based on a relationship derived from the correspondence between visual observations and water depth. The model approximates manatee behavior and most of the movement paths are located in shallow water habitats. However, movement across deep water areas is possible in the model. More complex analyses have been developed to estimate travel corridors, primary habitat, and time spent in specific habitats for individual tagged animals. Three posters using telemetry data were presented at the 11th Biennial Conference on the Biology of Marine Mammals held in Orlando in December 1995: Monica Fitzgerald, Richard Flamm and Brad Weigle analyzed "Movement patterns of radio-tagged female manatees"; Sherry Boddery, Beth Wright, Leslie Ward, and Suzanne Tarr worked on "Winter movements of radio-tagged manatees between warm water sources on the west coast of Florida"; and Weigle and Flamm won the Excellence in Science Communication Award for "GIS analyses for estimation of manatee habitat utilization and migratory corridors."

As the database of tagged-animal locations grows, patterns are beginning to emerge about migratory routes around Tampa Bay and north and south along Florida's west coast. Areas of high utilization, individual activity patterns, travel corridors, and habitat preferences are also being documented. Preliminary data indicate that as animals increase in size, the average monthly movement increases; females with calves are the primary exception. Immature manatees and adult females with calves generally confine their activities to well-defined ranges in the area where they were captured or released. In contrast, adult males and females without calves have traveled extensively outside the Tampa Bay area. Males tend to travel distinct circuits, probably to locate females in estrus.

Over 25,000 point locations of tagged manatees have been collected during the pilot study and first four years of the telemetry project. Analysis techniques to represent the data in ways that are comprehensible to both scientists and the public have been developed and are continuing to be refined. As the field portion of the project winds down in December 1996, the project staff will place an increased emphasis on timely completion and publication of the results of data analyses to provide additional input into the manatee protection efforts. Planning for the final report has already been initiated and time lines for report generation do not extend past the end of 1997.

### Life History and Biology

The FMRI Marine Mammals Program has assumed responsibility for maintaining the portion of the statewide manatee scar catalog for the area extending from Pinellas County south through the Everglades National Park in Collier County. The National Biological Service's Sirenia Project in Gainesville has been the primary repository for manatee scar photographs since the catalog's inception in the early 1970's. A computerized Manatee Individual Photo-identification System (MIPS) was developed by the Sirenia Project to store information on the location and type of scars found on many juvenile and adult animals. Both scar sketches and representative photographs of

cataloged animals are available on the computer system for comparisons to photographs of newly photographed manatees. When known animals are identified, the computerized system allows researchers to track the movements of distinctively scarred manatees over time, as well as examine survival and calving rates.

In 1995, a full time OPS staff member was hired to manage the FMRI portion of the catalog and to accumulate manatee scar photographs throughout the year at known high-use habitat locations. Photographs of all manatees brought to the Marine Mammal Pathobiology Laboratory for necropsy are also compared to those in the southwest Florida catalog at FMRI and then to the rest of the catalog at the Sirenia Project office in Gainesville. All animals netted during telemetry captures in Tampa Bay are added to the catalog as are animals photographed during field tracking of tagged manatees. During the winter of 1995-96, photographic efforts at the TECO power plant began on November 11, 1995, and ended on March 23, 1996. A total of 44 days were spent in the field accumulating scar photographs. The Tampa Bay portion of the catalog contains 123 manatees, including 23 animals newly added during the 1995-96 winter. Identifications were made on 17 animals that had been tagged previously during the telemetry study. Four of the previously tagged females were accompanied by calves. Six animals in the catalog have been photographed in the Ft. Myers area during cold months in previous years. One of the tagged manatees moved from Ft. Myers in November to TECO where she was retagged on January 5, 1996. Eight animals in the catalog have been seen in the Sarasota area during non-winter months. The catalog has also proven useful in identifying some of the manatees that died during the epizootic outbreak in southwest Florida during spring of 1996.

Beginning in 1993, each animal captured during the telemetry project was implanted with a pair of passive integrated transponders (PIT tags) that provide long-term marking of individuals for identification purposes. The PIT tags are about the size of a grain of rice and have no power source and therefore must be scanned from a distance of less than 10 centimeters. However, the tags are extremely reliable and should provide positive identification of individuals throughout their lifetimes. The PIT tags have already proved to be very beneficial in identifying dead manatees that are badly decomposed when recovered. Through July of 1995, sixty-four manatees have been implanted with PIT tags since the initial testing in 1991. The tagged animals include 30 rehabilitated animals and 34 free-ranging manatees caught during winter or open water captures for the telemetry study. The Sirenia Project has also begun implanting manatees with PIT tags as part of their research program and will provide the MMP with the identification numbers for the statewide database and for the possible identification of dead manatees arriving at the Marine Mammal Pathobiology Laboratory. A manuscript by Beth Wright and Scott Wright detailing the procedures used to implant PIT tags in manatees has been submitted for publication in a refereed journal,

Ultrasound measurements of manatee blubber thicknesses are collected during telemetry and rescue captures for comparisons with measurements from dead and injured animals, with the goal of establishing a technique to evaluate animal condition. Staff member Leslie Ward-Geiger prepared the study plan for the project as part of a Master's degree program at the University of South Florida's Department of Marine Science. Blubber thickness varied with reproductive status and sex

in free-ranging animals longer than 235cm, and was greatest in pregnant females, followed by lactating females and then males. Blubber thickness was generally found to be greater for long-term rehabilitated captives than for free-ranging manatees. Body condition of rescued emaciated manatees was significantly poorer than that of apparently healthy animals of similar lengths. Predictive models were developed to use easily collected morphometric data to predict weight and to interpret body condition of free ranging healthy manatees. The data are less clear than is the case for pinnipeds which have temporally and spatially distinct feeding and breeding. Nonetheless, the manatee models are proving useful to help assess whether free-ranging individuals are undernourished and may require care. The models are also being used to suggest whether rehabilitated captives have adjusted properly following reintroduction to the wild. The study report, written as an extensive Master's thesis, is scheduled for completion in early 1997.

### **Manatee Geographic Information System,**

A Geographic Information System (GIS) is a computer-based mapping system that is designed to manipulate, analyze, and display large volumes of spatial data. A key function of GIS is integrating co-referenced data layers to create files that pictorially or numerically answer queries. GIS's ability to integrate, analyze, and display spatial data makes it a principal tool of ecosystem management. Staff of the Marine Mammals program have been using GIS software to manage manatee data since 1987 (Weigle and Haddad, 1990).

The Marine Resources Geographic Information System (MRGIS) contains data bases dealing with marine, fresh-water, and wetland natural resources in Florida. It also contains some hydrologic and human-related features. The complete system will provide agencies with access to data for use in project planning and review and access to analytical techniques that enhance our interpretations of the data. Ultimately, the MRGIS will be an ecosystem management tool focusing on evaluating impacts of human activities on the manatee population and its habitat. Currently, local governments are using the Department's GIS in the production and implementation of their comprehensive growth management plans.

Within the FMRI Marine Mammals Program, the MRGIS allows research staff to view and analyze data in a variety of ways based on ranges of dates or other data attributes within geographic areas defined by the user. Layers available for manatee-related uses may include aerial sighting locations, satellite telemetry locations, carcass recovery sites, water depths, vegetation coverage, channel and regulatory sign locations, some boating speed zones, and shoreline development characteristics. The data and mapping provided by GIS staff are used extensively in the preparation of research project reports and presentations. Management staff use the same data to prepare manatee protection speed zone rules and assist in decisions for manatee protection plans.

At FMRI, manatee database development continues with routine entry of monthly mortality records. Data for aerial surveys flown by DEP staff over the last ten years have been entered and most are verified. Aerial survey flight paths are also being digitized and verified. Integration of

coordinates from global positioning system receivers have been used to create data layers for ongoing aerial surveys. These digitized aerial survey routes are used in mapping manatee abundance. Additional small waterways are digitized on the statewide shoreline map when necessary. Data from the ongoing west coast satellite telemetry project are also processed and incorporated into the MRGIS but the data are not scheduled for distribution until the end of the telemetry project.

Staff of the Manatee GIS project organize meetings of the Manatee GIS Coordinating Team. This group is comprised of representatives from FDEP, the U.S. Fish and Wildlife Service, National Biological Survey, the Marine Mammal Commission, and an independent GIS expert. The GIS Coordinating Team was created to develop and implement an operational plan for the Manatee GIS and oversee the Manatee GIS Working Group. Coordinating Team meetings are held twice a year in St. Petersburg. The Working Group is made up of people with an interest in using or contributing manatee GIS data and includes representatives of city, county, regional and state governments, private organizations including the Marine Industries Association, graduate students from various universities, and a number of consultants and private research groups. It is important to note that some members of the Manatee GIS Working Group oppose additional manatee protection. Four meetings of the Working Group have been held, also in St. Petersburg, to discuss GIS concepts including data acquisition, data sharing, and data-use ethics.

Analyses of mortality, aerial survey sightings, and telemetry data are conducted, reviewed, and are being refined in conjunction with input from project scientists, managers, and the GIS Coordinating Team. Aerial survey data analyses are focused on creating contoured surfaces illustrating manatee abundance patterns within the aerial survey route using a technique called spatial filtering. All verified aerial survey data have been filtered and maps were delivered to a contractor for use in assembling a set of Environmental Sensitivity Index maps that show areas of high manatee occurrence along with other marine species. Analyses have been initiated to examine the relationship between manatee abundance and habitat variables such as bathymetry, distance to seagrass, and distance to fresh and warm water discharge sites. Results of abundance/habitat analyses will help identify those areas that are potentially important habitat for manatees. Using satellite telemetry data, computer programs were written that estimate travel paths between two recorded animal locations. Rules based on observational relationships between bathymetry and animal sightings were incorporated into the program to estimate the travel paths; travel over shallow water was preferred because manatees tend to avoid deep water. Additional refinement of the analytical techniques are ongoing and remains a priority. Results of this analysis will help identify areas where animals spend considerable time, estimate the location of travel corridors, and permit modeling of manatee habitat utilization.

Two projects mentioned above deserve further explanation. The MRGIS reference guide is a guide for using manatee GIS data. It explains how the data is structured, the meaning of fields within each file as well as technical meta-data that describes the precision of data, collection techniques, map projection and datum, limitations of the data and suggested uses. The CD-ROM is a compendium of manatee data, primarily in GIS format. It includes the reference guide, mortality and aerial survey data created and used by the Department in manatee research and rule creation.

A test version of the CD-ROM included with this report is a test version distributed to members of the Manatee GIS Coordinating Team to look for errors and verify meta-data and text files. The final production CD-ROM, Version 1.0, is included with this report. Additional copies of the CD-ROM may be obtained by contacting the Marine Mammals Program, 100 Eighth Avenue Southeast, St. Petersburg, FL 33701 (813 896-8626). Future versions of the CD ROM will include addition manatee and habitat data, sample GIS programs, plot-ready maps, graphic images, and data provided by other members of the Manatee GIS Working Group. GIS data are being solicited from all known manatee researchers for this project.

## **ADEQUACY OF TAMPA BAY DATA FOR MANAGEMENT PURPOSES**

Managers were asked to list and rank the primary data sets used for statewide manatee protection efforts. Data sets that are available in GIS format were generally considered to be the most important information sources used for planning and protection. Both mortality distribution and extended-area manatee distribution surveys are extremely useful to managers in establishing manatee protection zones. Those two data sets were the first manatee data to be converted to GIS format and are now considered the standards necessary to evaluate and defend protection efforts throughout the state. Maps using points depicting locations of manatee deaths or groups can be created showing any specific time frame, from the entire set of data to a month of the year to a single week or day. Other GIS data sets that enhance the basic manatee data sets are also utilized to determine specific habitats that require protection. Examples cited included the shoreline coverage, bathymetry contour lines, sea grass distribution, marked boating channels, and county boundaries.

In many areas of the state, additional data are available but not yet accessible to managers in a usable format. Analyzed aerial survey data showing manatee density in specific areas had not been systematically provided to managers at FDEP in Tallahassee before the release of the CD-ROM. Another GIS data set mentioned as a valuable asset for protection plans would show locations where sick or injured manatees have been rescued. While the data are available in a database, only recently have the MMP GIS staff started to convert the data into a GIS coverage. Progress on the conversion is dependent upon availability of staff to enter and verify location coordinates. Other data listed that would be helpful to management staff included water temperature, boat traffic, marina and ramp locations, speed zone compliance, and responses of manatees to boat traffic.

Telemetry point data showing locations of individual animals have not been provided to managers for several reasons. Research staff have concerns that the telemetry data will be utilized like aerial survey data although the telemetry data shows movement of individuals over time instead of distribution of animals at a single point in time. Partial results from an extended telemetry project will only represent a small portion of the population, skewed towards the behavior of the few animals that have been tagged. Over the course of a five year telemetry project, enough animals are tagged to allow generalizations to be made that can not be ascertained using only the subset of the data available in the early years of the study. In addition, the accuracy of individual data points is variable from 150m to 1km, unlike aerial survey data that can be mapped with a high level of accuracy.

Analyses to accommodate these concerns with the misuse of telemetry data are under development as discussed in the Ecology and Migration section. It is anticipated that telemetry data should be available shortly after conclusion of the west coast project.

Managers were asked to rate manatee and environmental data for Tampa Bay on a scale of 1 to 10 (lowest to highest) in comparison to data for other areas of the state. All questionnaire respondents rated Tampa Bay data at level eight or above, primarily citing the immediate proximity of FMRI to Tampa Bay. Four management staff rated Tampa Bay data at a "10" level and one rated it as an "8". No other area of the state was rated higher for completeness of data. One research staff member gave Tampa Bay data an "8" rating, with Florida Bay and the Everglades rating a "10" in comparison. Individual responses to the questionnaire are provided in Appendix B.

## **RECOMMENDATIONS FOR PROGRAM CHANGES**

Suggestions to improve every project were proposed by both research and management personnel. Many of the proposed changes were directed at obtaining additional information from data that are already collected. Other suggestions involve new research directions that would cover both Tampa Bay and other areas of the state that would cost large amounts of money not currently available to the MMP.

### **Population Monitoring.**

While aerial distribution surveys are widely available as GIS data layers, managers do not have access to GIS data coverages of synoptic survey data. Of the seven synoptic surveys that have been flown, only three have been entered into the GIS and verified. The other four surveys need to be prioritized for processing by the population monitoring program. Managers also requested information on results from the line-transect method of aerial surveys that was tested in Brevard County and in Collier County. When evaluating specific areas for manatee protection, data on the exact location of manatees in relation to boat channels is required and not readily available in existing data. Managers would also stated they would use data on the time of specific sightings and direction of travel, if collected. They also requested data on boating activity that would require additional surveys or another way of collecting data such as photographs or video.

### **Mortality and Rescues.**

Mortality data are provided to managers in two formats on a monthly basis: a GIS data set with basic attribute data and the entire SAS mortality data set. Managers could easily use additional data from the necropsy SAS database if it were provided as additional fields in the GIS data coverage and could thereby reduce or eliminate the need to refer to individual necropsy reports. In addition, requests were submitted that included sub-coding causes of death to more easily access data on specific types of watercraft deaths, like propellers and impact; sub-categories of other human related deaths such as debris, crab traps, or monofilament; different types of natural causes, like pneumonia

or reproductive problems; and coding perinatal records by development stage like aborted fetus, stillborn, or information about stomach contents. Another suggestion involved moving the SAS database to a more user-friendly database like ACCESS, where query icons can lead users through menu choices. While age data can be determined from sectioning ear bones from carcasses and reading the growth rings, the ear bones need to be rapidly processed and included in the mortality database for use in population modeling.

### **Ecology and Migration.**

Field activities for the west coast telemetry project centered on Tampa Bay will conclude in December 1996 but field capabilities need to be maintained to monitor rehabilitated manatees released from captivity. Staff also need to look into new technologies for utilizing global positioning receivers in transmitters to collect more frequent and precise location information. Analyses of data and generation of a final report on the study need to be of paramount importance immediately following the conclusion of the project field work to ensure that managers have the information in a timely manner.

### **Life History and Biology.**

Extensive progress has been made by incorporating Tampa Bay and southwest Florida scar catalog information into the statewide Photo-identification system managed by the Sirenia Project. However, the entire catalog needs to be made available to FMRI in order to quickly match dead manatees against the statewide catalog and to document movements between Tampa Bay and northwest Florida. In addition, locations where identification photographs were taken need to be added to the GIS system along with sighting data to allow analyses of this important but sparingly used resource. Photograph acquisition also needs to be a year-round project, targeting non-winter areas where manatees are likely to be found. A dedicated project boat is required along with part time help to assist in field work and photograph processing. The full time OPS staff position should be converted to an FTE career service position since significant skill, experience, and continuity are required to fully benefit from the available data in the catalog.

Information on manatee behavior is generally not being collected during aerial surveys because of the difficulty in determining behavior while flying at 80 mph. Managers could use specific data about how manatees utilize specific habitats and how manatees respond to approaching boats. Previously an airship has been used to conduct behavioral research and boat/manatee interaction studies and it was suggested by several managers that additional studies be conducted using the airship platform. An airship could also be tested for acquisition of scar photographs and photogrammetric analysis of images to determine animal length.

### **Manatee GIS**

The Manatee GIS module of the Marine Resources GIS should continue to work with all of the other research projects to make data readily available to managers. The next version of the CD-

ROM should also include a user-friendly access system that incorporates ArcView as the primary tool for data query and display. A license that would be restricted to the manatee data sets could be provided on the CD for a minimal cost. Additional workshops need to be held to inform other managers of the availability of manatee data and to solicit new ideas for data analyses.

### **Statewide research.**

Managers proposed new statewide research projects that would provide answers to questions and problems that continue to arise. Estimation of the manatee population size requires good information on mortality, natality, calf survivorship, and the age structure of the population. One proposal to acquire some of the data involves the use of PIT tags to conduct a mark-recapture study of the population. Several inherent problems exist with a large PIT tag study including the need to tag at least 100 animals a year for a number of years and lack of a tag reader that is effective over an extended distance. Data are also necessary on voluntary compliance with boating speed zones, the effect of channel marking on propeller scarring of adjacent sea grass beds, and manatee reactions to approaching boats in a variety of habitats.

One of the most practical suggestions from managers involved hiring additional staff for analyses of data that have already been collected or freeing up existing staff to do analyses by hiring new field staff. Either scenario would be beneficial in providing more timely reports by finishing existing or recently completed field studies than by could be achieved by starting new projects. Because of the time already invested in project initiation and data collection, most scientists would probably want to hire staff for field operations so they could complete the analyses and write the reports. Again, funding levels will dictate future research and management directions.



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## APPENDIX A.

Five GIS maps depicting distribution of live manatees and locations of manatee mortality in Tampa Bay, Florida.

Figure 1. Winter distribution of manatees around Tampa Bay derived from spatially filtered aerial survey data, 1987-1994.

Figure 2. Non-winter distribution of manatees around Tampa Bay derived from spatially filtered aerial survey data, 1987-1994.

Figure 3. Locations of watercraft-related manatee mortality in Tampa Bay from 1974 to 1995.

Figure 4. Locations of perinatal manatee mortality in Tampa Bay from 1974 to 1995.

Figure 5. Locations of other natural manatee mortality in Tampa Bay from 1974 to 1995.

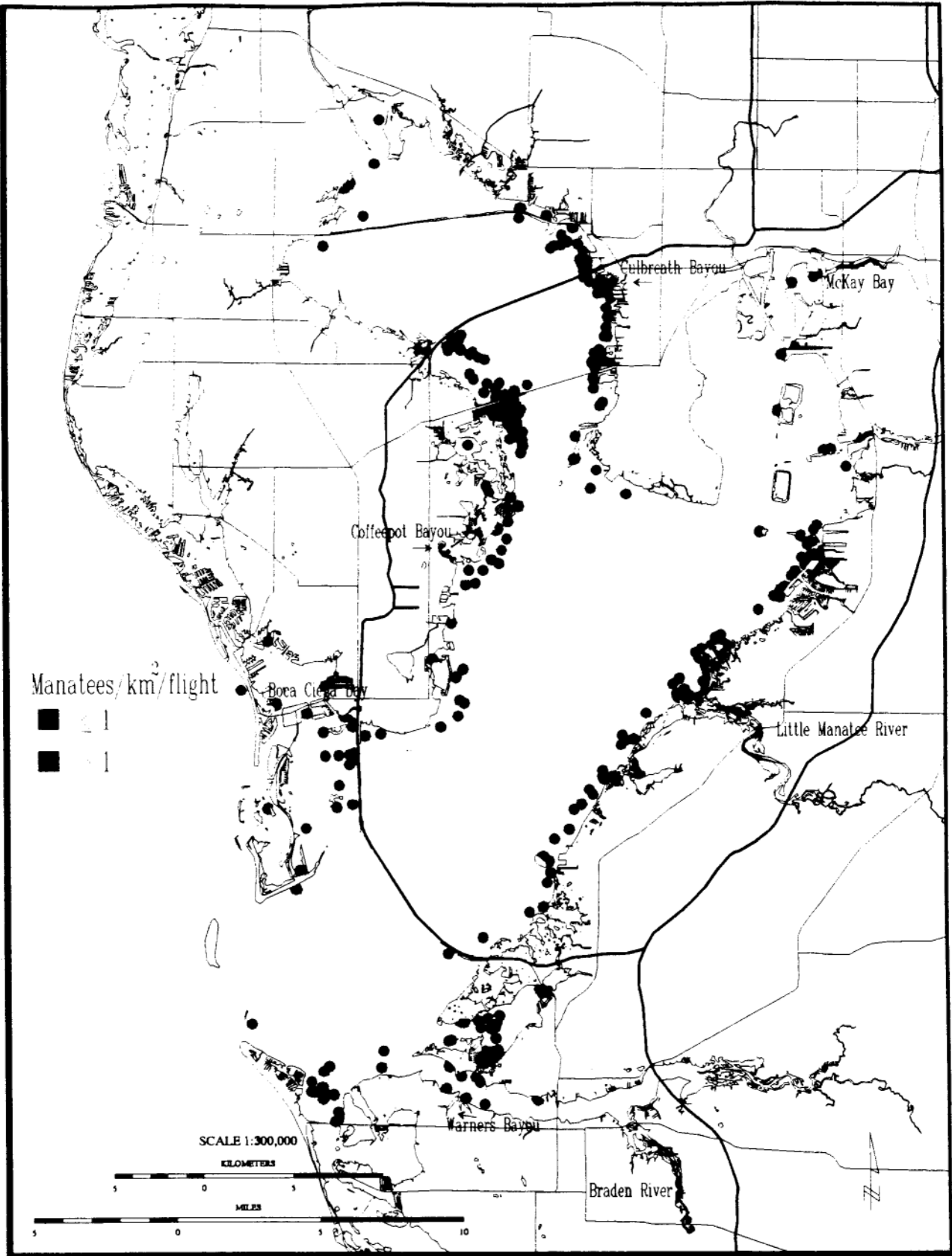
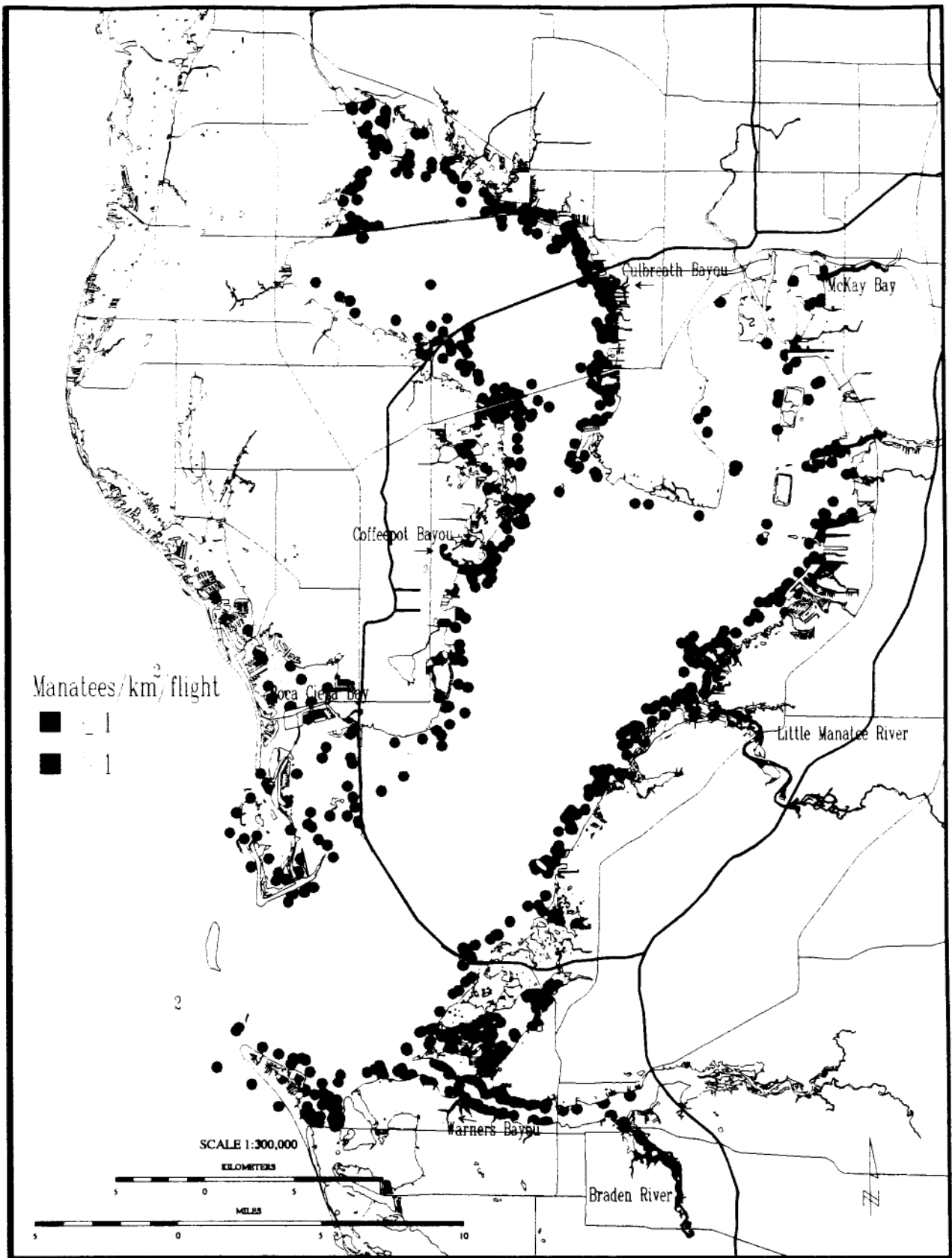


Figure 1. Winter distribution of manatees around Tampa Bay derived from spatially filtered aerial survey data, 1987-1994.



**Figure 2. Non-winter distribution of manatees around Tampa Bay derived from spatially filtered aerial survey data, 1987-1994.**

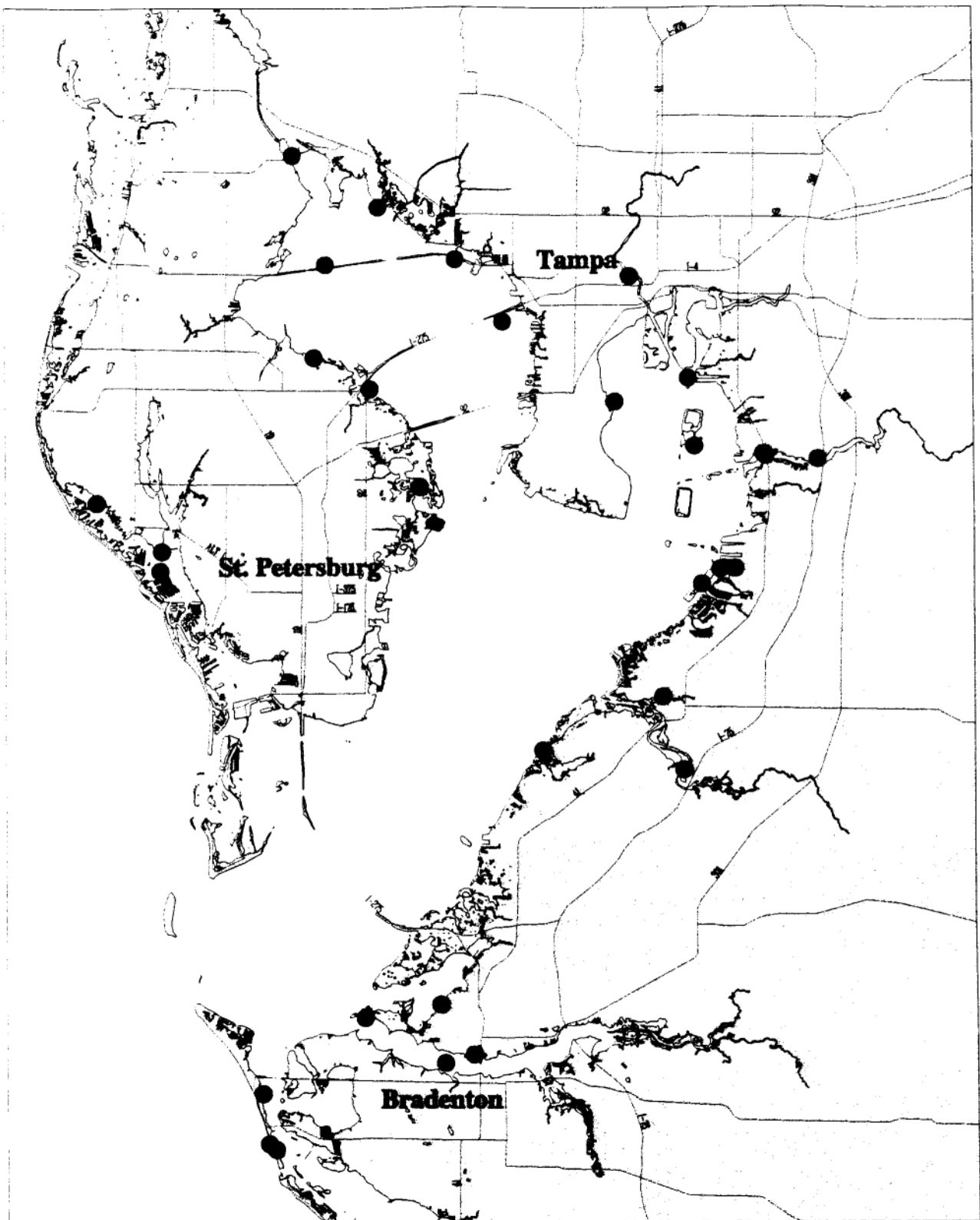
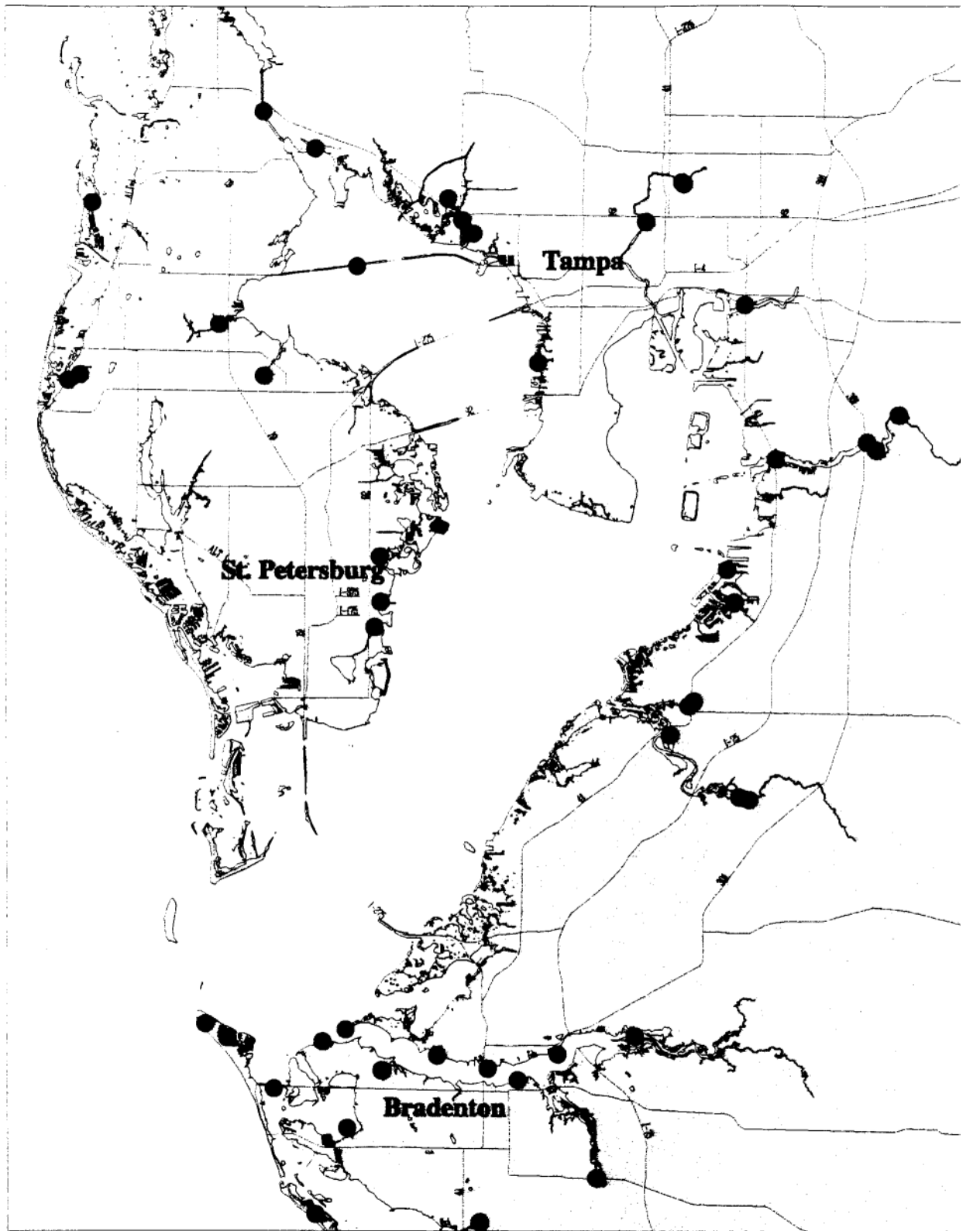
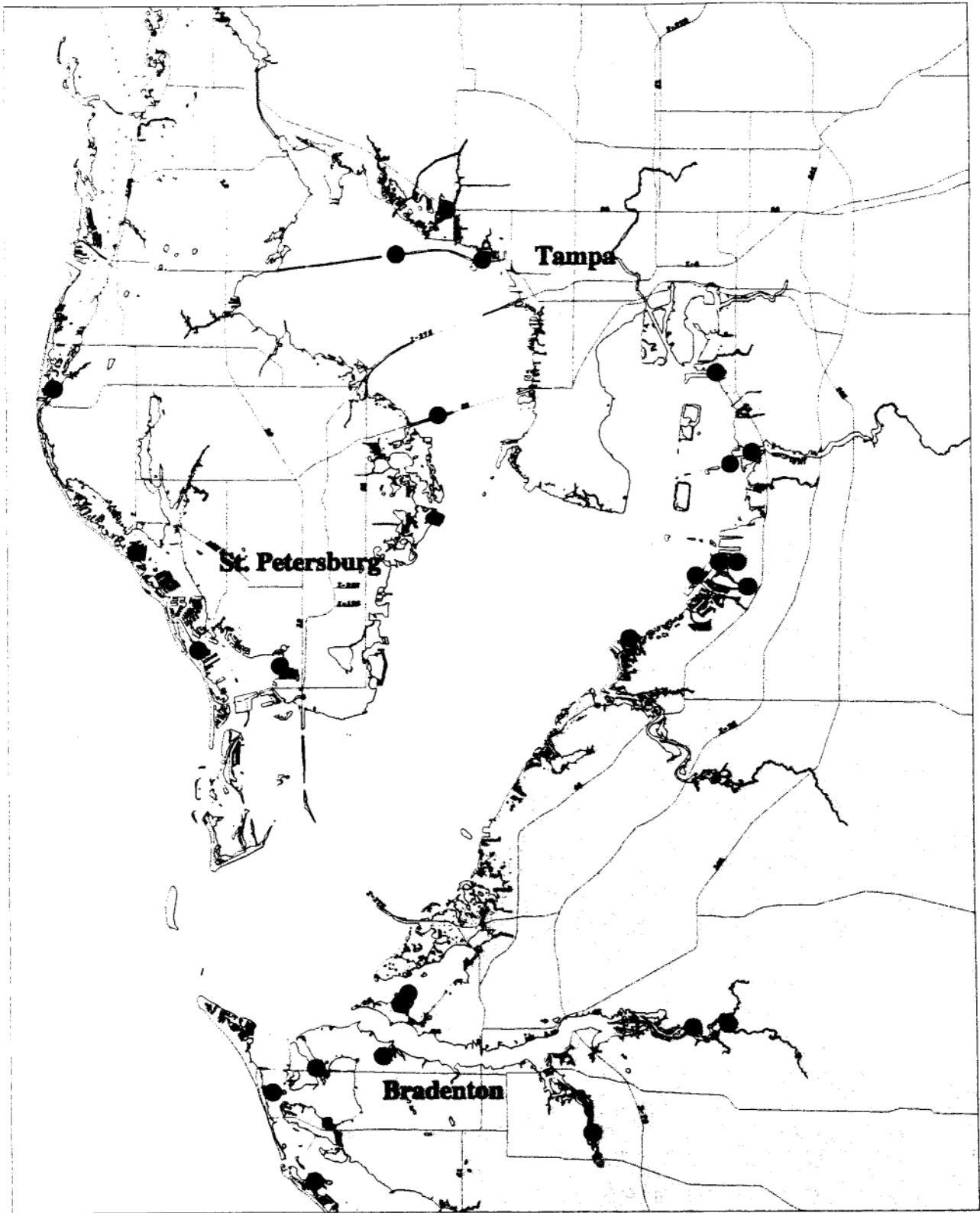


Figure 3. Locations of watercraft-related manatee mortality in Tampa Bay from 1974 to 1995.



**Figure 4. Locations of perinatal manatee mortality in Tampa Bay from 1974 to 1995.**



**Figure 5. Locations of other natural manatee mortality in Tampa Bay from 1974 to 1995.**



## APPENDIX B. MANATEE DATA QUESTIONNAIRE

### QUESTION #1

What are the primary data sets you use to create and evaluate areas for statewide manatee protection efforts? Please prioritize the list from most important to lesser importance and denote whether the data are available as a computerized database or as a GIS coverage. Also note if each data set is available for the Tampa Bay area (Pinellas, Hillsborough, Manatee Counties) and you have access to it.

- 1001 1- GIS covers of point locations from manatee distribution surveys  
2- GIS and SAS data on manatee salvage  
3- Knowledge of waterway characteristics including bathymetry, size and shape of waterway, presence of marked channels, boating patterns. These data are from nautical charts, maps, site visits, local knowledge, expert advice, boating studies, boat facility studies, etc  
4- Telemetry data (GIS, reports, summaries, personal communication with researchers)
- 1002 I do not access any data directly by computer at this time. I only review the work performed by others, so in a sense I am not creating coverage areas from the data.
- 1003 1- Aerial survey distribution data (database and GIS, exists for Tampa Bay). Tampa Bay, and many other areas.  
2- Mortality data (database and GIS, exists for Tampa Bay).  
I do not have ready access to these data sets.  
3- Florida Power and Light power plant surveys (database, not GIS) (I have)  
4- Crystal River National Wildlife Refuge, Blue Spring State Park winter counts (not computerized) (I have)
- 1004 Aerial survey, mortality, satellite telemetry, VHF telemetry, bathymetry, seagrass coverage, photo-identification, rescues, and other observational data (such as sightings reported by individuals). These are the primary data sets used to evaluate manatee use. Other data are **also** used when evaluating the need for protection, such as vessel traffic pattern and density data, and navigation charts (for locations of channels, etc.). Essentially, we use any data that provide useful information but what we use for a specific area is obviously limited to what is available.
- The aerial survey and mortality data are available to us as both computerized databases and GIS coverages. The telemetry data exist as both but are available to us primarily as maps of individual locations plotted from a GIS coverage. This situation varies somewhat depending on the area of the state being examined. For some areas, we have written summaries in addition to (or instead of) the maps; for other areas, we don't have any of the data. Bathymetry data has traditionally been available to us only from navigation charts but we have recently acquired the data as both a computerized database and as a GIS coverage. For the areas where seagrass coverage data have been available, it has been mainly from plotted GIS coverages but this situation has changed recently with our acquisition of GIS coverages for many parts of the state. Photo-identification and rescue data exist as both (I believe) but are available to us primarily **as** summaries printed from computerized databases. The availability and source of all other data varies. Most are available to us only in printed form (either map or text) but some are available to us as computerized databases and/or GIS coverages.

As far as I know, all are currently available for the Tampa Bay region.

- |      |  |   |  |
|------|--|---|--|
| 1005 | GIS/ArcView:<br>1- mortality<br>2- aerial survey (not available for wcoast)<br>3- shoreline<br>4- county | SAS:<br>1- mortality<br>2- Charlotte harbor<br>3- Tampa Bay | Printed maps when available:<br>1- VHF & Satellite telemetry |
|------|--|---|--|
- 1006 Mortality, shoreline, aerial survey, telemetry, seagrass, roads, bathymetry, boating studies, aid to navigation, navigation channels.  
All but telemetry are available, although many need work.
- 1007 1- Mortality - computerized and GIS  
2- Aerial Survey - GIS  
3- Telemetry - computerized and GIS  
4- Seagrass - GIS  
5- Rescue - computerized  
6- Scar catalog - computerized

The order of importance varies depending on the age and availability of data and the characteristics of the **area** under consideration. I am sure I have access to Tampa Bay data, but it is not an area with which I work.

- 1008 Seagrass coverage, aerial survey, mortality, and bathymetry. All are available as both computerized databases and GIS coverages, but I primarily rely on plotted GIS coverages. All are currently available for the Tampa Bay region mostly due to the fact that FMRI operates in this area, and FMRI is the primary original data source.

## QUESTION #2

What additional environmental and manatee-related data sets would you use that are not currently available to you? Please prioritize.

- 1001 1- Telemetry data (shown as points, travel routes, time allocation in areas, final reports)  
2- Aerial survey data shown in density (vs. point)  
3- Manatee boat interaction data
- 1002 1- West Coast of Florida telemetry data  
2- Database of injured animals that were rescued.  
3- I'd like to be able to see water temperature (satellite) and aerial photography (real pictures of shoreline analogous to what Beaches and Coastal Systems has for the ocean shoreline).  
4- I don't know if we have complete seagrass coverages but if we don't, that would be great.
- 1003 1- Mortality data (SAS database).  
2- Long-term water temperature data from fixed stations.

- 3- Long-term air temperatures data from fixed weather stations.
  - 4- Long-term water temperature data from power plants.
  - 5- Count data and weather data from Crystal River National Wildlife Refuge and Blue Spring State Park.
  - 6- Water temperatures from satellite radio tags.
  - 7- Rescue data (database, not yet GIS?).
- 1004 More telemetry data. More data on manatee habitat utilization patterns and behavior (especially behavioral data on manatee responses to vessels).
- 1005
- 1- West coast telemetry per GIS/ArcView
  - 2- Seagrass per GIS/ArcView
  - 3- Database for recovery/rescue; be able to search on waterway, county and/or locale
  - 4- Scar catalog (computerized/scanned)
- 1006 Manatee travel corridors with travel times, speed and direction,, marina and boat ramp location and use, boat traffic, speed and direction, land use, population, compliance with speed zones. Seagrass, water depth, water temp and salinity collected real-time would allow analysis of habitat used.
- 1007
- 1- East Coast telemetry data in GIS format. Aerial surveys in Brevard County are so old that this is the only current location data available.
  - 2- Any new Brevard County aerial survey data.
  - 3- Brevard County Banana River transect data entered into GIS.
- 1008 Land use GIS maps, estuarine watershed delineation maps, manatee telemetry (east and west coasts), water column light attenuation isopleths and identified pollutant constituents for estuarine systems (preferably plotted in regional format).

### **QUESTION #3A**

Do you have any suggestions/requests that would make the existing manatee mortality data set more useable?

- 1001 Can't think of anything
- 1002 I have previously suggested that as the database is updated it be sent via computer E-mail to Tallahassee. That would reduce chances of confusion if someone is maintaining separate records. Also, that would provide access to most up-to-date information and free up MMPL folks from having to answer some phone calls that are transferred to them from Tallahassee. As we get a growing subset of animals that we actually "knew" because of a history of sitings or tagging, etc., I see a need to establish a place where the life history of **an** individual animal is accessible.
- 1003 Code carcass records also by sub-categories of death (watercraft: barge, ship, jet ski,

propeller/impact, etc) (natural: pneumonia, red tide, reproductive problems, etc.) (perinatal: aborted, stillborn, abandoned, specific diseases) (human-related: debris, weapon, net, structure, etc.) so they can be retrieved and tabulated, by year, season, region, water temperatures, etc. (These items are presently mentioned in the comments, but not able to retrieved.)

Code carcass records from catastrophes (cold events, red tide, other) so they can be retrieved and tabulated. Re-code records from previous events.

More intensive matching of past and present carcasses to scar photo data set, especially areas covered by NBS.

Code perinatal carcasses by developmental stage (e.g. aborted fetus, stillborn, air in lungs, meconium in intestine, milk in stomach, fetal fold gone, etc.) and specific causes of death, when known, so specific causes can be tabulated by developmental stage, and correlated to length, weight, time of year, and water temperatures. Analysis of the long-term trend in size of newborn carcasses could be very important for population modeling.

Code reproductive status of females (immature/mature, pregnant/lactating). (These items are presently mentioned in the comments, but not able to retrieved.) (Miriam Marmontel computerized available data through 1991.) Analysis of the long-term trend in reproductive rates from carcasses will be very important for population modeling.

Embed specific keywords into records so specific factors and events can be readily tabulated, such as known ID animals, radiotags, rescues, rehabilitated animals, large ship deaths, barges, known vessels, flood gates, canal locks, catastrophes, red tide, etc.

Update age data for population modeling, and analysis of possible long-term trends in age/size of carcasses.

1004 It would be helpful if the computerized database contained more information on the circumstances surrounding the carcass and its condition (maybe in the notes field). Many times we have to refer to the individual necropsy reports to get more information (such as if there was any indication of whether a watercraft-related death was from the prop or impact, or if the animal was likely to have died quickly and hence near the recovery site or if it could have potentially been struck very far from the recovery site, etc.). A more detailed computerized database could reduce or eliminate the need to refer to the individual necropsy reports.

The monthly reports are useful. The only improvement I can think of would be if we could obtain the reports a little more quickly. I know this is not easy but many times, we don't receive the confirmed reports until 4-6 weeks after the end of the month.

1005 I would like to have all available information that is in the SAS database available on GIS, instead a shortened format. ArcView allows merging of two databases, which I use occasionally, but details can be important all the time.

1006 More selection fields. Some have already been addressed such as prop injuries.

1007 A/B- Is there currently a way to determine if any of the animals in the data set were injured by marine debris such as monofilament, but this was not the cause of death? This would be useful in making the case for enhanced litter control, to which believe it or not there is opposition. If this is not currently available in the SAS data base in a format for which a search specifically for this data could be conducted, it would be useful to include for future deaths.

1008 It would seem that SAS analyses are somewhat arcane for general users of the mortality data set. Perhaps duplicating the information in a more user friendly database like ACCESS, where query icons can lead users through menu choices. This would allow accessing the data from any PC without having to reauthorize SAS Department-wide each year. Set menus/icons could be developed to customize search parameters and statistical analyses for various variables. Use would then be more user friendly, and would ultimately reduce paper use (e.g. hard copy production).

### **QUESTION #3B**

Are there other types of data that could potentially be collected during carcass recovery and necropsy that would enhance the data set for you?

- 1001 If it were possible to indicate if the death was very rapid (matter of minutes) lingering (hours) or slow scars (days - weeks). If prop cut could be determined to indicate particular vessel sizes. Should indicate on report if scar pattern has been checked and if it matches with known animal.
- 1003 Create a "health score" or condition index, using factors such as: blubber thickness, amount of fat around organs, results of blood tests, weight:girth or weight:length ratios, and other observations, to categorize health status of manatees at time of death, as done recently for dolphins by NMFS. This could be correlated to length, weight, girth, time of region, year, and water temperatures, etc.
- 1005 Scanned images of propeller wounds/scars would make it easier to cross reference known animals from the scar catalog, etc. Some information (such as boat strikes from coast guard vessels, barges in area, etc.) weren't entered into database but were written on the reports. This type of information can be extremely important in management.
- 1006 I can't think of any that can be determined. Most of the unknowns are truly unknown. The most common question is 'where and when was that manatee hit?'
- 1007 See above
- 1008 With a more user friendly database system, a field recovery/necropsy notes section could be included that specified carcass condition, gut contents, recovery considerations, etc., in an expanded format to provide managers with a more complete picture of possible individual mortality circumstances.

### **QUESTION #3C**

Are the monthly reports from the Marine Mammal Pathobiology Lab useful and could they be improved?

- 1001 Yes
- 1002

- 1003 Additions of rescue records to monthly mortality summary in January 1996 are a big help. New GIS coverage of animals which were rescued and survived will also be useful. Tables and graphs of numbers of deaths should be updated showing year by county, cause by year, year by month, cause by year within regions, etc. and available on the network the Novell network and Internet (read-only). Monthly mortality summaries should be available too. This would reduce calls from the media and citizens, and also aid other scientists.
- Monthly summary reports presently only compare the current year to the previous year. It would be better to compare to a 5-year average of mortality counts. Comparing this year only to the previous year causes endless fluctuations back-and-forth due to spikes in mortality in various causes, in either of the two years. No year is ever completely normal, so comparing to a 5-year normal would be better.
- 1004
- 1005 Reports are useful. I personally don't use the charts comparing the death to last year, but others in the office do. A table for all counties updated with all types of death (with the latest confirmed) would be extremely helpful.
- 1006 They fill the need well for interim data.
- 1007 The monthly reports from the lab are very useful. The inclusion of the GIS map of Florida documenting the location of watercraft related deaths would be useful.
- 1008 Yes, these reports are useful, and other than gaining access to final monthly reports in a more timely fashion, no improvements are necessary.

#### QUESTION #4A

Do you have any suggestions/requests that would make the existing "relative abundance/distribution" aerial survey data sets more useable?

- 1001 Use a grid density of manatees/hectare or manatees/ square kilometer
- 1002 One of the untapped potentials that I see us having to utilize in the future is data on animal behavior when seen (resting, feeding, migrating, etc). Lots of questions about the relative importance of certain areas to manatees are being asked. Being able to have access to as much information as possible about what the animals are doing at a "spot" on the map would be great.
- 1003 Produce ArcView-ready versions (read-only?) with clipped-out background coverages, including bathymetry, ATONS, seagrass, roads. This would be ready-to-use and much faster to run on DOS machines. Put these coverages on CD-ROM and NOVELL network so everyone can browse.
- 1004 Existing aerial survey data sets are very useful. A lot of information can be gleaned from the

display of point data. However, some of the data sets are a little dated. More recent data are needed in many areas to determine if there have been changes in either distribution or in the relative number of manatees using the areas. I do not believe that any significant changes need to be made to the way the data are currently collected.

More behavioral data could potentially be collected during aerial surveys, especially behaviors associated with manatee-vessel interactions. The issue of manatees using navigation channels is also becoming increasingly important. Given the inherent inability to accurately determine a data point's precise location in relation to channels based on the mapped data, it would be useful if observers noted during surveys whether a particular manatee is actually in a channel or only near it. Locations of channels are oftentimes easy to discern from the air, so in most cases this information should be relatively easy to collect. Determining this information from the point data, however, is not practical.

There will always be a need to display the point data since this is the data in its "unanalyzed" format with no assumptions made about movement, etc. Density analysis of the data (or the average number of manatees seen per grid per flight--not necessarily by km<sup>2</sup>) would also be useful so that areas that have been surveyed at different levels of effort can be more readily compared. There are several ways of performing this analysis; which is used is dependent on the desired level of complexity. The most simplistic method would be just to divide an area into relatively large (> 5 km<sup>2</sup>) grids. This would give data users an idea of the relative amount of usage but would require only limited assumptions about movement. Point data as well as other information can then be used to determine if certain areas within the grid warrant different levels of protection, etc. The more complex fixed-area, flexible filter being developed by FMRI also has considerable promise but I see this type of analysis as having a different use than the grid, more akin to the analysis methods being developed for telemetry data (characterizing areas as primary habitat, travel corridors, etc.). More analysis along these lines would be useful.

It would also be useful if some measure of the biases involved in the surveys could be calculated so that data users would have a better idea of how many manatees may have been there but not seen. I realize this is not necessarily a component of "relative abundance/distribution" surveys but it would still be useful. Knowing the relative degree of bias becomes increasingly important as the complexity of the analysis increases.

- 1005 The aerial survey data sets are extremely useful when analyzed in ArcView, because all needed information cannot be done on one map. Many different sets of data, shown in sequence, can be useful. For example, maps broken out by month for each year, with the total number of animals shown, can show seasonal movements of the animals (I've seen this for Collier). Many different maps, broken out in many different ways, then summarized in text form would be extremely useful. Basically, answering the question: what are the animals doing in this area? And, what are the limitations of the data (survey routes, bad flights, visibility of water, etc.). Sometimes things that might be obvious to those flying the surveys can be difficult to document with the data alone.
- 1006 The Grid fixed and amorphous polygon analyses have promise. I would like to see something analogous to the SAS regression PRESS statistic used: in PRESS, every point is taken out of the model and error recalculated. The smaller the PRESS, the more stable the model. While the GRID analysis is not regression, the point here is to separate areas of congregation from

anomalies. Since the grid analysis yields very small numbers, anomalous points bias what is trying to be a quantitative assessment.

1007 No answer

1008 Current aerial survey data sets are useful in the format provided (point data). Density considerations, such as those with which FMRI are working (spatial filters), provide managers with needed information about the calculated likelihood of encountering a manatee in a given area at any time, but this is a difficult concept to grasp for the common citizen, and represents problems with data presentation at in public forums.

#### **QUESTION #4B**

Are there other types of data that could be potentially collected during "relative abundance/distribution" surveys that would enhance the data set for you?

1001 Even though every attempt is made to accurately place the location of manatees on maps, in certain waterways it is difficult or impossible to know from GIS maps if the manatees were in the channel, on the edge or some distance out of the channel. Perhaps in addition to marking the location on the map, observers could have a field for recording that information. It is becoming an increasingly important management issues as it relates to channel extent status.

1003 Sea turtle data already being collected should be entered into distribution survey coverages.

1004

1005

1006 Direction of travel, corridors, number using corridors, speed, direction, time of day, diurnal migration, seasonal migration. Seagrass, water depth, temp, salinity, human activity.

1007 The collection of boating data, such as location, speed, and activity would be useful for boating activity studies and compliance studies.

1008 As much behavioral data as could be collected from the air should be. Valuable activity pattern information concerning foraging, mating, resting, calving, response to human activities, etc., is virtually absent **from** the data sets in other than a cursory categorization. Perhaps observations from the airship will help in obtaining this information.

#### **QUESTION #4C**

How would you like to see the data analyzed to make it more useable for you?

1001 See A&B



1003 No answer

1004

1005

1006 I await the analysis that will make Rick Rawlings say, 'You are right: rational boat operation will save manatees.' I have no idea how to get there.

1007 No answer

1008 It would be useful to have overlapping data sets mapped (i.e. manatee distribution vs. seagrass coverage) to identify reasons for manatee abundance or lack thereof in certain areas.

#### **QUESTION #4D**

How useful is the statewide aerial synoptic survey for in manatee protection/evaluation efforts?

1001 Very Useful. It has provided more information on manatee population size than any other endeavor. The Synoptic survey is rarely used for looking at manatee distribution or as part of the GIS data. Its importance is that of providing a **known** minimum number. It is very doubtful that the synoptic will ever be useful for actually showing population trends. For this reason sampling can be limited in number to one/ year provided that conditions are good.

1002 I believe that the statewide synoptic survey is useful but only in a very limited sense. While it provides a number, I believe the confidence limits on that number are uncertain. I further believe that the public perception of what that number (when viewed with previous survey numbers) means is very cloudy.

1003 Very useful for estimating minimum population size by region.

1004 We have access to the data. It is somewhat useful in terms of providing a baseline population figure but that's about it. In recent years the synoptic count has shown us that the population is larger than we previously believed which is useful in evaluating the need for increased protection. But because the counts from previous years cannot be readily compared, the usefulness of the survey is limited. In some ways, the "incomparability" hurts protection efforts. We all know the population has not increased by 800 animals in the last two years but that is the way many people are interpreting the numbers. This belief is then translated in the political arena into a need to scale back protection since the population is "exploding." The survey would be extremely useful if it could be a way of gauging the status of the population but until this is the case, I don't believe the survey is very useful.

1005 Could be useful, every bit of data is a piece of the puzzle.

1006 From a management standpoint, the synoptic argue for strict controls in very small areas. This can work against county and region-wide management.

- 1007 The statewide synoptic survey is very useful to me. The results will further support the establishment of No Entry and Motorboats Prohibited zones around the Brevard County power plants. They will also help to stress the importance of Brevard County to the manatee recovery effort.
- 1008 Currently, it provides the only baseline from which annual trends can be measured, so it proves to be helpful in population estimation, but the identified variance in those estimates can prove to confound protection efforts in the political nature of management efforts. It would be ideal if we could develop and use estimation techniques in set locations to more accurately access the state of the population so that the public and their assigned politicians could easily comprehend measured trends.

#### **QUESTION #4E**

Do you have access to the data set?

- 1001 What data set?
- 1002 I don't believe that I have computer access to the synoptic survey data, but then I haven't asked. I did ask Bruce to send a break-out of the major areas when he had it but I don't recall seeing it.  
I believe the proper thing to do is to get expert advice on surveying for population estimating purposes before changing anything.
- 1003 No access to GIS product.
- 1005 No-not in computer form.
- 1006 We have access on request. It is the least-used aerial survey data set.
- 1007 Not directly. I ask Bruce Ackerman any questions I have.
- 1008 Use of the line transect methods used for dugongs and experimentally employed by FMRI should be established in areas and during seasons where they work so that regional population assessments can be made. This would provide information in high manatee use areas where applicable that could provide an indication of what the rest of the Florida population is doing.

#### **QUESTION #4F**

Would you change the current synoptic survey effort to better meet your needs; if "YES", how?

- 1001 No. Keep flying it. Would only fly multiple surveys in a year if other competing resources were met first.
- 1002

- 1003 No
- 1004
- 1005 No
- 1006 Travel corridors.
- 1007 Not unless flying on warm days, as was done with the most recent survey. I am totally unaware if there is warm weather protocol or not, but perhaps after the air and/or water temperatures reach a certain level, the survey area could be expanded in case animals are leaving the warm water sites.
- 1008 No answer

#### **QUESTION #4G**

Do you know of other types of aerial surveys that are not currently in use which could be conducted to provide manatee and habitat data?

- 1001 Need additional distribution surveys over areas that the data are old e.g. Brevard. Need to develop some type of survey for seagrass, assessing each year.
- 1002 Other than with a stable platform (Blimp) I do not know of any.
- 1003 Airship surveys.
- 1004 Use of line transect methods could be employed when practical to assess sizes and trends in regional populations. This information would be extremely important as it could be used to assess the effectiveness of protection efforts. Other aerial surveys, such as from an air ship, could also be conducted to study manatee behavior, especially behavior associated with interactions with vessels.
- 1005 I'm not sure I understand the question.
- 1006 Data collected using multi-channel spectral cameras would allow after-the fact analysis, not limited to the ability of the observers to write quickly. Night work could accurately reveal resting and aggregation areas.
- 1007 NO
- 1008 No, not currently. There are similar surveys used in California for great whales (blue and gray whales), but these are based on targeting identified "greatest density" centers for counts. They are not randomized, nor are they complete coastal coverage surveys.

## QUESTION #5A

Telemetry data from tagging projects are not yet available for general distribution. How important are telemetry data to overall manatee protection efforts?

- 1001 They have not been used extensively in most rule development (partly because they have not been available in many cases. However they would be used more if they were in arc view. An example is the recent controversy over the boat race in the Manatee river. BPSM staff had no telemetry data to look at in evaluating the race. If they had, the evaluation might have been different.
- 1002 Extremely important.
- 1003 Telemetry data are very important. They should be made available earlier in preliminary form, even raw point locations, in areas where there are large sample sizes, such as Tampa Bay.
- 1004 These data have the potential to be extremely useful. In some locations, they are the only data available, making them even more important. Because the data are only available for some areas and only in an "unanalyzed" format, their usefulness is not currently as great as it could be. I believe this is one of the more "untapped" sources of data we have.  
More should be done along the lines currently being pursued by FMRI to show primary habitat, travel corridors, etc. This is great data since it is essentially "real time" and provides different information than the more "point in time" aerial surveys. In general, I believe much more effort should be spent on telemetry and other sources of behavioral data.
- 1005 Telemetry would be another piece of the puzzle. It could be used to determine whether or not manatees can assess a particular waterway or creek/tributary that is:  
a- not surveyed by air, especially non-key counties;  
b- in areas of high turbidity where aerial surveys alone may not be the best determination of presence; For instance, the manatee river boat race. I had to make a determination based on the data available, which was aerial survey and mortality. For six years worth of data, the aerial survey data in March did not seem compelling enough (especially compared to other parts of the state) to deny the project if it went to court. The bottom line is, Can we win in court based on the data available during the review?
- 1006 For some areas it is the only data available, hence it can be very important.
- 1007 Overall, telemetry data are important to the protection efforts. The level of importance varies, according to the type, amount, and age of other data available. In Brevard County, they are the only recent location data available in most areas and will assist in defending the existence of some zones.
- 1008 In some locations, they are very valuable, as they are the only data available.

### **QUESTION #5B**

What analyses of the raw point location data would you prefer to make the data sets meaningful to you?

- 1001 Something that shows "areas" or corridors that are most often used.
- 1002 Dot to dot best estimate of pathway (considering depths and other obstacles), time spent in various locations, some data presentation format that helps us and the general public understand relative importance of some areas where multiple manatees are routinely sited.
- 1003 I would like to be able to view telemetry point location data and model-generated (predicted) movement path data, in Arc-View. In many areas, telemetry point or path data would be helpful in answering management and permitting questions. I would like to be able to view current/recent positions of tagged manatees, in ArcView (paths of manatees in previous 10 days).  
I would like to compare raw data points to aerial survey data. I would like to use the percentage of locations off of a given survey "study area", such as Tampa Bay, to get a handle on the true population size being surveyed, by month. The proportion of animals and locations off the study area would indicate the degree of absence bias. I would like to use the percentage of locations outside of the usual "flight path" to estimate proportion of animals present nearby, but missed during surveys, because they are in deep water parts of Tampa Bay, up small streams not surveyed, in areas not able to be surveyed, etc.  
I would like to monitor the water temperatures from the radio-tags, vs Tampa Bay temperatures away from power plants, to assess the proportion of manatees at power plants, and differences in temperatures used among large/small, adults with/without calves. This would also provide very important new data on the minimum temperatures that animals are able to tolerate in the winter (how cold, how long at low temperatures, how varies for different sized animals). I would like to see "Use-Availability" statistical analyses of habitat usage done, which use non-parametric statistical tests to compare the amount of different kinds of habitat available to that used by the animal (telemetry points). It could also be compared to the habitat usage estimated from the projected movement paths predicted by the movements model, although this is somewhat different.
- 1004
- 1005 The raw data points are important to determine presence (not absence), as discussed above. Very little analyzing would be needed to indicate presence. Other analysis would be helpful to long term protection measures, like a snap shot of the life history of the animal while it was tagged, preferably described/summarized in text form, accompanied by raw point data. This compared with all other tagged animals may indicate some trends. Information on what animals do at NIGHT would be interesting, and is not something aerial survey data would indicate.
- 1006 Travel corridors [have I said that before?], range of an animal, range of groups [is that discernable?], identity with other covers to provide county, depth reading and in/out of seagrass.

- 1007 First, all the data should be entered into GIS. On the east coast, they are entered only through 1991. The analyses are determined based on the situation.
- 1008 Perhaps, an application of a spatial filter identifying the amount of relative time spent in given areas for tagged animals. Accurate identification of travel routes to and from "residence" sites would also be useful, so some type of line graph connect-the-dots representation would be greatly appreciated.

#### **QUESTION #5C**

Besides the location and temperature data that are collected via satellite, what other sensors/data collection techniques would you like to see implemented during a future telemetry project?

- 1001 How about a hydrophone that recorded levels of underwater sound? This would be interesting in particular if a manatee with a transmitter was hit.
- 1002 Surface time vs down time??? Night behavior.
- 1003 GPS locations hardware.
- 1004
- 1005
- 1006 Is moving/not moving possible? If so, instantaneous speed and direction? A radio transmitter that would solve the problem of missed signals would make this project orders of magnitude more useful.  
The most useful single item would be points close enough together to map [not extrapolate or model] movement. This would answer a plethora of questions, including travel speeds, corridors, a little on aggregation and point to where other studies should be done.
- 1007 No answer
- 1008 If possible, any type of tag that would provide an assessment of behavior. For instance, blue crab tags have been developed that measure the electric potential of the mouth appendage muscles so as to assess when the crabs are feeding. I am unclear as to how this could be done with manatees, but it would have to be much less invasive than the technique used for blue crabs (there's an understatement!). It would be beneficial to use a video recording device on selected animals in clear water areas to identify behavior and potential threats to these animals (i.e. how many times the animal interacts with humans or is in close proximity to motor boats for risk assessment purposes).

## QUESTION #6A

Scar catalog data are not yet available for general distribution. How important are scar catalog data to overall manatee protection efforts?

- 1001 They have been used very sparingly.
- 1002 I believe that the scar catalog information is useful only to a small subset of manatee researchers and managers. The reason for this is obvious. The average citizen doesn't see enough of the manatee to make having access to scar catalog pictures important. I don't even think that computer access to managers in Tallahassee would be all that important. The people that should really be using it would be the field people. If population estimates are to be made in the future using some sort of mark/recapture study utilizing scar patterns, seems that a great deal of future effort will need to be made in this area. Scar catalog data appears to be most useful in endearing the public to the cause. Graphic photos of what can happen to manatees probably convinced a few thousand people to join the cause. Now, identifying with a particular animal is of great value to programs like Adopt-a-manatee, but really puts the emotional connection into the equation. The whole "Boomer" issue was a pull on the emotional strings. I don't know if it helped overall manatee recovery efforts or not. Would having every single manatee named increase awareness of the boaters? Perhaps if media coverage was such that common knowledge about animals' identities was readily available, people would begin to watch for specific animals and we would learn more about them. This really should be a "Deep Thought" question I guess.
- 1003 Very important,
- 1004 These data can be of considerable importance. They have not been used extensively for management purposes up to this point mainly because the data have not been provided to us. The times we have relied upon the data, we have made requests for specific analyses. The data can be very useful when evaluating movements between warm-water aggregation sites. For instance, this proved very useful when developing the speed zone rule for Broward County because it showed the importance of the ICW in northern Broward County--an area where we have little aerial survey data. Scar catalog data can also be used in population modeling by helping to calculate calving intervals, etc. Information that could potentially be gleaned from this data set include: movement patterns, calving intervals, and frequency of watercraft strikes, as examples. I'm sure there is much more that could also be done. In general, any available behavioral data should be collected, such as the number of other manatees in the area when each sighting occurred, behavior of the subject animal as well as others in its presence, etc.
- 1005 Another piece of the puzzle. Why did it take so long to identify Boomer? With our technology, we should be able to cross reference all our data points. The more data points of different varieties that are available, a clearer picture will develop.
- 1006 Partly because they are not available, it has not been used extensively. My first thought is identification serves as great PR handle: Boomer's death inspired a great deal of public sympathy. Identification of mother-calf pairs also inspires protective fervor. I don't see it

being useful in BPSM's protection efforts directly, but it is still of great value indirectly

- 1007 Once again, it varies with the situation. Scar catalog data have been useful to very generally determine travel routes. They also assist in making the case for the high amounts of boat/manatee interactions and the need for manatee protection zones and other protection efforts.
- 1008 Scar identification has allowed an understanding of the movement patterns of a large percentage of the manatee population that would not be feasible with the financial constraints of tagging efforts. The data obtained from this program should be made readily available for individually identified animals for management efforts. As it is, we know that it exists, but rely on a black box system for its interpretation.

### **QUESTION #6B**

What analyses of the scar catalog data would you prefer to make the data set meaningful to you?

- 1001 Indicate travel history of known individuals that are found dead (necropsied)
- 1002
- 1003 More intensive matching of past carcasses to scar catalog, to remove dead animals from scar catalog. This will be very useful in improving estimates of survival rates from scar catalog records statewide. I would like to see survival rates and reproductive rates calculated from Tampa Bay, Ft. Myers scar catalog records. Comparison of Tampa Bay scar photos with those from Crystal River in the past.
- 1004
- 1005 Snap shot pictures of life histories-preferable summarized in text form accompanied by location maps/dates.
- 1007 A summary by animal of all of the locations and dates an animal has been photographed and the number of scars due to separate manatee/boat interactions. For example, the average manatee photographed in Brevard County has been scarred by separate collisions about 4.5 times and the maximum number of separate boat hits of a Brevard animal is at least 9. There are also 30 photo sites in Brevard County.
- 1008 Movement patterns, confirmed calving periods, frequency of watercraft strikes (numbers of vessel-related scars) and residence periods should be tweezed from the data sets. This information would be best represented in a manner allowing viewing of a picture of the scarred individual with its history in a single file.



### QUESTION #6C

What other data could be collected at the time scar photographs are taken that would be useful to you?

1001 Not sure.

1002 I don't have any thoughts on how the scar data should be interpreted nor on what other information should be collected.

1003 No answer

1004

1005 Date seen, location, temperature, activity, behavior, anything possible.

1006?

1007 Don't know.

1008 Again, behavioral data. I am not that familiar with the collection of scar photographs, but I would assume that behavioral should be an integral component of the process. Knowledge of the feeding and inter/intra specific behavior of this animal obtained from this data could vastly improve science's understanding of its food needs and ethology.

### QUESTION #7A

If you had \$1,000,000 in NEW MONEY to do manatee-related research that is not currently occurring, how would you apportion it (in increments of \$20K) to projects? If you need data in specific areas that do not have current research/data collection, you can allocate money to those efforts. You can also propose pilot projects for new techniques/technology that you have heard of. This is another chance to be creative! While you don't have to justify the expenditures here, be prepared to discuss the ideas further in a follow up interview.

- 1001 Since a portion of the STM Trust fund can be used for other marine mammals I considered the option of using some of the money for right whales.
- 1- 300,000 - Evaluation and testing of commercially available forward looking sonar for right whale detection.
  - 2- 100,000/yr - Expanded use of PIT tags. This provides the best chance at providing population estimates and determining trends. Aggressive campaign of PIT tagging 100 manatees/year should be initiated.
  - 3- 200,000 - Manatee boat interaction studies relating to avoidance behavior, response times, use of channels etc.
  - 4- 200,000 - Independent testing of propeller designs for both performance efficiency and ability to protect.
  - 5- 100,000 - Evaluation of impacts of channel marking and speed zones on boat traffic and prop scarring.

- 6- 100,000 - Evaluation of dock construction techniques on seagrass.
- 1002 1- 240,000 - into manatee/boat interactions (fixed platform observations if necessary but also I'd consider observations from vessels--like tuna towers).  
 2- 300,000 - into field staff. This would be a new effort that would put more people in the water trying to fill in the gaps on manatee habitat usage and especially see if we could get a handle on perinatal mortality by quicker recovery of small carcasses.  
 3- 160,000 - on an intensive effort to confirm or refute some of the assumptions about habitat degradation from exempt boat docks.  
 4- I'd spend some amount on a pilot project in Brevard or Lee County to try and evaluate boater compliance and boater usage patterns since these are **high** mortality areas.  
 5- Finally, I'd try to resolve the manatee "alarm" (field application of hearing study work) issue either positively or negatively as fast as possible so as not to damage our reputation and further lend credibility to naysayers.
- 1003 1- 100,000 - Development of GPS radio tag that would uplink to ARGOS satellite. This would give more accurate locations, around the clock, and more frequently during each day.  
 2- 100,000 - Satellite telemetry, Ft. Myers.  
 3- 100,000 - Satellite telemetry, Crystal River to Panhandle (camouflage the tag).  
 4- 10,000 - Aerial distribution survey of upper St. Johns River.  
 5- 20,000 - Aerial distribution survey of Brevard County.  
 6-40,000 - Ten airship surveys of west coast of Florida for scar pattern matching, for mark-recapture population estimate.  
 7- 20,000 - Airship surveys of Tampa Bay power plants repeatedly during winter, and video tape the sightings.  
 8- 20,000 - Analysis of red-tide toxins in blood serum and liver tissue samples, taken prior to 1995, from carcasses and rescues during the mortality "event" in Summer 1995 in Lee to Sarasota counties, and during the mortality event in Spring 1996. Analyze some archived blood/liver samples. Take serial blood samples from tagged animals in Ft. Myers area. Correlate unexplained deaths in other years to known red tide events.  
 9-40,000 - Additional staff at DEP/FMRI Marine Mammal Pathobiology Lab to process ear bones to obtain age data, and match carcasses to existing scar photo databases.  
 10- 10,000 - Better procedures to provide boat race observers.  
 11- 10,000 - Develop clip-on rescue radio tag.  
 12- 20,000 - Develop routine procedure to get near shore water temperatures from satellite imagery.  
 13- 50,000 - Put 200 PIT tags out on west coast of Florida, for population estimate. Develop underwater reader on pole from canoe or snorkeling.
- 1004 Sorry, but I didn't have enough time to think this one through. Without assigning dollar amounts, here are some areas (listed by priority) that I think deserve more money:  
 1- More frequent distribution surveys (at least every five years), especially for key areas like Brevard County and Southwest Florida;  
 2- Analysis of telemetry data so that more information is available for management decisions;  
 3- Studies of manatee behavior, especially of behavior associated with manatee-vessel

interactions;

4- Development of a reliable population model to assess population trends;

5- Studies of the effectiveness of boat speed zones to determine if changes in the current management scheme are needed;

6- Studies of the efficacy of propeller guards;

I'm sure we could come up with enough worthwhile projects to exhaust any hypothetical amount of new money...If only it wasn't hypothetical.

- 1005 I would hire staff or free up staff to perform analysis on data already collected, and to perform studies on what research/management directives would be the best and most cost efficient way to accomplish what needs to be done. There is a lot of analysis of permitting data that is needed, such as the increase in the number of slips in certain areas, that need to be examined with the manatee data. There is a lot of seagrass impacts that are occurring as a result of permitted projects where monitoring efforts are almost nonexistent. There is a lot to be done. There are studies on sea grasses that need to be done to determine dock/shading interactions for permitting activities. Boating studies are really needed everywhere, and should be analyzed with manatee data. There is not a definite line between what is needed as "research" and "management", since it seems like half of the pieces of the puzzle are missing, and the other half haven't been put together yet.
- 1006 1- Develop useful boating studies, probably seeking the advice of highway traffic engineers.  
2- Manatee boat avoidance
- 1007 In order of importance:  
1- Need new Brevard aerial survey data for the entire county! Don't know how much it costs.  
2- Need St. Johns River telemetry data, especially for Volusia County. Don't know how much it costs.  
3- I do not know the status of the observations by blimp of manatee boat avoidance abilities, but this project needs to be continued or restarted.
- 1008 1- 100,000 - Experimental dock study addressing the most environmentally sensitive way to build docks, piers, etc. so as to ameliorate impacts to seagrass systems.  
2- 100,000 - Assess the protective efficacy (both for manatees and their habitat) of marketed propeller guards by an independent testing laboratory using standardized methods.  
3- 100,000 - Monitor the effect of manatee speed zones on seagrasses in areas where implemented. answer the question, "Do speed zones created for manatees protect or adversely impact marine habitat?"  
4- 200,000 - Establish an animal model for manatees (e.g. rock hyraxes) and experimentally test potential environmental contaminants like heavy metals and PCBs on the animal model in vitro.  
5- 100,000 - Experimentally determine an economically feasible way to prevent manatees from becoming entangled in crab pot and other buoyed lines.  
6- 200,000 - Develop technologically feasible alternatives to existing artificial warm-water refuges for manatees in defined locations.  
7- The remaining \$200,000 could be used to buy an airship, the finest roving fixed platform in

the world for environmental data collection! Just think of the possibilities.....

### **QUESTION #7B**

Independent from your answer above, if you had \$250,000 to do new Tampa Bay manatee-related research, how would you apportion the money (in increments of \$10K) to projects?

- 1001 Do number 3 above
- 1002 60,000 - for refinement of manatee behavior model.  
60,000 - for site specific observational work.  
100,000 - for marine mammal pathobiology lab as necessary for improvement/enhancements  
30,000 - for seagrass/dock evaluation..
- 1003 Ten airship surveys of scar photos in Tampa Bay, with simultaneous airplane distribution surveys.  
10,000 - Better procedures to provide boat race observers.  
50,000 - Put 200 PIT tags out on west coast of Florida, for population estimate. Develop underwater reader on pole from canoe or snorkeling. \$50K  
20,000 - Airship surveys of Tampa Bay power plants repeatedly during winter, and video tape the sightings.
- 1004 I am not nearly familiar enough with Tampa Bay to assess needs other than the general needs I identified above. However, I don't believe there is a need to acquire additional manatee distribution or telemetry data--there is more data available for this area than we have anywhere else in the state.
- 1005 It seems, compared to the rest of the State, there is a lot of data already collected. There needs to be some analysis and studies done to use this data. Speed zones would be needed to be studied and probably established and posted, as well as a vigorous boating education program initiated.
- 1006 No answer
- 1007 Do not know enough about available data to answer this question.
- 1008 I am unfamiliar with the nuances of Tampa Bay to suggest specific projects not related to what I have already discussed. I do think that I would use the lump sum to determine how best to eliminate non-point source nutrient and contaminant additions to Tampa Bay in order to secure existing and expand essential manatee habitat in the bay.

### **QUESTION #8A**

The FMRI Manatee Research group has been working with the FMRI Coastal and Marine Resource Assessment group (CAMRA) to produce a CD-ROM containing marine resource GIS coverages in ARC/INFO export format. This CD is currently in final testing and will be available this spring at a

minimal cost. Do you know how to use this resource -- either with ARC/INFO or ARC View 2?

1001 No

1002 No

1003 No, I don't have/know ArcView, but want to learn. I would like to receive training.

1004 I have accessed other GIS coverages using ArcView so I don't anticipate any problems using the CD-ROM. My current computer has a CD drive. I don't know its specifications but the computer is a Pentium with 32M of RAM and a 1G hard drive.

1005 Yes-ArcView 2.

1006 No answer

1007 Do not know enough about available data to answer this question.

1008 I will work with ARC View in the future, but have not as yet had the opportunity to do so. I hope to learn this software when seagrass data is available in ARC View format.

#### **QUESTION #8B**

Are there other formats that would be more beneficial to you?

1001 Not sure

1002 No

1003 I would prefer to have the same GIS ArcView coverages on the Novell network.

1004

1005 I think a format where the data is maintained on the cd drive and not need to be exported would be the most useful. That way, users with little hard drive space can just use the information off the cd drive while running ArcView. The data would not be accidentally (or intentionally) altered, since it would only be reading the information.

1006 No answer

1007 Don't know

1008 The read-only format of a CD-ROM is adequate, but data set overlays should still be made possible in some format.

### QUESTION #8C

Do you currently have access to a computer that has CD-ROM capabilities and at least 16M of RAM? Yes, If "YES", what are the general system specifications (processor, memory, hard drive size, etc.).

1001 486/66, 1.5G drive, S3 video chip

1002 Yes, Pentium 66 Mhz, 16MRam, 1GHard Drive

1003 I do not have ready access to computer with CD-Rom. There is only one CD-reader on this floor. I have 16MRAM. (I have one at home.)

1004

2003 Yes. Pentium, 16M Ram, 1G hard drive, 90Mhz.

1006 No answer

1007 No

1008 Yes. I currently have a Dell 466T with a 4x CD-ROM drive. My system has a 486/120 Hz processor with 16M of RAM, and two 0.5 G hard drives.

### QUESTION #9

Have you ever attended the Manatee GIS Working Group meetings held in St. Petersburg twice a year? If "YES", please evaluate the effectiveness of these meetings and whether you plan to continue participating in the group. If "NO" and you knew about the meetings, why did you not attend? If you would like more information about the Working Group, please note that fact here.

1001 Yes. I am not sure there needs to be a working group. I have not found the concept particularly useful. I no longer attend, but send Bill Porter instead.

1002 No, I have other staff to attend and report to me.

1003 Yes. I have attended every meeting when I could be in town. I plan to continue participating, but may not be able to travel all over the state to attend each time. I would prefer NOT to spend the whole time discussing data issues (availability, ethics, etc.), but rather hear some speakers every time on progress and innovative new uses and techniques, from DEP manatee researchers, or from other speakers doing innovative GIS research on other species elsewhere.

1004 No. BPSM sends at least one representative to the meetings so my presence has not been required.

1005 No. Never invited. Not sure what it is, so I don't know if it is even something where it

would be useful for me to go to.

1006 No answer

1007 No

1008 No. I have known about them prior to working group meetings, but I have not felt the need to attend. BPSM has a representative that I am confident expresses the needs of DEP manatee managers. We meet with this representative regularly to express our GIS data concerns, which he addresses at the working group meetings.

#### **QUESTION #10**

How would you rate manatee and environmental data for Tampa Bay on a scale of 1 to 10 (low to high) in comparison to other areas of the state?

1001 I would give it a "8". There is way more data for this area in relation to the management needs. (in other words, its close to FMRI so there is a lot of research done there).

1002 10

1003 8 - Florida Bay and Everglades is a 10.

1004 If the manatee data doesn't rate a 10 compared to other areas of the state, I don't know what would. From what I know, the other environmental data is equally strong.

1005 10

1006 No answer

1007 Do you mean quality of data in relation to the rest of the state or the importance of collecting the data in relation to the rest of the state? If quality is the question, I do not know enough about the data. If importance is the question, Brevard County is the most important county for which new data should be collected. It leads all counties in manatee use and manatee mortality. Collection of telemetry data for the St. Johns River system around Volusia County would be near the top; there are no aerial survey or telemetry data for this area.

1008 Due to the close proximity of FMRI to Tampa Bay, the manatee and aquatic environmental data for this system are exceptionally complete. I would rank them as a 10 when compared to other areas of the state. Ongoing monitoring programs for this system should ensure that this data status will be enjoyed for the foreseeable future.

## **QUESTION #11**

Recommendations for Tampa Bay manatee protection measures have been developed by the Tampa Bay National Estuary Program. Please review the attached pages and comment on the proposals.

1001

1002 No comment at this time, awaiting full Bureau comments.

1003 Does not mention existing protection zone at TECO Big Bend. Need to update synoptic survey and mortality facts. A few errors here and there. Does not mention proposed protection zone for sea grasses around FPC Bartow power plant and Weedon Island, or in Little Manatee River. It's a good start.

1004 The suggested protection areas and methods look good to me. FMRI staff are obviously much more knowledgeable about the area's needs than I am so I'll defer to their judgement. The pros and cons of establishing the zones by local ordinance versus state rule should be explored. The main advantage of local establishment is the zones can be adopted more quickly (assuming the local political will exists). The main disadvantage is that locally-adopted zones are more subject to change because of changes in political will. For long-term protection, establishment by state rule is probably preferable. I would suggest trying it at the local level first but adopting by state rule later on, especially if it appears that the zones are subject to change.

The implementation strategy is similar to strategies being used for other areas of the state. The review of previously-established zones is currently being conducted in other areas. As always, funding is the primary obstacle. I'm far from an expert on the subject but from what I've heard, the benefits of using propeller guards is still being debated. While there are certainly benefits, I'd be careful about stating unequivocally that they should be used.

1005 Did not receive attached pages.

1006 No answer

1007 1- Page 190, Action - Boat propeller guards should be encouraged for use throughout the Bay, not just outside of designated manatee protection zones.  
2- Page 190, Background - Update the statistics in paragraph 1.  
3- Page 191, Paragraph 1, Sentence 3 - Would motorboats prohibited zones be adopted for non- winter months? If winter months are the only months for which these zones would be enacted, this should be stated. Otherwise, as it is worded now, boaters could perceive the possibility for longer periods of restricted areas, thus causing unnecessary opposition.  
4- Page 191, Paragraph 2 - Additional enforcement money could be obtained from the boater registration ad-on fees being instituted by the counties bordering the Bay. This is being pursued in Brevard County. 93% of boaters will experience a less than \$10 fee increase and this will result in the addition of 5 FMP officers and 3 dispatchers for Brevard County alone. Volusia County is considering reallocating the use of their ad-on fee to fund more FMP officers. Finally, the investigation of FMP/boat manufacturer partnerships to provide new boats to new officers should be investigated. This, too, is being investigated as part of the



Brevard County process. Any excess ad-on fee funds will be used toward education projects.  
5- Page 191, Step 4 - Include support of the expansion of the FMP Coast Watch program begun in Brevard County.

6- Is there money to revise, reprint, and distribute the Tampa Bay Boater's Guide once new zones are in place. If not, funding strategies should be included in this plan.

7- Who will be responsible for posting the zones? In addition, FIND is developing some new "You Are Here" signs for boat ramps in manatee protection zones. This is much more effective than the previous narrative method and may be useful to the Tampa Bay speed zone education effort.

8- Page 192 - Monitoring Environmental Response - A suggestion to monitor enforcement efforts/violations of these new zones should be included.

1008 Establishing the manatee protection zones in the key manatee use areas appears to be wise, but my knowledge of this system is limited. Compliance and enforcement must be measured and augmented respectively if this plan is to be effective.

The use of propeller guards is wise, but the cage-type guards that the plan section mentions are by no means readily available. They are also no where near the \$100.00 figure cited in the plan. The scientific jury is also still out on whether or not propeller guards protect sea grasses from vessel damage. Most affordable designs actually expand the outer circumference of influence, and may increase damage to aquatic plants. Without adequate testing of various designs, this issue cannot be settled. I would delete the reference to protection of Tampa Bay's sea grasses by mandating the use of propeller guards at this time.

Funding is generally the road block to implementing the ideas outlined in the plan. The authors may want to use local user fees, like boater registration add-ons, to fund these programs.

### **QUESTION #12**

Do you have any other comments about the way manatee management and research are being conducted in Florida? How would you change things if you were the "Manatee Czar"? You can be specific about individual programs (state, federal, independent) if you choose. Your comments will remain anonymous in the final report but you must fill in your name at the top of page one to have your comments and survey responses included.

1001 Define the criteria for down listing so that it is clear what needs to happen for down listing to occur.

1002 If I were the "Manatee Czar" I think that I would have monthly coordination conferences between all parties actively involved in implementation of the recovery plan. Some of these would be in person but some could be by conference call. I'd have a measurable work plan identifying where everyone was headed. I'd probably eliminate the differences between the Florida Research and Management Program and have all state efforts combined under a single program head.

1003 Need to get updated GIS coverages to the USFWS Permitting Offices in Vero Beach and Tampa. Need to get DEP and NBS telemetry GIS data available for management and

permitting activities.

- 1004 No additional comments at this time. There is more I could say but in the interest of time, I won't (since this response is already a day late). If you can allow a few more days for additional commentary, please let me know and I'll provide more. Thanks.
- 1005 Management is useless without accurate and defensible data, and research is useless (to the public good) unless it has a purpose. First, I think the concept of a "Manatee Czar" is a dangerous one, and may be the one main thing that is wrong with any program. If one person has total control over research and management, you put all your eggs into one basket, and you can end up in left field. A working group is the way to go-although there does need to be a "higher echelon" of research and management staff to make the hard decisions and settle disputes between the working group. There are a lot of good staff members in both the research and management offices, who have good ideas, which should be heard and priorities established. I think starting from the lowest staff and going up is the best way to find out how a program can be improved. Informal and frequent interaction between FMRI manatee field staff and BPSM would be highly useful (not just the supervisors). However, state (and federal/local) governments tend to maintain status quo of not "rocking the boat" and I don't think good ideas are encouraged. The main comment I have, I guess, is that both research and management staff are overworked, they can see how things could be better, but can't spare the time to make things happen. Especially since ideas won't be taken seriously anyway by top DEP officials. Sorry to be cynical, but politics play more a part in research and management than you or I do.
- 1006 No answer
- 1007 If I were the "Manatee Czar" I would encourage Sirenia Project and FMRI to work together to input the east coast telemetry data into GIS. I do realize that this short request is not that simple, as there are many projects competing for researcher's time. This is my number one request. I would also make Brevard County the number one county for new aerial surveys. It leads the state in manatee use and manatee mortality. Third, if money was available, I would encourage the establishment of an education/awareness/volunteer coordinator position for each of the key counties. This is a critical component of the recovery effort, and there are a number of activities which would keep such a person permanently busy.
- 1008 Generally, I feel as though the biological information obtained from independent researchers and those involved in the manatee recovery effort should guide management efforts rather than the political winds of the time. Political realities are such that individuals with their specific biases toward one group or another dictate which management strategy is employed at any given time. For instance, U.S. Coast Guard doctrine is such that providing additional channel markers for "environmental protection" is not allowed. This leaves managers with few options to protect manatee habitat other than making areas idle speed or no entry zones. Concerns for propeller guard use implementation on a state wide basis are stymied by primarily litigious issues related to the motor manufacturers rather than the fact that propeller induced trauma is responsible for 45% of manatee watercraft mortality. Economics and human convenience will drive the manatee to extinction, not a lack of scientific

understanding.

If I were "Manatee Czar", I would ensure that significant headway was made addressing concerns for potential **or** employed management efforts. Questions like, Are propeller guards effective in reducing injuries to manatees?, would be answered definitively, and a management strategy to use them, if deemed necessary, would be employed. Habitat protection and monitoring would be a principle concern of both research and management, **as** a recovering population of any animal requires habitat stability. USFWS and DEP data propriety concerns would be eliminated, and the two programs would reduce redundancy with the artificial split between east and west Florida coasts. Data bases would be mutually accessible towards the goal of protecting the animal in question rather than for the determination of which organization publishes which paper first. The effectiveness of current management strategies would also be monitored and revised if deemed necessary on a continuing basis.