The Status and Demography of the Ornate Diamondback Terrapin (*Malaclemys terrapin macrospilota*) within the Saint Martins Marsh Aquatic Preserve

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ABSTRACT
Trapping and mangrove island surveys were conducted to document the presence of ornate diamondback terrapins within the Saint Martins Marsh Aquatic Preserve. Surveys were conducted from 2 October 2003 through 12 December 2003. Three areas within the preserve were targeted for trapping surveys. Two hundred and fifteen individual terrapins were captured at three black mangrove islands within the St. Martins Keys between 8 October 2003 and 3 December 2003. Recapture rates for the study were 15.3%. No terrapins were captured in the salt marshes of the Salt and St. Martins River or at the Salt Marshes North of the Nuclear Power Plant discharge canal. Nesting sites were documented by the presence of raided nests at two spoil islands within the preserve. Records for Malaclemys from the Florida Museum of Natural History, the Department of Environmental Protection's (DEP) Fisheries Independent Monitoring Surveys and numbers of blue crab fishermen are provided for Citrus County in this report.

SPECIES BACKGROUND
Diamondback terrapins are small emydid turtles that are restricted to the mangrove and salt marsh habitats of the North American Continent from Cape Cod south to the Keys, and along the Gulf Coast to Texas. Of the more than 270 species of turtles in the world, terrapins are the only species, other than sea turtles, to evolve for life exclusively in marine environments. In fact, they possess a lachrymal salt gland in their eyes to excrete excess sodium. Other animals which possess such a mechanism for salt excretion include; marine iguanas, sea snakes, crocodiles and the sea turtles. Being emydid turtles, terrapins are most closely related to the Map turtles of the Gulf of Mexico river drainages. Like map turtles, terrapins exhibit extreme sexual dimorphism. On average, female terrapins are 75% larger than male terrapins (Figures 6 & 7).

Sub-species Range
Although there is only one species of diamondback terrapin in the world, there are seven described sub-species in the United States from Massachusetts South to the Florida Keys and around the Gulf Coast to Texas. The Northern diamondback terrapin (Malalcemys terrapin terrapin) is found from Cape Cod South to Cape Hatteras, NC. The Carolina diamondback terrapin (M. t. centrata) is found from Cape Hatteras, NC south to St. Augustine, Fl. The Florida East coast terrapin (M. t. tequesta) continues down from St. Augustine to Miami. The Florida Keys and Florida Bay are home to the mangrove terrapin (M. t. rhizophorarum). The ornate diamondback terrapin (M. t. macrospilota) (Figure 8) has the largest range in Florida, which extends from Collier County North to Escambia in the panhandle. The Mississippi diamondback terrapin (M. t. pileata) occupies a small area of extreme Western Florida and extends West in to Louisiana. The Texas diamondback terrapin (M. t. littoralis) extends from Western Louisiana into Southern Texas. All of the sub-species, other than the Northern and Carolina diamondback terrapin have large vertebral knobs on their carapace as hatchlings. Although many of the males retain them throughout their life, females absorb them with growth once they are sexually mature (Figure 9) (Lamb and Avise, 1992).

Wood (1994), recommends that an eighth subspecies be added. He observed distinct morphological variations between mangrove terrapins of the upper and lower keys. He describes the lower keys population as the true mangrove terrapin (M. t. rhizophorarum) and proposed that the upper keys and Florida Bay population be described as a new subspecies. Based on Commander Bill and Fran Fords commitment to preserving the flora and fauna of the Florida

Keys, he recommended that the new subspecies be listed as (Malaclemys terrapin fordorum) in their honor (1994). Although ten years have passed and the name of the upper keys population has not been changed to reflect Wood's recommendation, the subspecies is now fully recognized as an un-described and separate subspecies.

A population of diamondback terrapins also exists on the island of Bermuda, some 1,000 km east of the Carolinas. Bermuda lies some 200 km south of the Gulf Stream and two to six eddies reach the islands each year by spinning off of the Gulf Stream, which may have been the source of the terrapins' arrival on the islands. However, it more likely the animals were introduced by mariners heading from the Carolinas east to Bermuda and Europe in the nineteenth century. (Wolfgang Sterrer, Curator Bermuda Natural History Museum, written communication, 2004).

THREATS

Soup Industry

Between 1850 and 1930 terrapin stew could be found in the homes of all classes and cultures, particularly in coastal areas and cities (Burke, 2000). Carr (1952) explained that a diet too heavy in diamondback terrapins prompted tidewater slaves in the United States to go on strike. By the turn of twentieth century, demand had exceeded supply and the terrapin fishery collapsed. In Maryland, one of the only states to keep detailed records, annual harvests dropped from 42,000 kg in 1880 to less than 1,000 kg by 1900 (Burke, 2000). Approximately 200,000 terrapins were processed in the state between 1880 and 1936 (McCauley,1945). Females were preferred over males in they market as they are roughly three times the size of males (Lovich and Gibbons, 1990).

Predation

Although predator prey relationships have evolved to keep species in check, a vast imbalance has occurred with respect to raccoon predation of turtle nests. Habitat fragmentation, roadway mortality, coastal armoring, development of nesting beaches, and by-catch in commercial fisheries, along with other threats have significantly reduced terrapin populations throughout their range (Seigel and Gibbons, 1995). Raccoons, however, are extremely adaptable and continue to thrive despite the encroachment of civilization. In fact, they are one of the most common species of wildlife in urban areas. Their ability to thrive in the face of development is also augmented by the fact that most of the raccoon's natural predators are no longer found throughout their range. As a result, raccoon populations have increased since the turn of the twentieth century. Although, raccoons have readily adapted to altered habitats, their preferred habitat is woodlands near water. Additionally, raccoons become sexually mature the first year of their life and produce an average of three to four young per litter (Kays and Wilson, 2002).

Diamondback terrapins do not become sexually mature until the second or third year for males and the fifth or sixth year for females (Seigel, 1979). Although female terrapins may nest up to three times per year, clutch sizes are small with a mean of 6.7 eggs per clutch for the southern sub-species (Seigel, 1979; Butler 1998). Less than ten percent of terrapin nest evade predation and complete the 65 day incubation period. Once hatched, terrapins may fall prey to predation by imported red fire ants, and once in the marine environment may fall prey to any number of predators (i.e. crabs, fish, birds, mangrove and salt marsh snakes). Terrapins who survive

raccoon predation on the nesting beach, fire ant predation during emergence, and predators during their first vulnerable years of life, are then subjected to significant by-catch mortality in the commercial blue crab fishery during the adult phase of their life cycle. Additionally, raccoons (Procyon lotor) have been found to predate adult terrapins throughout the entire range of the eight sub-species by breaking the terrapins necks and removing one of the rear limbs in order to access the entrails (Seigel 1980a; Feinberg 2000).

Raccoon predation of terrapin nests was found to be 100% for thirty-three nests that were located at a study site in Connecticut. Numerous footprints in the area along with bite patterns indicated that the predators were raccoons. In each case, the contents of all the eggs were consumed and then the shells were found discarded adjacent the clutch cavity (Aresco, 1996). Feinberg (2000) documented that predation of terrapin nests at Jamaica Bay National Wildlife Refuge in New York rose from 7% in the 1980's to 92% in the late 1990's after raccoons were introduced. Burger (1976a) found that 64% of terrapin nests at a New Jersey study site were destroyed by raccoons.

Although, diamondback terrapins and sea turtles occupy different families in the order Testudinae, both terrapins and sea turtles are marine chelonids which require coastal nesting beaches for their reproductive efforts. High predation rates of sea turtle nests has resulted in protocols for nest relocations, nest screening and aggressive predator control efforts by biologists throughout the United States. Researchers monitoring sea turtle nesting beaches in the Ten Thousand Islands found predation of nests by raccoons to be 95% during the 1992 nesting season. Between 1992 and 1996, 47 raccoons were trapped and removed from the beaches. It took 390 trap days just to capture nine raccoons during the last two years of trapping. Even with increased efforts by biologists for predator control, predation of sea turtle nests by raccoons was found to be 97% in 1996 (Garmestani, et. al., 1997) (Figure 10).

Biologists have documented that the predation of adult terrapins and nests has surpassed the impact of roadways on terrapin populations. Seigel (1980a) found that as many as 10% of the nesting females were predated by raccoons annually as they came ashore to nest at Meritt Island National Wildlife Refuge. The carcasses of twenty-three female terrapins that were eaten by raccoons were found at a nesting site in New York (Feinburg, 2000). At Tarpon Key, in the Pinellas National Wildlife Refuge forty-three adult terrapins were killed by raccoons in a five year period (Figure 11). This problem is very unsettling as extensive trapping efforts over the years have only documented 148 terrapins at the island.

By-catch in the Blue Crab Fishery

One of the most significant limiting factors in terrapin populations today is the issue of by-catch in the commercial blue crab fishery (Figure 12). Diamondback terrapins have high site fidelity, unlike sea turtles, which leaves them vulnerable to high levels of take; weather it be from drowning in crab traps, predation by raccoons, or roadway mortality. Roosenburg (1997) found that a population of terrapins may be reduced by as much as 15-78% in a single year as a result of by catch in the commercial crab fishery. The National Museum of Natural History in Washington has catalogued 31 dead terrapins from a single crab trap at Alafia Bank, Tampa Bay in 1982 (USNM # 241553 - 241584).

Another problem caused by the commercial crab industry is the selective removal of males, which creates female biased sex ratios. Diamondback terrapins exhibit sexual dimorphism, females being three to four times the size of the males. In the case of terrapins, females are three to four times the size of the males which average around 300 grams. Once the females reach sexual maturity they become too large to enter the funnels of the crab traps. The smaller males remain vulnerable throughout their entire life cycle and as a result, populations throughout the range are becoming female biased. Sex ratios for mangrove terrapins were found to be 22:1 (female:male) at Barrocouta Key, 5:1 for Key Lois and 11:1 at Everglades National park (Mealey and Parks, 1999). Sex ratios at Tarpon Key in the Pinellas National Wildlife Refuge are 2.5:1 female biased (Boykin, 1999).

Bishop (1983) found catch per unit effort (CPUE) per baited trap (trap day) to be 0.16 terrapins daily during the months of April and May in South Carolina. He documented that if traps were checked daily that only 10% of the terrapins drown. Based on a total of 743 commercial blue crabbers for the year 1982, he estimated that 2,853 terrapins were caught daily during the months of April and May. If the fishermen checked their traps daily then about 285 terrapins would die from drowning and as many as 17,100 would drown during April and May alone each year. However, few fishermen pull their lines on a daily basis, so considerably more terrapins were drowned. The older females were excluded from the traps due to their sheer size. Median straight plastron length (SPL) for 86 females captured during the study was 121 mm (76-175 mm) and median for male terrapins was 100 mm (79-128) SPL.

Hoyle and Gibbons (2000) determined that the recreational blue crab fishery is significantly larger than the commercial fishery in South Carolina and may pose an even greater threat than previously recognized. In 1997, 20,552 pots were fished by 277 commercial crabbers, which results in an average of 74 pots per crabber. In the same year 70,000 recreational fishermen were licensed to set blue crab traps. The South Carolina DNR estimated that at least 25% of the 70,000 recreational fishermen licensed fished the maximum of two pots. This number would put the number of recreational pots at a minimum of 35,000. The population estimate, based on a Jolly-Seber model, was 233 terrapins at a study site in the Kiawah River, SC. In 1995 the population estimated had dropped to only 168 animals. To put things in better perspective, 148 terrapins were captured during the study in 1988 and only 22 were captured in 1995. Hoyle and Gibbons contribute this sharp decline in numbers to the population increase on Kiawah Island and the increased blue crab fishing pressure which results in terrapin mortality through by-catch in the fishery.

In 2000, Crowder et al. found that diamondback terrapins drown in as little as five hours in a blue crab trap. However, drowning can happen in less than 45 minutes during the hot summer months. The study also found that terrapins are more likely to enter a crab trap and drown in pots that are near the shoreline in shallow water. Pots fished slightly further from shore in deeper water have little impact on populations of Malaclemys.

There is a significant blue crab fishery along the Gulf of Mexico, though declines in the fishery have begun to cause closures, clean-ups of abandoned gear which is constantly taking crabs and a freeze on issuing new blue crab licenses in many states. Over 948,120 blue crab traps are

fished annually in the near-shore waters of Alabama, Louisiana and Texas (Table 1). This number does not include recreational crab traps, which in some states outnumber
Commercial traps. This number also does not include commercial crabbers from Mississippi, where no data was available.

In 2004, records of blue crab endorsements from the Florida Fish and Wildlife Conservation Commission's office of Commercial Salt Water and Licensing, shows that there are 138 blue crab fishermen in Citrus County. Data from FWC's Florida Marine Research Institute shows that 55,491 blue crab traps are reported from the 138 endorsements with an average of 402 traps per endorsement (Figure 13). FWC's 2002 Annual Landings Summary from their Marine Fisheries Information System show that 595,239 lbs. of blue crabs were taken in Citrus County in 2002. The 595,239 lbs. of crabs were taken during 3,078 trips and had a market value of $663,088. An additional 2,778 lbs of soft shell crabs were taken during 52 trips with a commercial value of $24,227.

STATUS AND PROTECTION

Two of the seven described sub-species of terrapins have been listed as Species of Special Concern, the mangrove terrapin (Malaclemys terrapin rhizophorarum) and the northern diamondback terrapin (Malaclemys terrapin terrapin). The remaining five sub-species are considered non-listed imperiled species. Diamondback terrapins are listed as threatened by the World Conservation Union. The mangrove terrapin is listed as a rare species on the Florida Natural Areas Inventory (FNAI) and in the Florida Committee on Rare and Endangered Plants and Animals (FCREPA).

In 1994, the (FFWCC) put together a team of biologists to rank the status of 668 vertebrate taxa in Florida. The committee found that diamondback terrapin populations in Florida were sparse and recommended that all five subspecies become a priority for research and monitoring efforts (Millsap e. al., 1994). Ten years later, terrapins are considered a non-listed imperiled species in the state by the FFWCC.

In 1994 a committee of thirteen terrapin biologists convened to ascertain the status of diamondback terrapin populations throughout the United States and recommended that all seven subspecies be listed as candidate taxa under Appendix II (Threatened) of the U. S. Endangered species Act (Seigel and Gibbons, 1995). The committee will convene again in September of 2004, some ten years after it's inception to discuss progress, expanded research efforts and review its potential listing in Appendix II.

Museum Voucher Specimens

The Florida Museum of Natural History boasts one of the largest Herpetology collections in the world, which is understandable considering the rich herpetological diversity of the state. Biologists at the museum have catalogued 170 voucher specimens for Malaclemys in Florida. Four records exist for the Saint Martins Marsh Aquatic Preserve in Citrus County. The specimens were collected at the following locations; (1) CR 494 near Ozello, (2) CR 44 near Fort Island Gulf Beach, (3) 0.7 miles from the end of CR 44 and Gulf, and (4) spoil island adjacent the cross Florida barge canal. At least two of the specimens were taken while attempting to nest. The one at the spoil island was collected on 30 April 1972 and the one 0.7 miles from end of CR

44 was collected on 26 April 1991. Although the later female was collected in Juncus marsh, it is believed she was near the road (one of the only areas above the tide line) for reproductive efforts.

An additional 33 records exist for the Big Bend Aquatic Seagrasses Preserve which is also managed through the office of the Saint Martins Marsh Aquatic Preserve and the Crystal River State Preserve (formerly State Buffer Preserve). The 33 voucher specimens were collected in Levy, Dixie and Taylor Counties. Each of the Counties had 21, 8, and 4 terrapins respectively. The 21 accounts from Levy County were collected in the following locations; 19 were from Cedar Key, 1 from Rattlesnake Key and 1 from Seahorse Key. At least one of these individuals was collected while nesting as the one from Rattlesnake Key was collected on 30 May 1976 on the West beach of the island.

Six of the eight records for Dixie County are from Shired Island. However, one record is from Suwannee and the other from the mouth of the Steinhatchee River. At least three of these specimens were collected while nesting (either on their way to or returning to the water after completing). All three of the nesting females were captured on the beach at Shired Island on the following dates; 29 and 31 May 1973 and also in May of 1988. Three of the four records from Taylor County are from Cedar Island and the fourth is from Big Grassy Island.

Although no records exist for the Big Bend Region of Florida, there have been numerous records of bald eagles preying on diamondback terrapins (Figure 15). In addition to this record, there are 17 specimens in the collection at the Florida Museum of Natural History (FMNH) (FMNH # 39406-39422) that were also found in the nests of bald eagles in Everglades National Park between the years of 1968 and 1973. Ornithologists still continue to find terrapin remains in the nest of bald eagles while banding chicks, however, they find them in much smaller numbers now (Brian Mealey, oral comm., 1999).

By-Catch records of Malaclemys from FFWCC's FIMS

Fisheries Independent Monitoring Surveys (FIMS) are conducted by the FFWCC out of six field offices around the state. Field offices are located in Apalachicola, Cedar Key, Tampa Bay, Charlotte Harbor, Tequesta, Indian River Lagoon and Jacksonville. In January of 2002, the department began keeping detailed records of the numbers of diamondback terrapins that they captured as by-catch in their nets. In 2002 and 2003 the program incidentally captured 125 diamondback terrapins. Three of the field offices had no captures of terrapins and include; Apalachicola, Tequesta and Indian River. Jacksonville had the highest number of captures (89 = 71.2%) and Charlotte Harbor had the lowest number of captures (3 = 2.4%). Twenty-four terrapins were captured in Tampa Bay (19.2%). Cedar Key is the closest field office to the Saint Martins Marsh Aquatic Preserve. It lies approximately 39 km northwest of the preserves northern boundary. Nine terrapins were captured in Cedar Key, which comprises 7.2% of all the terrapins captured by the program during the two year period.

STUDY SITE

The Saint Martins Marsh Aquatic Preserve encompasses the watersheds of the Withlacoochee River, the Crystal River, the Saint Martins River, and the Homosassa River (Figure 16). The aquatic habitat is dominated by salt marshes which lie nearer to shore and eventually giving way

to mangrove islands off-shore. The preserve lies in the northern limits for mangrove development and evidence of this can be seen by stunted mangroves which lie between the inshore marshes and the offshore mangrove islands. The primary study sites within the preserve were three black mangrove (Avicennia germinans) islands in the Saint Martins Keys. These islands were chosen out of about twenty islands total in the group of keys for the following reasons; (1) the dominant vegetation was black mangrove rather than red mangrove (Rhizophora mangle), (2) visual assessment from the airboat showed these islands to have older or at least taller mangroves, (3) these three islands had an open under-story which allowed for ease of movement while conducting mangrove surveys (Figure 17), (4) these islands most closely resembled (based on the three afore mentioned reasons) other Malaclemys study sites in Tampa Bay and the Florida Keys. The Saint Martins Keys are a group of islands in the Southern portion of the preserve that lie offshore between the mouths to the Homosassa and Saint Martins Rivers. Since many of the islands do not have names, they will be referred to as SMK I, SMK II and SMK III throughout the report (Figure 18).

The region is referred to as the springs coast as it has several Magnitude I and Magnitude II springs, which pump out enormous tidal volumes of about 72^0 F fresh water every day. The shallow water of the region, coupled with limestone hard bottom, numerous oyster bars and murkier water near shore, requires the use of air boats for safe navigation (Figure 25). The area has been designated by the FFWCC as a Strategic Habitat Conservation Area and is home to numerous species of wildlife, many of which are protected, threatened or endangered. Some of the wildlife species include: bald eagles, peregrine falcons, sandhill cranes, whooping cranes, white pelicans, west Indian manatees, bottle-nosed dolphins, ornate diamondback terrapins and the Kemp's ridley sea turtle (Laakkonen, 2003).

PROJECT OBJECTIVES

The objectives of the following study were to (1) determine if ornate diamondback terrapins are present within the SMMAP, (2) obtain information on population size, population structure and sex ratios of ornate diamondback terrapins within the preserve, (3) contrast morphological characteristics of the population with those of M. t. macrospilota from Tampa Bay, and (4) identify limiting factors for the population such as; (a) by-catch in the commercial blue crab fishery, (b) fire ant predation of nests and young, (c) and the impact of predators (i.e. raccoons) on nesting beaches and potentially adult terrapins.

MATERIALS AND METHODS

Three sampling methods were utilized to capture terrapins, locate nesting areas and assess population size, population structure and sex ratios. Five modified traps (1.6m high) (Figure 19) were deployed at a depth of 0.3– 1.5m and five standard traps with floats (Figure 22) were deployed at a depth of 0 m to 1 m deep. The five modified and five standard blue crab traps were baited with 3.2 kg blocks of ground menhaden chum per day. It is important to note that no terrapins drowned during this research as the tops of the traps always remained above the surface of the water. The modified blue crab traps used in the study were checked within 24 hours of baiting. Traps were emptied of any remaining chum each Friday evening and baiting was resumed the following week.

Mangrove Surveys were conducted to search for terrapins swimming through the the islands interior pneumatophores at high tide (Figure 20). Mangrove surveys were also conducted at moderate and low tides to capture terrapins as they lay buried in the mud (Figure 21) or beneath tidal wrack (Figure 22).

Although no natural beaches occur within the preserve, several spoil islands within the preserve have had nesting based on records from the FMNH and observations by locals. Areas with sand such as Fort Island Trail beach (Figure 23), Shell Key and the spoil islands adjacent the cross Florida barge canal (Figure 24) were checked for the presence of raided nests (egg shells / fragments can linger for years) and the presence of predated adults.

Terrapins were photographed (carapace and plastron) to document morphological variations, barnacle load and scars. Females were weighed to the nearest 50 grams using a 5kg Pesola spring scale. Males were weighed to the nearest 10 grams using a 1kg Pesola spring scale. Straight plastron length (SPL) were taken with Hagloff calipers. Head width and width of vertebral knobs were measured with an Spi 2000 dial caliber. A hand held hack saw was used to make small notches in the terrapin's marginal scutes for identification (Figure 25).

Population estimates were calculated using the Lincoln Petterson index. Microsoft Excel was used to determine descriptive statistics and conduct ANOVAs. ANOVA was conducted to detect differences among female weights and SPL between islands, among male weights and SPL between islands and differences between female and male weights and SPL.

RESULTS

A total of 215 individual terrapins, 114 female and 101 male, were captured 255 times over the three month study period. Recapture rates at SMK I were 18.5%. Recapture rates at SMK II were 15.4%.

Female and male straight plastron lengths (SPL) were significantly different (ANOVA, $p < 0.05$). Female SPL ranged from 155 - 201 mm with a mean of 175.4 mm $\pm$ 8.2 mm. Male SPL ranged from 103 - 134 mm, and averaged 118.2 mm $\pm$ 5.9 mm (Figure 1). Female and male weights also differed significantly (ANOVA, $p < 0.05$). Female weights ranged from 800 – 1550 g, and averaged 1184 g $\pm$ 153.2 g. Male weights ranged from 240 - 490 g, and averaged 354.2 g $\pm$ 43.1 g (Figure 1, 2).

SPL of females between sites did not differ significantly (ANOVA, $p > 0.05$). Females captured at SMK I had a mean SPL of 175.5 $\pm$ 7.8. Females captured at SMK II also had a mean SPL of 175.5 $\pm$ 9.8. Mean SPL was 174.2 $\pm$ 5.9 at SMK III . SPL of males between sites did not differ significantly (ANOVA, $p > 0.05$). Males captured at SMK-I had a mean SPL of 118.4 $\pm$ 6.0. Mean SPL at SMK II was 118.7 $\pm$ 5.9. SMK III mean SPL was 115.7 $\pm$ 5.5 (Figure 3).

Weights of females between sites did not differ significantly (ANOVA, $p > 0.05$). Females captured at SMK I had mean weights of 1188.6 g $\pm$ 149.8. Mean weights of females from SMK II were 1182.1 $\pm$ 179.1. SMK III females had mean weights of 1152.8 $\pm$ 64.3. Weights of males between sites did not differ significantly (ANOVA, $p > 0.05$). Males captured at SMK I had

mean weights of 352.5 g ± 43.3. Males from SMK II had mean weights of 360.5 g ± 44.3 and males from SMK III had mean weights of 341.7 g ± 37.6 (Figure 4).

Four terrapins from three other locations in the preserve are included in the 215 total captures from SMK I, II and III. On 17 October 2003 a mullet fishermen in Ozello brought in an adult male and female he had caught near the northwestern most island in the Saint Martins Keys. On 5 November 2003 one adult female was captured during a island survey at this island. A small adult female was entrapped in the holding basket of Progress Energy's cold water intake canal on 18 November, 2003. This was the smallest adult female (800 g) encountered during the study. The two terrapins from the mullet fishermen were released the following day at island of capture and the small female from Progress Energy was released in the marshes north of the warm water discharge canal.

Population estimate

Lincoln Peterson population estimates were calculated for SMK I and SMK II. The population estimate for SMK I was 255 ±143-367 and the estimate for SMK II was 141 ± 81-201. Population estimates were not calculated for the third site with the group of islands, (SMK III), due to a small sample size.

Sex ratios

Mean sex ratios for the Saint Martins Keys were 1.1:1 female biased. Sex ratios were female biased at SMK I 1.4 : 1. However, sex ratios were male biased at SMK II and III (0.8 : 1at both islands) (Table 2). Catch Per Unit Effort (CPUE) for mangrove surveys yielded 0.5 terrapins per hour and CPUE for trapping captured 0.91 terrapins per trap day. Figure 5 depicts mean monthly seawater temperatures in Cedar Key, which lies approximately 39 km North of the preserve.

Movements

Movement of terrapins between study sites in the Saint Martins Keys were only observed in one individual. Female 43 was originally captured on SMK I on 16th October 2003. She was recaptured at the island a second time on 18th November. On 24th November, she was recaptured at a different island (SMK II).

Abnormalities

Missing limbs were found on 2.1% (2) males and 4.3% (5) females within the study. Scute abnormalities were present in 8.2% (6) of the males and 6.3% (9)of the females. The vertebral scutes were split on 6% (7) of the females and 0% of the males (Table 3).

Morphological Variations

Striped pants, or dark vertical lines behind the rear limbs, (Figure 26) were found on one female (0.9%) and no male terrapins within the study. Two percent of the terrapins within the study had less than 10% pigmentation on their plastrons (Figure 27). 8.8% of the terrapins had less than 50% pigmentation on their plastrons (Figure 28). The majority of the terrapins in this study (89.3%) had dark plastrons, with greater than 50% pigmentation (Figure 29) (Table 4).

Molluscan fouling

Barnacles, and in one case oysters, were found to foul the shells of 11.8% of the female terrapins within the study (Figure 30). Barnacles and mollusks were absent from the shells of male Malaclemys within the study. Barnacle scars (Figure 31) were present on 10% of the female terrapins and none were found on the males (Table 3).

Mating & Nesting

Mating was never observed, but terrapins were found in pairs on SMK I on two occasions in October of 2003. On 23 October, a male was found pursuing a female in 30cm of water in the interior portion of the island. On 29 October, another male was found pursuing a female in 0.33 m water at SMK I. Egg fragments from predated nests were found on Shell Island on 2 October 2003 and one of the spoil islands adjacent the cross Florida barge canal on 3rd December 2003.

Predation

Predation of adult terrapins by raccoons was not documented during the study. The skeletal remains of an adult female terrapin were found on SMK I on 8th October 2003. The animal was catalogued at the FMNH's Herpetology Collection (FM# 140785).

DISCUSSION

Demographics

Mean SPL mm for female (175.4) and male (118.2) terrapins from SMMAP were larger than those found in Tampa Bay (165.0) and (110.0) respectively (Boykin, 1999). Mean SPL for mangrove terrapins, the closest sub-species to the south are 148.1 mm for females and 100.3 mm for males (Mealey and Parks, 1999). Mean weights g for females (1184) and males (354.2) were also larger than those reported from Tampa Bay (994) and (306) (Boykin, 1999). Mean weights for mangrove terrapins in the Florida Keys were reported to be 772 g for females and 264 g for males (Mealey and Parks, 1999).

Population estimate

The sample size for SMK III was too small to obtain a population estimate, as the Lincoln Peterson index requires a minimum of 30 captures in the initial sample. Ideally, a mark and recapture population estimate will be based on two separate samples of a site. Time did not permit duplicate sampling of sites and thus the population estimate is based on the number of neonates during the first five days of sampling at SMK I and SMK II and the number of neonates and recaptures during the second five days of sampling at SMK I and II. More accurate estimates may be established by sampling at both of the sites for the same duration in 2004. The population living in the Saint Martins Keys seems to be thriving. Population estimates for just two of islands estimate almost 400 terrapins. If these numbers are indicative for all of the St. Martins Keys then there are 1,000+ terrapins in the area.

Sex ratios

The sex ratios between male and female turtles have been shown to vary tremendously among and within species. Trapping method, determination of maturity and season of capture can each affect sampling bias. Gibbons discusses four demographic factors which may influence sex ratios within a population of chelonians: (1) differences in age at maturity of the sexes, (2)

differential mortality of the sexes, (3) differential emigration and immigration rates of the sexes, and (4) sex ratios of hatchlings (Lovich and Gibbons, 1990).

Sex ratios with the SMMAP were found to be 1.1:1 female biased. This is similar to sex ratios found in Tampa Bay (2.5:1) (Boykin, 1999). Studies in the Florida Keys found sex ratios to be as extreme as 21:1 female biased (Mealey and Parks, 1999). Seigel (1984) found sex ratios in the Florida East coast terrapin to be 9:1 female biased. Research by Butler (1998) found sex ratios to be 5.1:1 female biased.

Abnormalities

Diamondback terrapins have temperature dependent sex determination (TDSD) and females are produced at higher temperatures. Scute abnormalities also occur at higher temperatures and it is understandable that females would possess greater scute aberrations. Incubation experiments conducted by Roosenburg and Kelley (1996) found that higher incubation temperatures of 32^0 C produced exclusively female terrapins and lower incubation temperatures of 26^0 C produced exclusively male terrapins. Jeyasuria (1997) found that incubation temperatures below 28^0 C produce males and incubation temperatures above 30 degrees produce females. Research on map and painted turtles along the shore of the Mississippi River found that nests with males were located under vegetation which cooled the nests and nests with females were found in areas of open sand (Madge, 1985).

Morphological variations

Only one terrapin (0.5%) in the SMMAP had dark vertical bars between rear limbs. The lines, also called striped pants, are present on 13% of the terrapins at Tarpon Key, 140 km south. Striped pants were once considered a distinguish-characteristic of the mangrove terrapin from Florida Bay and the keys where over 90% of terrapins exhibit this marking.

Only 2% of the terrapins in the study had plastrons with < 10% pigmentation. 140 km south in Tampa Bay over 31 % of terrapins were found to possess clean plastrons. 8.8% of the terrapins had plastrons with < 50% pigmentation. 44% of the terrapins at Tarpon Key in Tampa

Bay had plastrons with < 50% pigmentation. 89.3% of the terrapins in the study had dark plastrons with > 50% pigmentation. In contrast, only 25% of the terrapins in Tampa Bay had plastrons with > 50% pigmentation.

Molluscan fouling

Ross and Jackson (1972) describe the fouling of an ornate diamondback terrapins shell by two species of barnacles (Balanus improvisus and Chelonibia patula), the edible oyster (Crassostrea virbinica) and a slipper shell (Crepidula plana). The adult female was captured in the shallows of Shired Island, Dixie County, Florida on 9th December 1962 and the terrapin died the next day . On 9th July 1967, Crawford Jackson found a female ornate diamondback terrapin that had six scorched mussels (Brachidontes exustus) living inside the vacant shell of a barnacle (Balanus eburneus) near Cedar Island in Taylor County, Florida (Jackson et al., 1973).

The posterior patch of oysters found on the Shired Island terrapin from Dixie County were so large that biologists speculated it would interfere with and possibly prevent successful copulation (Jackson and Ross, 1971). Seigel (1983) discovered that three species of barnacles are regularly found on the Florida East coast terrapin. In addition to Balanus eburneus, which was also

described in relationship to diamondback terrapins by Jackson et. al., Seigel found Chelonibia manati and C. testudinaria. 72% of 125 examined terrapins were classified as having heavy barnacle infestations (16-15 barnacles). Seigel stated that the most significant problem with heavy barnacle loads on terrapins is shell erosion and interference with nesting activity. Necropsies of two terrapins that were found dead during this study showed massive scar tissue adjacent internal organs on the animal's plastrons (Seigel,1983).

Heavy barnacle loads in the posterior regions of the plastrons may also interfere with nesting efforts of adult females and result in shallower nest depths. Burger (1976b) found that hatching success was directly correlated with nest depth. He found that nests with mean depths of 125 mm had 0% hatching success and nests with mean depths of 182 mm had 100% hatching success. In nests with intermediate depths of 143 mm, the bottom eggs developed and hatched while the shallower eggs remained undeveloped.

Predation

The two most significant limiting factors for terrapin populations in the nation today are by-catch in the blue crab fishery and predation of adults and nests by raccoons. Raccoons, raccoon tracks and raccoon feces were found on many of the spoil islands by the cross Florida barge canal, at Shell Island and Fort Island trail (Figure 32). This is significant as these are the only known nesting areas and raccoons are present. Raided nests were found at Shell Island (1) and at one of the spoil islands (3) by the barge canal.

Forty-five dead adult terrapins were discovered during mangrove surveys. It was determined that they were killed by raccoons as their necks were broken and the rear limbs were removed for access to the entrails. Thirteen of the predated terrapins were marked individuals, which comprise 9% of the total terrapins marked at the island. The remains of these terrapins have been placed in the Florida Museum of Natural History's (FMNH) department of herpetology collection (FMNH # 135309-135326, 137317, 137319-137340, 140783-140784 and 140786). One specimen was sent to the National Museum at the Smithsonian in D.C. (NMNH # 529966).

Potential limiting factors for the population

The preserve is large and could possibly support many populations of terrapins as they have high site fidelity. Two other areas of the preserve were also sampled for terrapins, but yielded no captures. The intersection of the Salt River and the St. Martins River was sampled for 45 trap days with no results in early October of 2003. In December, the traps were moved from the St. Martins Keys to the marshes just north of the warm water discharge canal at the Progress Energy Nuclear Power Plant (Figure 33). It was hoped that the warm water effluent would allow terrapins in the area to remain active during the cooler months when terrapins elsewhere where hibernating. However, no terrapins were captured at this site either during 45 trap days. Blue crab traps were present throughout the preserve, particularly in creeks and rivers and near shore marshes. The St. Martins Keys are further off shore and thus prevent raccoons from island hopping (walking and sometimes swimming) from island to island at low tide across flats. The waters around the Saint Martins Keys are extremely shallow and extensive flats are exposed at low tides. This, along with their distance from shore, deter commercial blue crabbing activities.

Future research needs

Reproductive work on the sub-species would add valuable data to the states knowledge of terrapin reproduction. Reproductive work on Malaclemys in Florida has been limited to one study in the Merritt Island National Wildlife Refuge on the Florida East Coast terrapin and a study in Duval County by Butler on the Carolina Diamondback Terrapin. Mullet fishermen in Yankeetown shared that the waters around the spoil islands by the barge canal are full of terrapins each spring. It was speculated that terrapins were utilizing the spoil islands for nesting as this has been documented in Steinhatchee (within the Big Aquatic Seagrasses Preserve) and the Indian River Lagoon. Nesting work on the ornate diamondback terrapin would be very beneficial to the management of the species, particularly with the problem of raccoon predation throughout the range.

Although the group of islands in the Saint Martins Keys lie very close to each other, only one adult female was documented to have moved to a different island. It is known that diamondback terrapins exhibit high site fidelity. However, female terrapins in Duval County may travel as far as 8 miles to locate suitable nesting beaches (G. Heinrich, Heinrich Ecological Services, oral communication, 2003). No suitable nesting areas (that is no areas above the high tide line) occur anywhere within two miles of the Saint Martins Keys. In fact, the only known nesting areas are in Ozello, Fort Island Trail, Shell Island and the spoil islands of the barge canal. There are islands along the Saint Martins River between Ozello and the off-shore keys with upland areas, though they are primarily shell islands. With this in mind, it is likely that females from the Saint Martins Keys do make annual nesting migrations to one of these areas. It is also possible, as it has been documented, that the males follow them to the nesting beaches (Seigel, 1980b).

Research by Roosenburg et. al. (1999), found that female terrapins moved further from shore and moved more frequently than hatchlings, juveniles and adult male terrapins. Juveniles and males were found more often in shallower water near the shore. Results from a study on movement of diamondback terrapins in the Chesapeake Bay found that terrapin movement is very minimal and occurs primarily along shorelines (Roosenburg, 1993). Tracking research on this population through the use of radio-telemetry contribute imperative data for the management of the populations within the preserve.

Although research on diet and prey items was not an objective of this study, fecal samples were inadvertently and deliberately collected on several occasions. Fecal samples were sorted by sexes but not by individuals or size classes. The two primary prey items were (Littorina irrorata) and (Geukensia demissa). Prey items for Malaclemys within the SMMAP are different than those found within the Pinellas National Wildlife Refuge in Tampa Bay, where the primary prey items are (Melampus sp.). Further research on the diet of Malaclemys with the preserve based on size classes and sexes of individuals would be beneficial.

CONSERVATION MEASURES

New regulations for by-catch reduction devices (BRD's)

Three states have now passed regulations requiring commercial and recreational crabbers to affix BRD's to the four entrance funnels on their traps. Maryland, New Jersey and Delaware are the

first states to lead the way in an effort to reduce by-catch mortality of diamondback terrapins in the blue crab fishery. Commercial fishermen are required to use BRD's (2" x 6") in manmade lagoons and waters less than 100' and 150' wide in New Jersey and Delaware respectively. In Maryland, recreational blue crab fishers are required to use BRD's ($1^{3/4}$" x $4^{3/4}$"). Research around the nation has shown that terrapins are more likely to drown in near shore traps than those further from the shore in deeper water. Many other states have formed Blue Crab Advisory Boards (Appendix A) and are working to save a collapsed fishery as well as to address the long standing problem of terrapin mortality in the pots.

Research conducted on BRD found that their use prevented the drowning of most size classes of diamondback terrapins and also increased the percent of legal blue crabs by 32.9% per trap day (Guillory and Prejean, 1998). Biologists from the University of Ohio working in Chesapeake Bay used modified crab traps that were approximately .66 m taller than standard crab traps for their BRD study. The taller traps prevented the drowning of terrapins and allowed them to obtain the data they needed on funnel size and dimensions of BRD. Three sizes of BRD were tested during the study and were as follows; 4 x 10 cm, 4.5 x 12 cm and 5 x 10 cm. The 4x10 cm BRD was the most successful at excluding terrapins (0% captured), though it also reduced the number of legal blue crabs (Callinectus sapidus). Both of the other BRD had no effect on the number of legal crabs retained in the trap and reduced terrapin by-catch by 82% and 47% respectively (Roosenburg and Green, 2000).

Statewide clean-Ups of derelict blue crab traps

Texas, Louisiana, Mississippi and Alabama have collaborated to form the Gulf States Marine Fisheries Commission. All four states have initiated statewide shallow water clean-ups of derelict blue crab traps (Appendix B). On 13th March, 2004 375 abandoned blue crab traps were removed from the near-shore waters of Alabama, which was down 65 percent from 1,075 traps collected in the 2003 cleanup. 856 traps were collected in the three coastal counties of Mississippi in March and April of 2004. This was down by 40 percent from the 1,429 traps collected in 2003. Over 215 volunteers worked together to remove 6,676 traps from Louisiana during their first annual clean up in the spring of 2004. Texas Parks and Wildlife Department worked with volunteers to remove 3,571 derelict blue crab traps in 2004. This number was similar to the 2003 efforts which removed 3,838 traps. However, the 2004 numbers of 3,571 traps removed were down by 56 percent from the 2002 clean-up which removed 8,070 traps.

Florida conducted a small scale trap removal program in the Saint Marks area back in 2002. This clean up was related to marine mammal entanglements in the area. In 2003, FWC designated Chapter 68B-55.001 which defines trap retrieval and trap debris removal guidelines (Appendix C). 2004 derelict trap removal efforts are being targeted for the Indian River Lagoon, Tampa Bay and the Saint Martins Marsh Aquatic Preserve.

Acknowledgements:
Special thanks to the preserve manager, Keith Laakkonen, for his interest in diamondback terrapins and for soliciting this research. Thanks also to the Crystal River State Buffer Preserve and St. Martins Marsh Aquatic Preserve for funding the work. The staff of the preserve were extremely helpful in showing me the waterways, how to drive an airboat, capturing and processing terrapins, filling in time sheets, etc. Thank you Jeanne, Kathy, Chris, Melissa, Jeff, Rich, Chad, Vickki, J D and Tom.

I also want to thank Bob Breichtel (Turtle Bob), Jonathan Boore, Dr. Tony Tucker (Mote Marine Lab) and George Heinrich (Heinrich Ecological Services) for visiting, participating and contributing to this research. Special thanks to Sherri Emer of Georgia State University for editing and statistical assistance.

Thank you Kathy, Leroy and Painter for welcoming me into your beautiful island home.

LITERATURE CITED

Aresco, M. 1996. Malaclemys terrapin terrapin (Northern Diamondback Terrapin). Reproduction and Nest Predation. Herpetological Review 27 (2):77.

Boykin, C. S. 1999. The Status of the Ornate Diamondback Terrapin at Tarpon Key, in the Pinellas National Wildlife Refuge. Senior Research Project, Eckerd College 27 pp.

Bishop, J. M. 1983. Incidental Capture of Diamondback Terrapin by Crab Pots. Estuaries (6)4:426-430.

Burger, J. 1976a. Behavior of Hatchling Diamondback Terrapins (Malaclemys terrapin) in the Field. Copeia 4:742-748.

Burke, V. J. 2000. Diamondback Terrapin: A Coastal Species. Turtle Conservation. Smithsonian Institution Press, Washington, D. C. pp 168-170.

Butler, J. 1998. Population Ecology, Home Range and Seasonal Movements of the Carolina Diamondback Terrapin, Malaclemys terrapin centrata, in Northeastern Florida. Final Report To FFWCC, Nongame Wildlife Project 1-44.

Carr, A. 1952. Handbook of Turtles. Cornell University Press, Ithaca, New York p 168.

Crowder, L., Hart, K., and Hooper. 2000. Trying to solve a bycatch and mortality problem: Can we exclude diamondback terrapins (Malaclemys terrapin) from crab pots without compromising blue crab (Callinectes sapidus) catch?

Feinberg, J. 2000. Nesting Ecology of Diamondback Terrapins (Malaclemys terrapin) at Gateway National Recreation Area. Masters Thesis, Hofstra University 1-112.

Garmestani, A. S., Percival, H. F., Rice, K.G., and K. M. Portier. 1997. Sea Turtle Nesting in the Ten Thousand Islands of Florida. Florida Cooperative Fish and Wildlife Research Unit, USGS-Biological Resources Division Technical Report 56. 96 pp.

Guillory, V., and P. Prejean. 1998. Effect of a Terrapin Excluder Device on Blue Crab, Callinectes sapidus, Trap Catches. Marine Fisheries Review (60)1:38-40.

Hoyle, M. E., and J. W. Gibbons. 2000. Use of a Marked Population of Diamondback Terrapins (Malaclemys terrapin) to Determine Impacts of Recreational Crab Pots. Chelonian Conservation and Biology 3(4):735-737.

Jackson, C. G., and A. Ross. 1971. Molluscan Fouling of the Ornate Diamondback Terrapin, Malaclemys terrapin macrospilota Hay. Herpetologica 27(3):341-344.

Jackson, C. G., Ross, A., and G. L. Kennedy. 1973. Epifaunal Invertebrates of the Ornate Diamondback Terrapin, Malaclemys terrapin macrospilota. The American Midland

Naturalist 89(2)495-497.

Jeyasuria, P. 1997. Temperature-dependent aromatase expression in developing diamondback Terrapin (Malaclemys terrapin) embryos. Journal of Steroid and Biochemical Molecular Biology 61 (3-6):415-425.

Kays, R. W., and D. E. Wilson. 2002. Mammals of North America. Princeton University Press, Princeton, New Jersey p 204.

Laakkonnen, K. 2003. Crystal River State Buffer Preserve Draft Ten-Year Land Management Plan (2004 – 2014). Office of Coastal and Aquatic Managed Areas. Florida Department of Environmental Protection 95 pp.

Lamb, T., and J. C. Avise. 1992. Molecular and Population Genetic Aspects of Mitochondrial DNA Variability in the Diamondback Terrapin, Malaclemys terrapin. Journal of Heredity 83(4):262-269.

Lovich, J. E., and J. W. Gibbons. 1990. Age at Maturity Influences Adult Sex Ratio in the Turtle Malaclemys terrapin. Oikos 59:126-134.

Madge, D. 1985. Temperature and Sex Determination in Reptiles with Reference to Chelonians. Testudo (2)3:1-5.

McCauley, R. H. 1945. The Reptiles of Maryland and the District of Columbia. Privately Published, Hagerstown, Maryland.

Mealey, B., and G. Parks. 1999. The Demographics of the Diamondback Terrapins (Malaclemys terrapin) of the Florida Keys. Miami Museum of Science Annual Report. Miami, FL.

Millsap, B., Gore, J., Runde, D., and Cerulean, S. 1994. Setting Priorities for the Conservation of Fish and Wildlife Species in Florida. Wildlife Monographs 111: 1-57.

Roosenburg, W. M. 1993. The Chesapeake Diamondback Terrapin Investigations (Final Report). Chesapeake Research Consortium Publication No. 146:1-59.

Roosenburg, W. M., and K. C. Kelley. 1996. The Effect of Egg Size and Incubation Temperature on Growth in the Turtle, Malaclemys terrapin. Journal of Herpetology (30)2:198-204.

Roosenburg, W., Crecko, W., Modesitte, M., and Robbins, M. 1997. Diamondback Terrapin (Malaclemys terrapin) Mortality in Crab Pots. Conservation Biology 11(5):1166-1172.

Roosenburg, W. M., Haley, K. L., and S. McGuire. 1999. Habitat and Movements of

Malaclemys. Chelonian Conservation and Biology 3(3):425-429.

Roosenburg, W. M., and J. P. Green. 2000. Impact of a Bycatch Reduction Device on Diamondback Terrapin and Blue Crab Capture in Crab Pots. Ecological Applications (10)3:882-889.

Ross, A., and C. G. Jackson. 1972. Barnacle Fouling of the Ornate Diamondback Terrapin. Malaclemys terrapin macrospilota. Crustaceana 22:203-205.

Seigel, R. A. 1979. The Reproductive Biology of the Diamondback Terrapin, Malaclemys terrapin tequsta. Masters Thesis, University of Central Florida 1-40.

Seigel, R. A. 1980a. Predation by Raccoons on Diamondback Terrapins, Malaclemys terrapin tequesta. Journal of Herpetology 14(1):87-89.

Seigel, R. A. 1980b. Courtship and Mating Behavior of the Diamondback Terrapin Malaclemys terrapin tequesta. Journal of Herpetology 14(4):420-421.

Seigel, R. A. 1983. Occurrence and Effects of Barnacle Infestations on Diamondback Terrapins (Malalcmeys terrapin). The American Midland Naturalist 109(1):34-39.

Seigel, R. A. 1984. Parameters of Two Populations of Diamondback Terrapins (Malaclemys terrapin) on the Atlantic Coast of Florida. Vertebrate Ecology and Systematics 36:77-87.

Seigel, R. A., and J. W. Gibbons. 1995. Workshop on the Ecology, Status, and Management of the Diamondback Terrapin (Malaclemys terrapin), Savannah River Ecology Laboratory, 2 August 1994: Final Results and Recommendations. Chelonian Conservation and Biology 1(3):240-243.

Wood, R. C. 1994. The Distribution, Status, Ecology and Taxonomy of Diamondback Terrapins, (Malaclemys terrapin) in the Florida Keys. A Symposium on the Status And Conservation of Florida Turtles. Eckerd College, St. Petersburg, FL. 111

Alabama:	174 crabbers	150 traps average	26,100 traps
Mississippi:	256 crabbers	*no estimate*	
Louisiana:	3,347 crabbers	260 traps average	870,220 traps
Texas:	259 crabbers	200 traps average	51,800 traps
Total			948,120 traps

** Data taken from website of Shallow Water Angler*

Table 1. Numbers of blue crab endorsements, average number of traps and total traps.

	SMK I (N=124)	**SMK II (N=66)**	**SMK III (N=21)**	**TOTAL (N=211)**
Female	73	29	9	111
Male	51	37	12	100
Sex Ratio	1.4:1	0.8:1	0.75:1	1.1:1

Table 2. Adult sex ratios (females : males) per study site within the SMMAP.

	Females	Males	Total
Barnacles	11.8%	0%	6.3%
Barnacle Scars	10%	0%	5.4%
Missing Limbs	4.3%	2%	3.3%
Scute Abnormality	8.2%	6.3%	7.3%
Split Vertebrals	6.0%	0%	3.3%
Striped Pants	0.9%	0%	0.5%

Table 3. Data collected from photo documentation.

Plastron Pigmentation	**Female**	**Male**	**Total**
< 10%	2%	2.1%	1.9%
< 50%	3.6%	14.7%	8.8%
> 50%	94.5%	83.2%	89.3%

Table 4. Morphological variations among plastrons of *Malaclemys* from SMMAP.

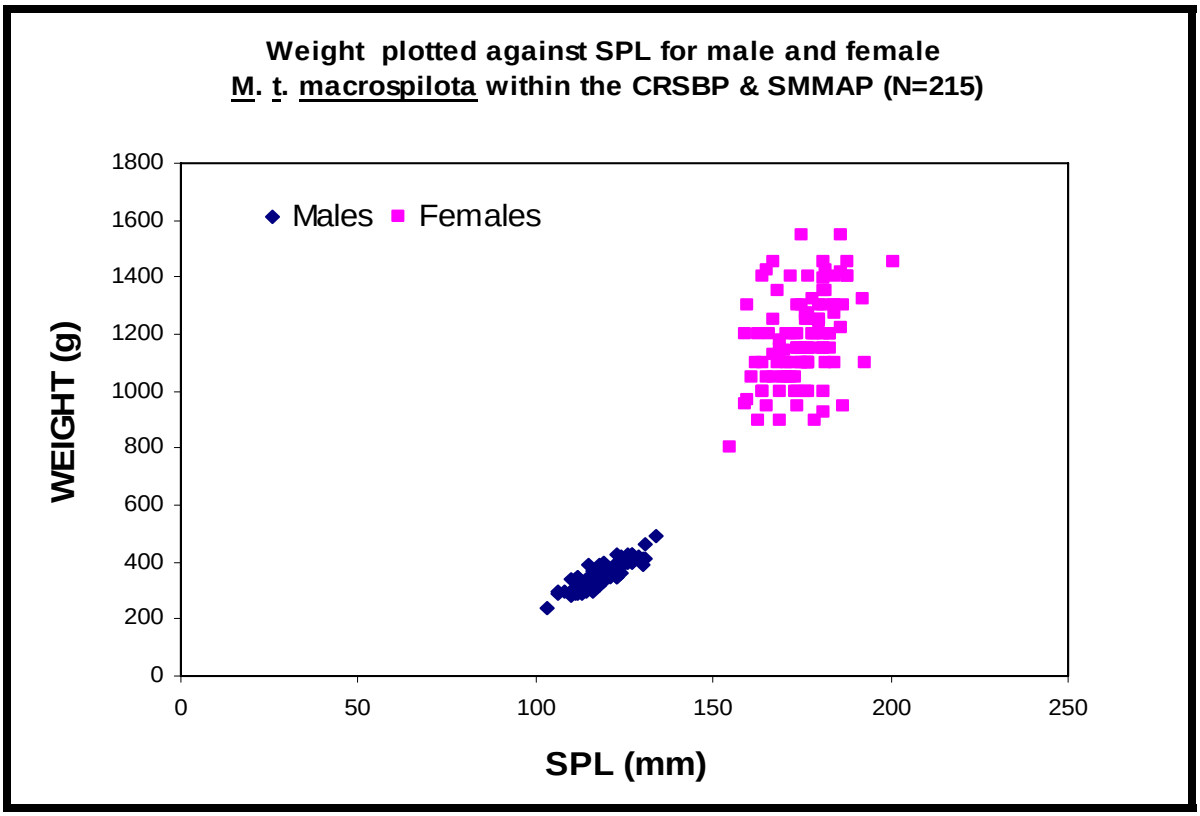


Figure 1. Weight plotted against SPL for male and female *Malaclemys* from the SMMAP.

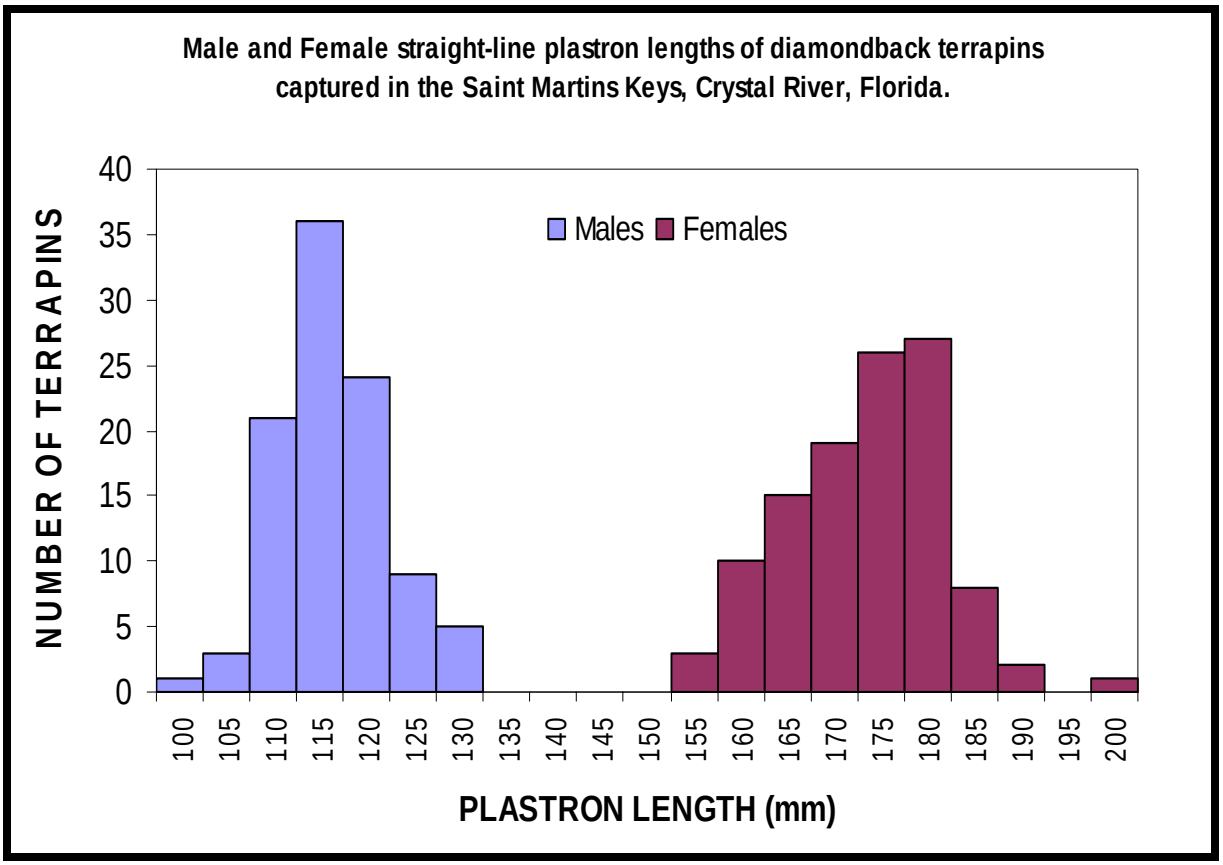


Figure 2. Histogram of male and female SPL from the SMMAP.

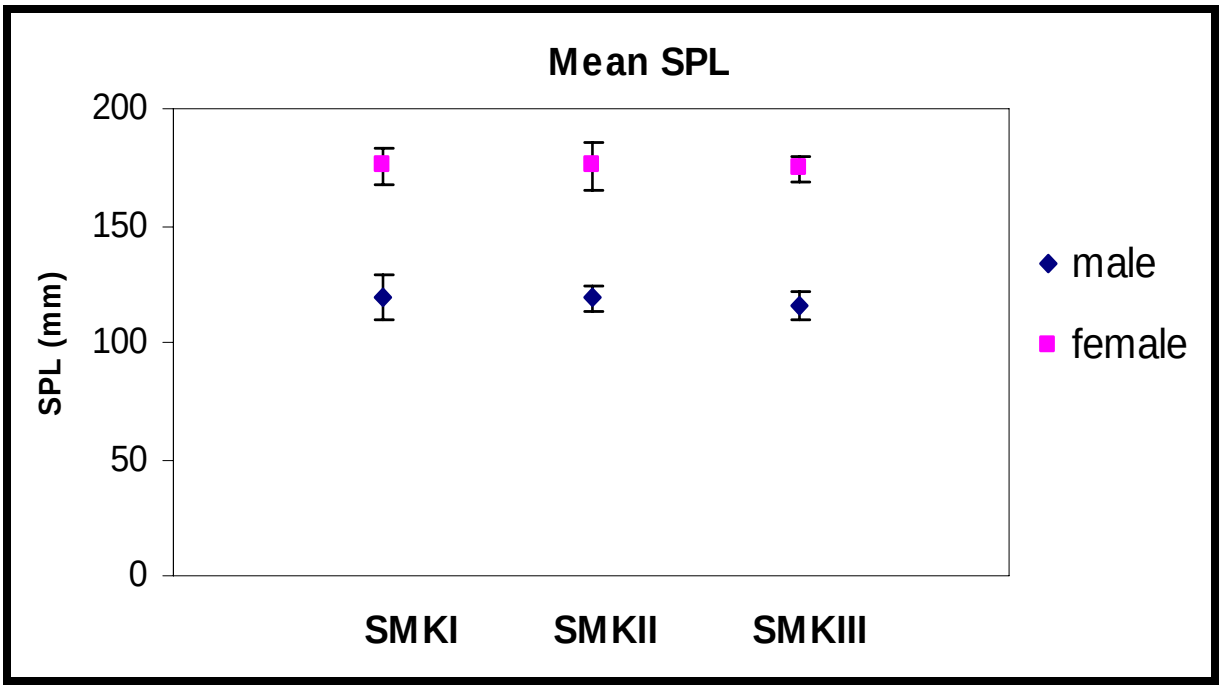


Figure 3. Mean SPL mm for male and female *Malaclemys* from three islands in the Saint Martins Keys.

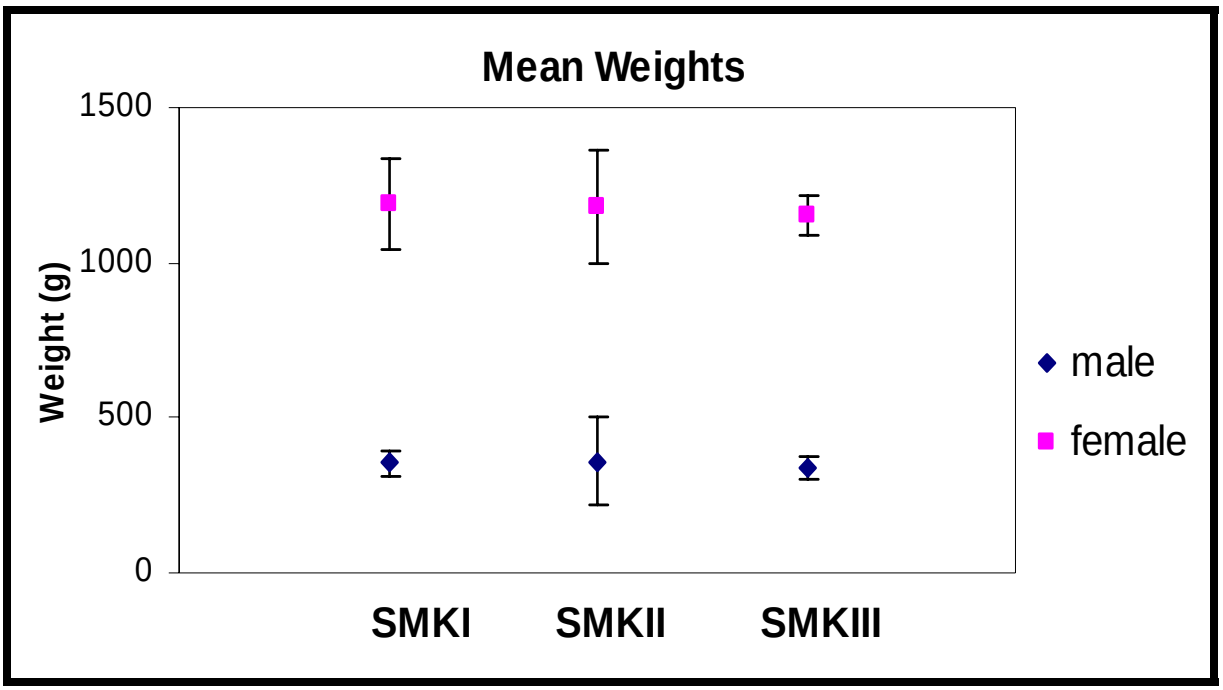


Figure 4. Mean mass (g) for male and female *Malaclemys* from three islands in the Saint Martins Keys.

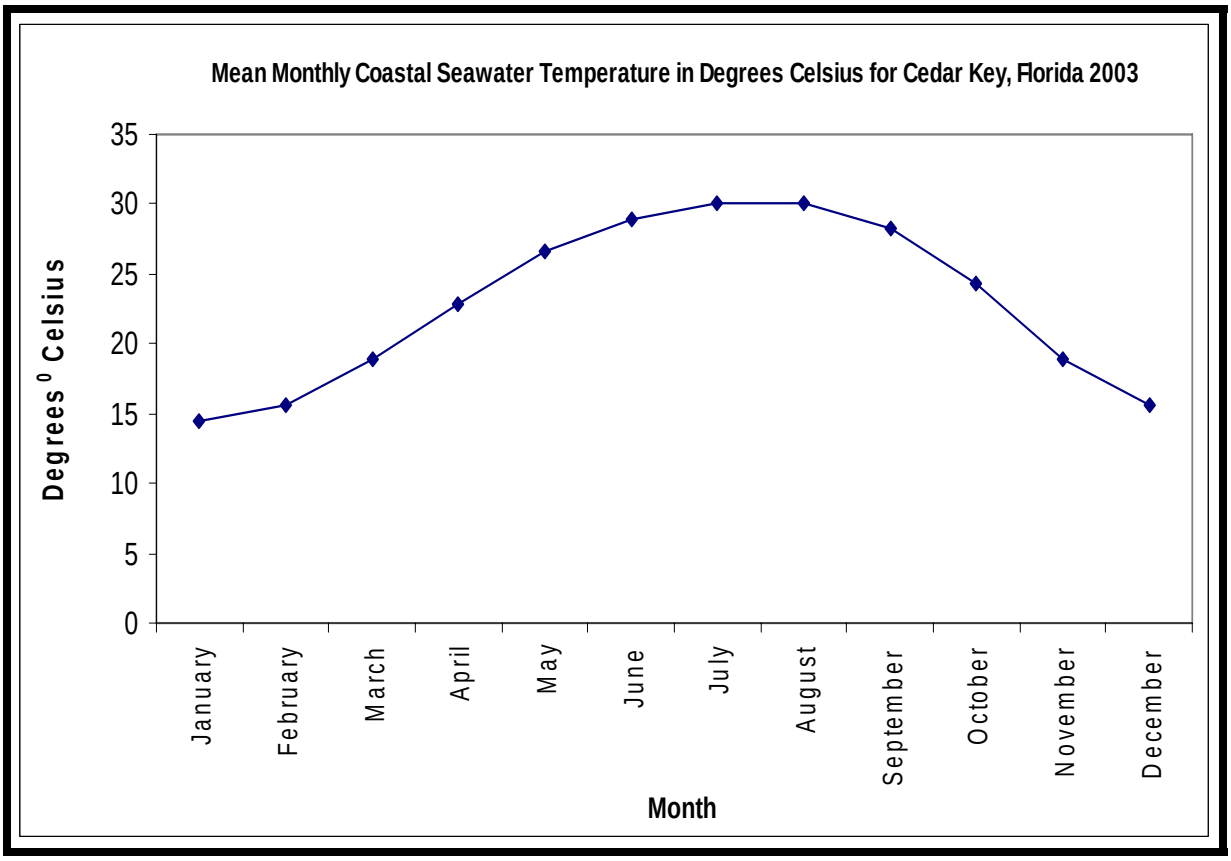


Figure 5. Mean monthly seawater temperatures for Cedar Key.

Figure 6. Adult ornate diamondback terrapin from SMMAP. Male (left) nd female (right).

Figure 7. Note the tremendous difference in head width for adult *Malaclemys* from SMMAP. Male (left) and female (right)

Figure 8. Carapace and plastron view of adult female ornate diamondback terrapin.

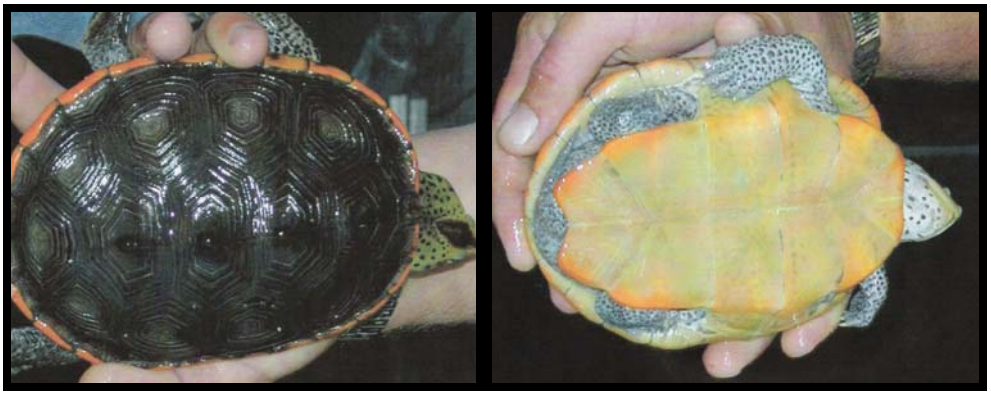


Figure 9. Carapace and plastron view of sub-adult female Mississippi diamondback terrapin from J. L. Scott Marine Biology Lab in Ocean Springs, Mississippi.

Figure 10. Vertebral knobs are only found on the Florida & Gulf Coast sub-species. They are present on hatchlings, juveniles, and young adults, but are worn down and absorbed by growth over time.

Figure 11. Two adult female ornate diamondback terrapins that were killed by raccoon at Tarpon Key in the Pinellas National Wildlife Refuge. The female in the left photo had her neck broken (see extended neck with flesh removed) and the female in the right photo had her left rear limb and entrails removed (see exposed bone).

Figure 12. Mississippi diamondback terrapin that was found dead on 27th March, 2004 during Mississippi's statewide derelict trap clean-up. Photo by Gulf States Marine Fisheries Commission

Figure 13. Seven derelict blue crab traps on a mud flat in Alabama. Texas, Louisiana, Mississippi and Alabama have each conducted statewide clean-ups to remove abandoned traps in 2003 and 2004. Florida has clean-ups planned for Tampa Bay, the Indian River Lagoon and Crystal River.

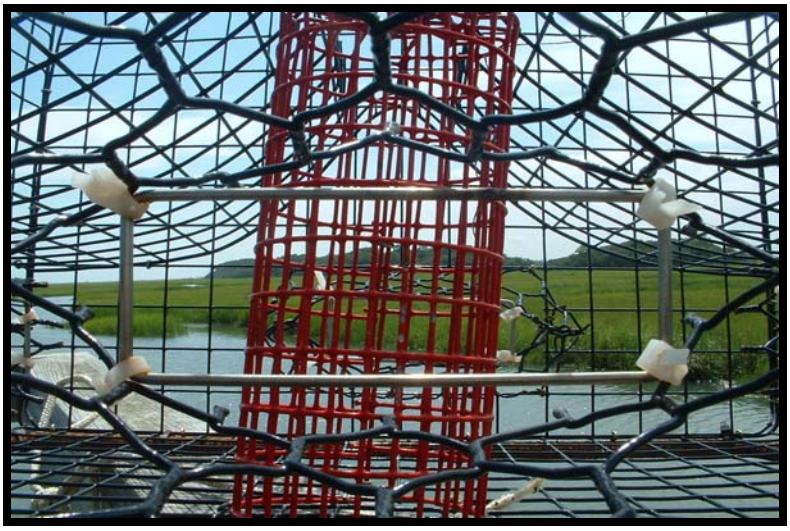


Figure 14. By-catch reduction device (BRD) being used in a terrapin study at Pritchard's Island, South Carolina.

Figure 15. The remains of 14 diamondback terrapins that were found inside a bald eagle nest in Everglades National Park.

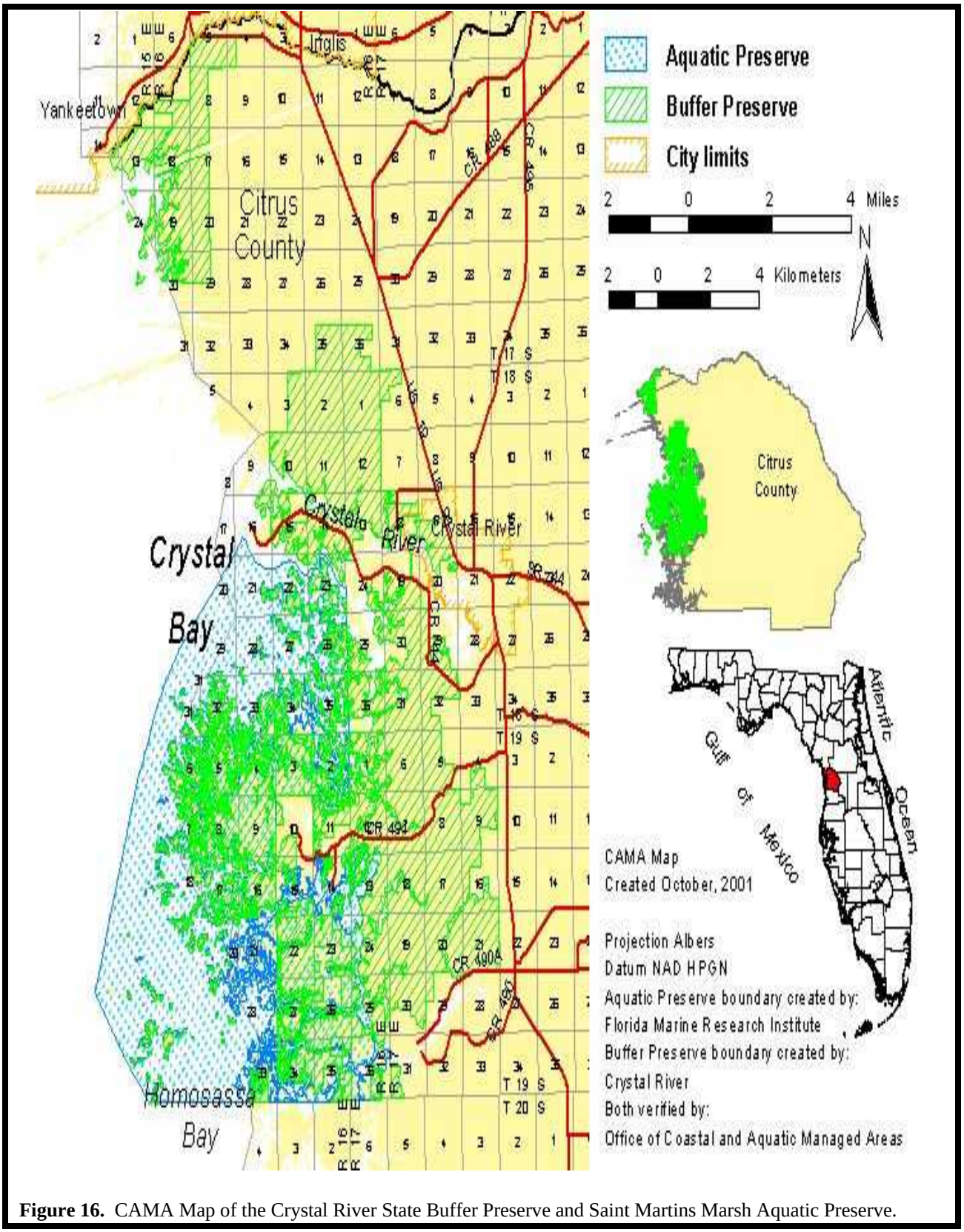


Figure 16. CAMA Map of the Crystal River State Buffer Preserve and Saint Martins Marsh Aquatic Preserve.

Figure 17. Black mangrove forest surveys entailed walking through the island to hand capture terrapins when they were encountered. Although it was not known at the time of this photo, there is a terrapin in the bottom center of the picture just to the left of the log and behind the great egret feather. Photo taken in the Saint Martins Keys at Study Site I (SMK I).

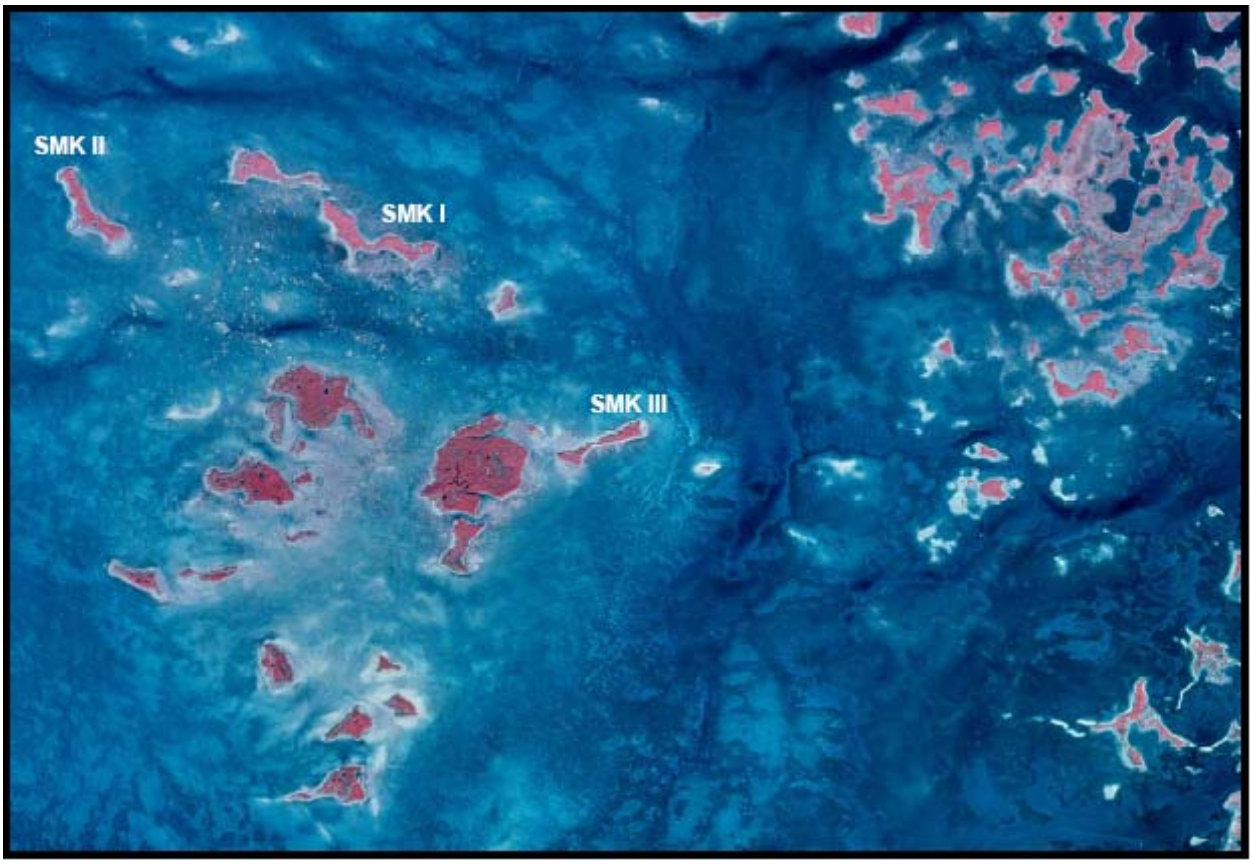


Figure 18. The Saint Martins Keys were the primary study site within the preserve and lie Southwest of the Saint Martins River and West of the Little Homosassa River.

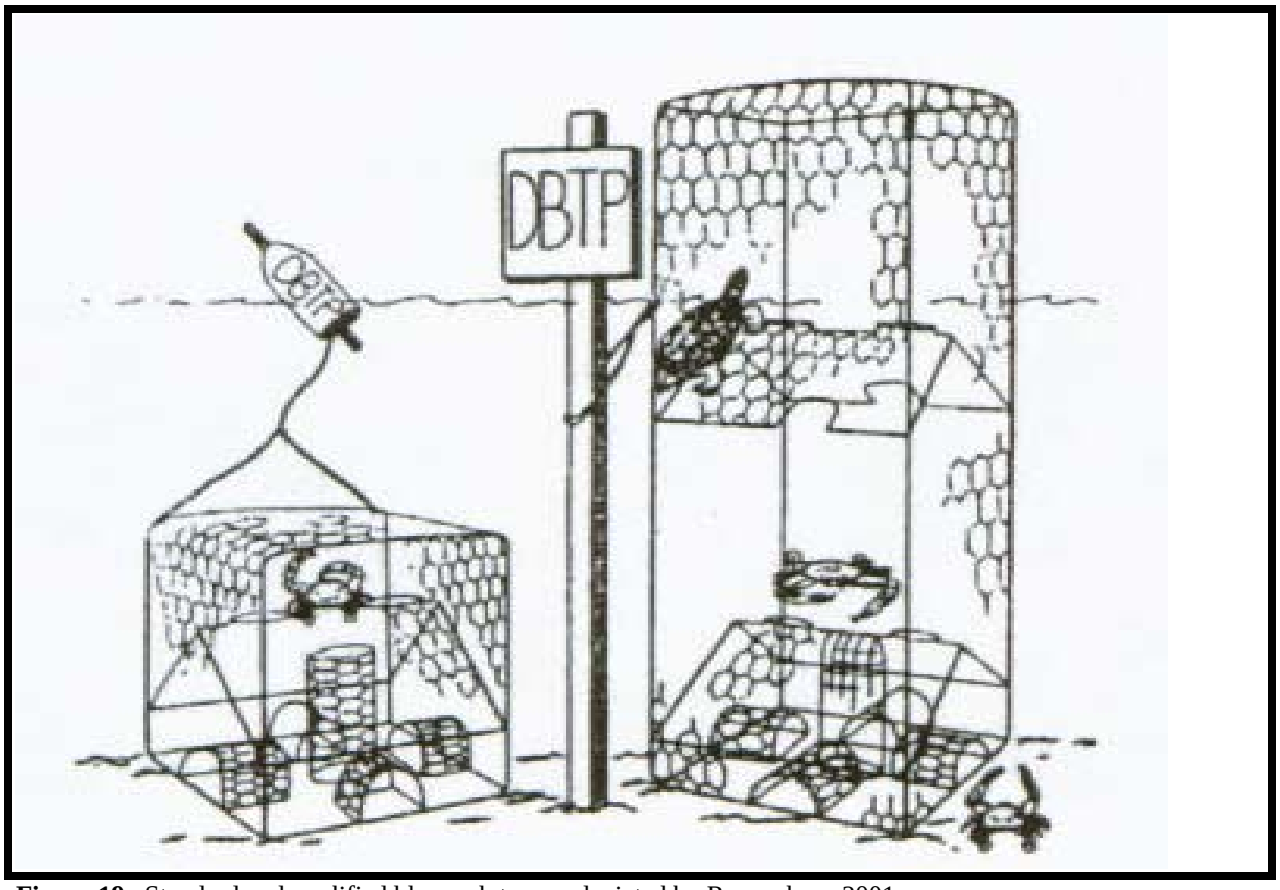


Figure 19. Standard and modified blue crab trap as depicted by Roosenburg 2001.

Figure 20. Standard blue crab trap affixed with floats and deployed

under mangrove fringe at edge of island.

Figure 21. Ornate diamondback terrapin buried in muddy substrate on SMK I.

Figure 22. Ornate diamondback terrapin partially buried beneath accumulated tidal wrack at SMK I.

Figure 23. Beach at Fort Island Trail.

Figure 24. Two of over a dozen spoil islands adjacent the cross Florida barge canal.

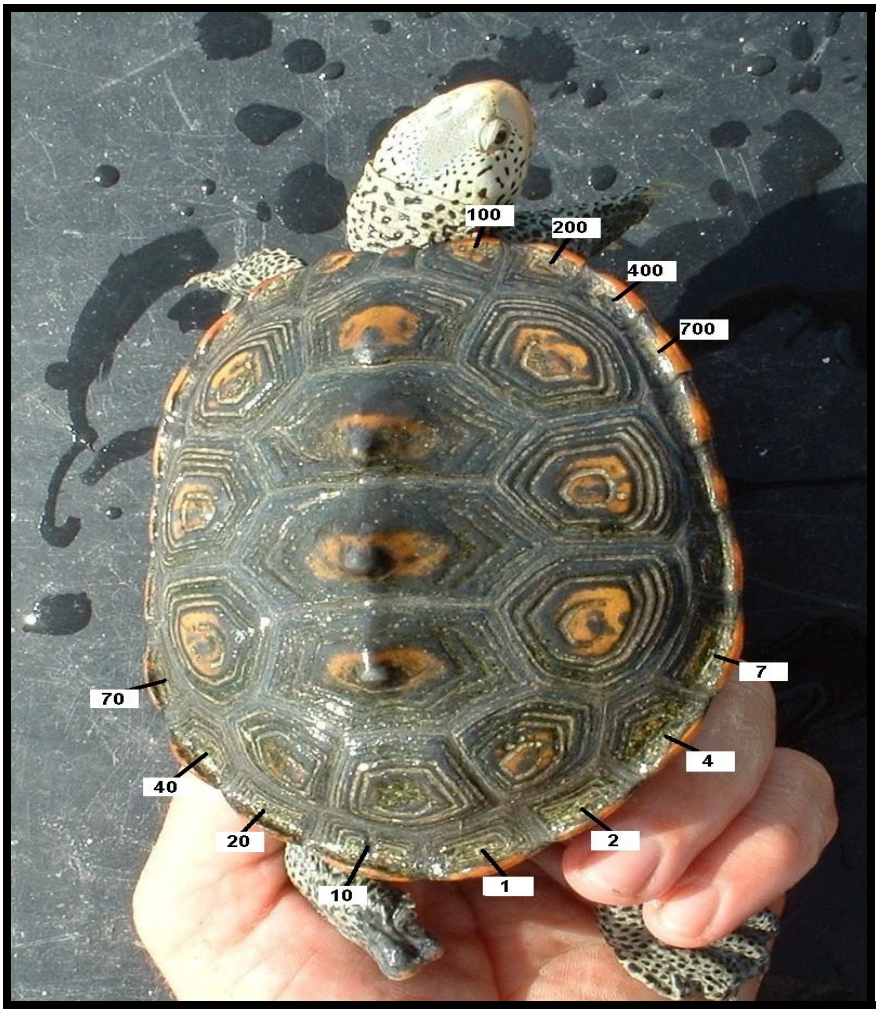


Figure 25. Notching system for marking terrapins.

Figure 26. Only one terrapin (0.5%) in the SMMAP had dark vertical bars between rear limbs. The lines, also called striped pants, are present on 13% of the terrapins at Tarpon Key, some 140km south. Striped pants were once considered a distinguish-characteristic of the mangrove terrapin from Florida Bay and the keys where over 90% of terrapins exhibit this marking.

Figure 27. Only 2% of the terrapins in the study had plastrons with < 10% pigmentation. 140 km south in Tampa Bay over 31 % of terrapins were found to possess clean plastrons.

Figure 28. 8.8% of the terrapins had plastrons with < 50% pigmentation. 44% of the terrapins at Tarpon Key in Tampa Bay had plastrons with < 50% pigmentation.

Figure 29. 89.3% of the terrapins in the study had dark plastrons with > 50% pigmentation. In contrast, only 25% of the terrapins in Tampa Bay had plastrons with > 50% pigmentation.

Figure 30. Adult female with barnacles and oyster growing on plastron and posterior marginals.

Figure 31. Female with barnacle scars on third and and fifth vertebrals.

Figure 32. *Procyon lotor* in large coontie plant on terrapin nesting beach near Yankeetown (spoil island of barge canal).

Figure 33. Standard traps with floats near the marshes of the warm water discharge canal.

Appendix A

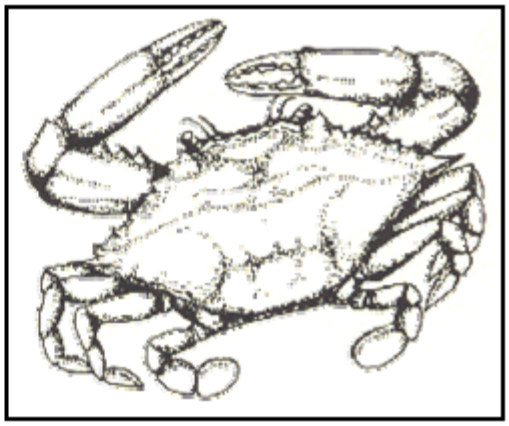
BLUE CRAB ADVISORY BOARD

Florida Fish and Wildlife Conservation Commission
Division of Marine Fisheries
February 2004

STAFF RECOMMENDATION

Staff recommends that the Blue Crab Advisory Board proposals be taken to a series of regional workshops to gather public testimony on a proposed management plan. These workshops would occur during March and April with results presented to the Commission in June 2004.

BACKGROUND



In 1998, the Legislature, concerned about rapid growth and other problems in the blue crab fishery, established a moratorium on the issuance of new blue crab endorsements (V-number). After the moratorium expired in 2000, the Commission extended it until July 1, 2005. Problems in the fishery included the seasonal crowding of traps in confined water bodies, lost traps and bycatch, overcapitalization that forced many fishermen into part-time participation, latent endorsements that were not being used, conflict between local and transient crabbers, conflict between soft crab and hard crab producers, and regional concerns about declining abundance.

In April 2002, the Division of Marine Fisheries contracted the University of Florida Sea Grant College Program to conduct a series of workshops to elicit fishermen's comments regarding the important needs of the fishery. The final report, received on March 25, 2003, provided information about blue crab regulations in ten other Southeastern states and summaries of the 16 workshops held in Florida between July 2002 and January 2003.

In summer 2003, DMF decided to assemble an industry advisory board to develop an effort management program, and in August 2003, board applications were sent to 653 Saltwater Products License holders who reported more than 500 pounds of blue crabs. The Division received 43 applications from which an ad hoc blue crab advisory board of 15 harvesters and wholesale dealers was formed to develop a recommended management plan with assistance from FWC staff and Florida State University's Conflict Resolution Consortium. The board also contains one voting member representing the FWC for a total of 16 members. At this writing, the Board has held three public meetings (September 23-24, 2003; October 30, 2003; December 3-4, 2003) with a fourth scheduled for January 6-7, 2004.

The Board has provided recommendations to the Division that would establish an effort management plan based upon: 1. capping the number of participants (endorsements) in the fishery; 2. developing qualifying criteria; 3. establishing a maximum number of traps per endorsement; 4. requiring trap tags; 6. separating the peeler fishery from the hard crab fishery; 7. transferability of endorsements; 8. establishing regional short-term closures for trap clean-up activities; and, 9. developing certain gear modifications. At this time, DMF and FMRI are analyzing those recommendations in terms of numbers of endorsements and traps that would be authorized by their proposal, and will present them to the Board at the January 6-7 meeting. We will provide an update of the Board recommendations and our analyses at the Commission's February meeting.

Appendix B

Missing Attachment from Gulf States Marine Fisheries Commission

Appendix C

TRAP DEBRIS AND DERELICT TRAP REMOVAL DRAFT RULE REVIEW

FLORIDA FISH AND WILDLIFE CONSERVATION COMMISSION
DIVISION OF MARINE FISHERIES
NOVEMBER 2002

ISSUE

There are five types of traps used in Florida to harvest marine species. The fisheries where traps are used include lobster, stone crab, blue crab, black sea bass, and pinfish. At present, there are approximately 540,000 lobster traps, approximately 1.6 million stone crab traps, and an undetermined number of blue crab, black sea bass and pinfish traps deployed in Florida waters. The three main trap fisheries (spiny lobster, stone crab, and blue crab) combined accounted for over $85 million in dockside value in 2000. Two undesirable consequences of trap fisheries are trap debris and derelict traps and their impacts on the environment. Derelict traps and trap debris exist for various reasons:

1. Abandonment of traps by individuals who leave the fishery seasonally or permanently.
2. Improper disposal of old traps.
3. Loss of actively fished traps resulting from:
    a. Tides, currents or storms
    b. Deterioration of floats, lines or knots
    c. Negligence in assembling and maintaining floats and lines
    d. Clipping of float lines by vessel propellers
    e. Intentional cutting of floats by vandals

Efficient removal of trap debris and derelict traps is hindered by Chapter 370.1107, Florida Statues, which states that "it is unlawful for any person, firm, corporation, or association to be in actual or constructive possession of a licensed saltwater fisheries trap registered with the Fish and Wildlife Conservation Commission in another person's, firm's, corporation's, or association's name". This language allows for the closed season possession of traps with written permission by the owner, or by FWC staff. Similar policies are contained in blue crab, lobster, and stone crab statutory language and the Commission’s rules.

A number of states with blue crab trap fisheries have established closed seasons so that any trap in the water during the closed season may be removed as a derelict trap. While Florida already has closed seasons established for the spiny lobster and stone crab fisheries,

there is no closed season for blue crab harvest. The use of a single closed season for retrieval may not be appropriate statewide. The extent of our shoreline and fisheries mean that any statewide

program would be very ambitious and costly. Therefore, we would like to explore physical attributes of traps and debris that can be used to determine when their removal is in all our interests.

We have developed draft rule language to assist in the retrieval of derelict traps and debris by both FWC staff, federal other state and local government staff, and volunteer groups. Funds available for the FWC retrieval program are not sufficient to address a comprehensive statewide program. Therefore, in the foreseeable future we will have to partner with volunteers to accomplish meaningful results. In that spirit, we held a working group meeting where we invited representatives of Organized Fishermen of Florida, Monroe County Commercial Fishermen, Florida Fishing Federation, Reef Relief, Ocean Conservancy, Florida Department of Environmental Protection, and the Keys Sanctuary to help develop draft rule language.

DRAFT RULE SUMMARY

68B-55.001, establishes certain definitions that specify closed season, trap debris, derelict trap, fishable trap, and trap. These definitions distinguish functional or "fishable" traps from derelict traps and trap debris, thus allowing for their removal during open and closed seasons.

68B-55.002, allows for the retrieval of trap debris, and authorizes specified groups to organize coastal clean-up efforts from shoreline areas and other areas of state waters.

68B-55.003, establishes a trap retrieval program for lobster and stone crab during the closed season for each respective species pursuant to s 370.143, F.S. It also specifies the type of information to be gathered for each trap retrieved, and allows trap owners a reasonable amount of time to claim their traps.

68B-55.004, establishes a derelict trap retrieval period for closed and open seasons. During closed seasons, traps still remaining in the water are considered to be derelict and may be retrieved as part of coastal cleanup events. During the open season, the retrieval of derelict traps may occur at any time deemed appropriate by the Commission.

68B-55.005 addresses other rule concerns.

TRAP DRAFT RULE 2TRAP DRAFT RULE 3TRAP DRAFT RULE 4