Distribution of the Ornate Diamondback Terrapin (*Malaclemys terrapin macrospilota*) in the Big Bend Region of Florida

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Abstract - Little is known about the Ornate Diamondback Terrapin (*Malaclemys terrapin macrospilota*) from the Big Bend region of Florida (Wakulla, Jefferson, Taylor, and Dixie counties), and only 12 museum specimens from this area are known. We surveyed for this ecologically significant coastal species from the St. Marks River south for approximately 135 km to the Suwannee River in order to identify populations, locate and assess nesting habitats, create distribution maps for the species, and offer management recommendations to improve terrapin conservation in the Big Bend region. Using modified crab pots, head counts, and land surveys, we documented 37 new site records for Ornate Diamondback Terrapins. We captured 5 live terrapins, and recorded 5 heads, 6 intact nests, 16 crawls, terrapin material from 48 individuals, and 453 depredated terrapin nests. This survey documents the importance of the Big Bend region as significant habitat for this imperiled species. Managers should evaluate proposed development projects along this coastline for potential impacts to terrapin habitat and populations. We also recommend continued surveys of potential Diamondback Terrapin habitat along the Gulf coast of Florida so that additional populations can be located. We suggest that field studies commence at the terrapin population centers/nesting sites that we identified at Big Grass Island and vicinity, islands at the mouth of the Suwannee River, and areas surrounding the mouths of both the Steinhatchee and St. Marks rivers.

Introduction

Malaclemys terrapin Schoepff (Diamondback Terrapin) occurs in 16 states along the Atlantic and Gulf coasts of the United States, and the coastline of Florida represents approximately 20% of the species' entire range. Three subspecies, including *M. t. macrospilota* Hay (Ornate Diamondback Terrapin) are endemic to Florida, with a total of five of the seven subspecies present in the state. The other states have only one or two subspecies each, and considerably less habitat diversity. Consequently, Florida should be considered an important state for terrapin conservation.

In 2004, 54 researchers, agency biologists, and other individuals with knowledge of Diamondback Terrapins ranked major rangewide threats and management actions for this declining species (Butler et al. 2006a); the top four threats were ranked as crab-pot mortality, habitat loss, nesting habitat alteration, and predation. Recommended management actions included crab-pot regulations, habitat protection, field studies, abandoned pot removal,

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distribution surveys, and others. In Florida, distribution surveys were ranked third for management actions needed (following field studies and crab-pot regulations). To address these major threats and implement management strategies, existing local terrapin populations should first be identified and documented. Only then can biologists initiate field studies, and managers determine if and where habitats are in danger and what actions will assure persistence of these populations.

More recently, Florida's State Wildlife Action Plan ranked Diamondback Terrapins as one of the species of greatest conservation need (Florida Fish and Wildlife Conservation Commission 2012). Regarding the protection and management of Diamondback Terrapins throughout the state, the Florida Natural Areas Inventory recommends that "statewide population surveys and monitoring are sorely needed" (Hipes et al. 2001).

Several Diamondback Terrapin populations in Florida have been identified and studied. Extensive studies have been conducted in northeastern Florida on capture and population assessment, home range, nesting, hatching, and predation of *M. t. centrata* Latreille (Carolina Diamondback Terrapin) (Butler 2000, Butler 2002, Butler et al. 2004). Seigel (1980a, b, c; 1984) studied *M. t. tequesta* Schwartz (Florida East Coast Diamondback Terrapin) on Merritt Island National Wildlife Refuge on the central Atlantic coast, and follow-up studies suggested a major decline in that population (Seigel 1993). Wood (1992) and Baldwin et al. (2005) have worked with several *M. t. rhizophorarum* Fowler (Mangrove Diamondback Terrapin) populations in the Florida Keys. Hart and McIvor (2008) studied a Mangrove Diamondback Terrapin population in western Everglades National Park. Additionally, populations of *M. t. pileata* Wied-Neuwied (Mississippi Diamondback Terrapin) have been identified in the extreme western panhandle region of Florida (L.R. O'Connor, University of Florida, Cantonment, FL, pers. comm.). We know from previous research that Ornate Diamondback Terrapins exist in Panacea and Cedar Key (Butler and Heinrich 2007), and that populations occur at St. Martins Keys near Crystal River (Boykin, no date), Tarpon Key in Tampa Bay (C.S. Boykin, Florida Department of Protection, Miami, FL, pers. comm.), and the Sanibel Island area (C. Lechowicz, Sanibel-Captiva Conservation Foundation, Sanibel, FL, pers. comm.). There are no published records in the area between those sites; however, we expect that terrapins are present in at least some areas.

A survey of 20 major natural history museums (Butler et al. 2006b) revealed only 12 Diamondback Terrapin specimens from the entire Big Bend region located in the northwestern Florida peninsula (Fig. 1). All but 1 of these records represent collections of single individuals, and the most recent record is from 1988. Seemingly appropriate Diamondback Terrapin habitat is present, and we believe the paucity of data from the Big Bend region is due to the relative inaccessibility of the coastline, a circumstance that could prove beneficial to terrapin conservation.

In this study, we surveyed the Big Bend region of Florida for Ornate Diamondback Terrapins. Our objectives were to identify populations of terrapins throughout the area, locate and assess nesting habitats, create a series of maps of the Big Bend region illustrating the above locations, and outline suggestions for improving terrapin conservation.

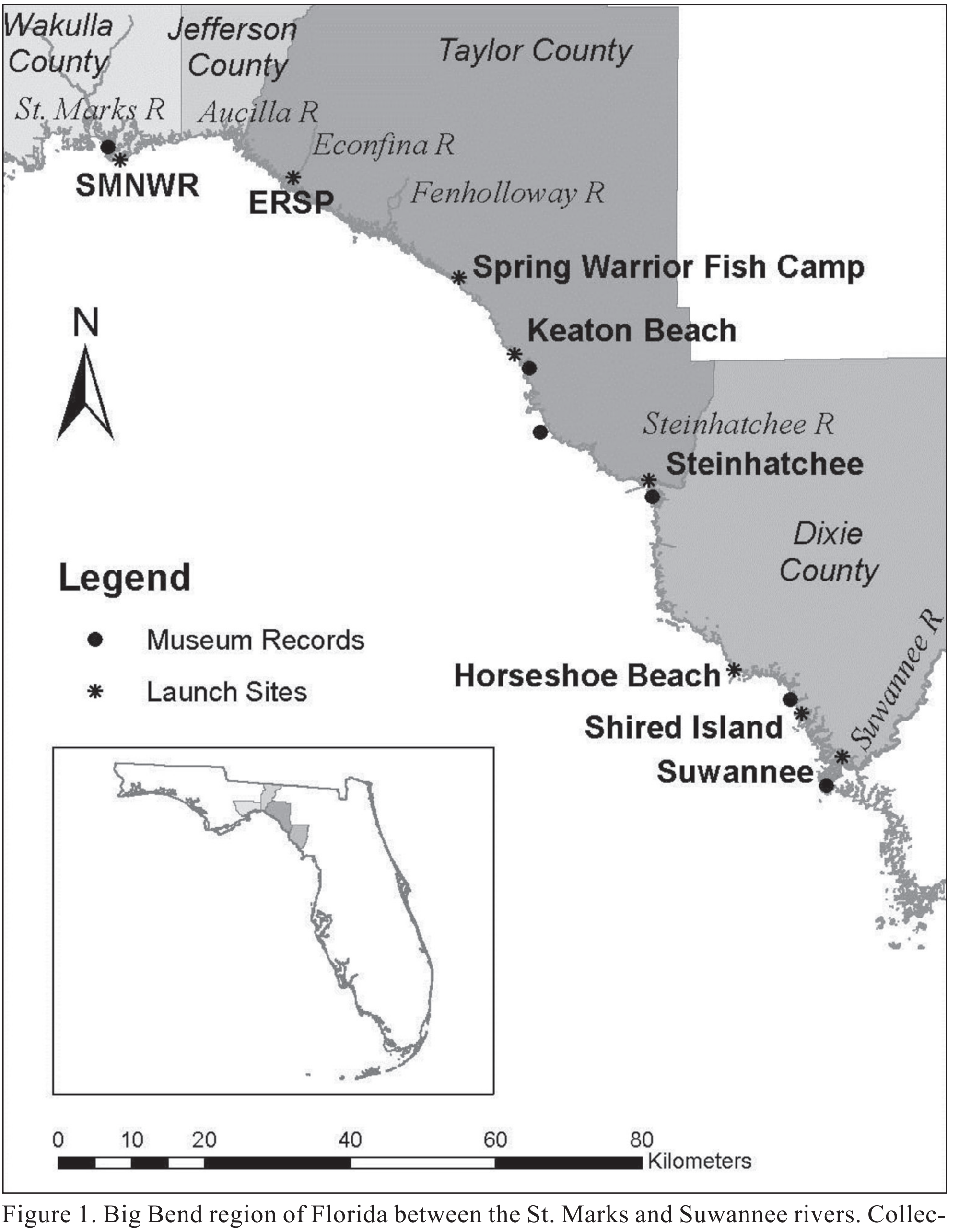

Figure 1. Big Bend region of Florida between the St. Marks and Suwannee rivers. Collection sites for 12 Ornate Diamondback Terrapin museum specimens recorded prior to this study are indicated, as are towns or other sites from which we launched.

Methods

Study area

The study area encompassed the Big Bend region of Florida from the St. Marks River south approximately 135 km to the Suwannee River, including 4 counties: Wakulla, Jefferson, Taylor, and Dixie (Fig. 1). In addition to the 2 bordering rivers, the Aucilla, Econfina, Fenholloway, and Steinhatchee rivers also drain into the northeastern Gulf of Mexico in this region. Most shorelines are composed of saltmarsh, dominated by *Spartina alterniflora* Loisel (Smooth Cordgrass) and *Juncus roemerianus* Scheele (Black Needlerush), and few sandy beaches are present (Kruczynski et al. 1978). The marshes extend inland for several kilometers in most areas and are penetrated by numerous tidal creeks. Wave action is classified as "zero" and water is generally shallow, with low tides leaving many creeks and near-shore areas empty (Tanner 1960). The study area shoreline has some protection due to its location within the Big Bend Seagrasses Aquatic Preserve (BBSAP), which includes the St. Marks National Wildlife Refuge (SMNWR), Big Bend Wildlife Management Area (BBWMA), Econfina River State Park (ERSP), and the Lower Suwannee National Wildlife Refuge.

During 2007–2009, we traveled to various areas in the Big Bend region for a series of eight 5-day research trips during the months of May, June, and July. A ninth expedition consisting of 9 days was undertaken in 2008. Our field bases offered both lodging and boat ramp access, and we launched from SMNWR (SR 59), ERSP (SR 14), Spring Warrior Fish Camp (SR 361A), Keaton Beach (SR 361), Steinhatchee (SR 361), Horseshoe Beach (SR 351), Shired Island (SR 357), and Suwannee (SR 349) (Fig. 1). When inclement weather prevented us from using the boat, we traveled by car to accessible spots and conducted land surveys.

Modified crab pots

Lovich and Gibbons (1990) demonstrated that Diamondback Terrapins exhibit a high degree of site fidelity; therefore, recording their presence in an area at one point in time has predictive value for their subsequent presence. One method we employed for establishing terrapin presence was using modified crab pots to capture them (Butler 2002, Roosenburg et al. 1997). Terrapins are known to enter crab pots used to capture *Callinectes sapidus* Rathbun (Blue Crabs), where they become entrapped and will drown if not released (Grosse et al. 2009). We cut the tops off of 6 commercial crab pots and modified them by installing PVC pipe frames which extended trap heights to 1.2 m so that trapped terrapins could surface for oxygen. We secured the pots by enclosing the frames in commercial crab-pot mesh. Pots were baited with dead fish (*Mugil* sp. [mullet]), deployed near shorelines on the first day of each survey trip, and anchored into the mud with 4-m-long steel pipes. We trapped for 3 days giving us 18 trap-days at each site, except during the third season when inclement weather and boat-related mechanical problems precluded us from trapping. Previous studies using this method showed that when terrapins are nearby, they are usually caught soon after trap deployment (1–4 days; Butler 2002).

Prior to the second and third seasons, we sent letters to all licensed Blue Crab trappers (n = 105) throughout the Big Bend region requesting information concerning local terrapin populations. We included a self-addressed, stamped postcard to encourage their responses. Our goal was to gather location information that might help guide us with trap placement, head counts, and land surveys.

Head counts

Capture of Diamondback Terrapins unequivocally demonstrates their presence, but if there is little or no need to have terrapins in-hand, there are less labor-intensive methods to assess populations (Harden et al. 2009). We performed daytime visual surveys from a boat (4.9-m Carolina Skiff with a 30 hp Yamaha motor) along shorelines, around near-shore islands, and in most creeks. Adult terrapins rarely leave the water (except females to nest), but they surface often for air when active, so we recorded their presence by counting heads as we moved through areas at idle speed. We recorded GPS points for each sighting using a hand-held unit (Garmin GPSMAP 76CSx).

Land surveys

From the boat, we searched shorelines for suitable terrapin nesting sites (i.e., areas above the high-tide line with exposed sand; Roosenburg 1994). Most often we found these areas on Gulf islands or at river and creek mouths. Frequently, sandy areas were obscured by tidal wrack, and we used shrubs as indicators of sites with appropriate elevation and soils for nesting. We performed walking surveys of beaches and shorelines that appeared promising as Diamondback Terrapin nesting areas. At those sites we recorded terrapin presence as live Diamondback Terrapins, intact nests, crawls, terrapin material (carcasses, bones, and scutes), and depredated nests. We identified terrapin nesting areas by finding nests depredated by *Procyon lotor* L. (Raccoon; Butler et al. 2004). In some cases we were able to identify the tracks (crawls) left by female terrapins that had come ashore to nest (Butler 2002). We recorded the dominant plant species at each nesting site, and we occasionally captured female terrapins at these sites. Latitude and longitude of all sites were recorded with a GPS unit.

Maps

We used all recorded GPS points to create a series of maps using ArcGIS 10.0 (Environmental Systems Research Institute, Redlands, CA). Maps include our launch sites, all surveyed creeks and shorelines, museum records, all terrapins located with head counts, individuals captured live, intact nests, crawls, terrapin material, and depredated nests.

Results

Our survey of licensed Blue Crab trappers within the Big Bend region resulted in the return of 11 postcards (10.5%): five indicating they had information on terrapin locations and six stating that they had no information. We recorded 533 observations of Ornate Diamondback Terrapin presence from 41 separate sites in Wakulla, Taylor, and Dixie counties but none from Jefferson County. We considered all terrapins or their signs recorded during this study to be new site records if they were documented in areas without previously collected museum specimens. Our survey established 37 new terrapin site records in the Big Bend region.

Modified crab pots

We captured no Diamondback Terrapins using the modified crab pots at any location during 126 trap-days. Inclement weather and boat engine problems prevented us from trapping during the third year of the study (2009).

Head counts

We recorded 5 Diamondback Terrapins using head counts, all in Taylor County during 2008, with 4 of those representing new site records (Table 1). Three were seen at creek mouths (Eaglenest, Spring Warrior, and Crooked creeks), and 2 were observed in a lagoon at Dekle Beach (Fig. 2A). Time constraints and inclement weather precluded us from performing head counts on every creek; however we searched the majority of creeks, particularly those south of the Econfina River (Figs. 2A, 2B, 2C, and 2D).

Land surveys

Of our 37 new site records, 33 were the result of land surveys (Table 1). Of the 5 live female terrapins collected during land surveys, 3 were found as they nested. Individual terrapins were captured at Spring Warrior Fish Camp, Sponge Point, and Big Grass Island in Taylor County (Fig. 2A), Pepperfish Keys in Dixie

Table 1. Records of Ornate Diamondback Terrapins or their sign documented in the Big Bend region of Florida during this study. Head counts were recorded from the boat; all other observations were made during land surveys. Data from north and south of the Steinhatchee and Econfina River State Park (ERSP) launch sites are presented separately.

Launch sites	Heads	Live terrapins	Intact nests	Crawls	Terrapin material	Depredated nests	New site records
2007							
Horseshoe Beach					20	16	3
Shired Island					2	7	2
Suwannee					2	80	5
2008							
Spring Warrior	1	1	2	4	2		3
Keaton Beach	3	2	1		8	128	9
Steinhatchee (North)	1		1	1	4	118	5
Steinhatchee (South)		1	1	11	6	64	5
2009							
St. Marks		1	1		2	26	3
ERSP (North)					1	14	1
ERSP (South)					1		1
Totals	5	5	6	16	48	453	37

County (Fig. 2B), and Palmetto Island in Wakulla County (Fig. 2C); all represent new site records.

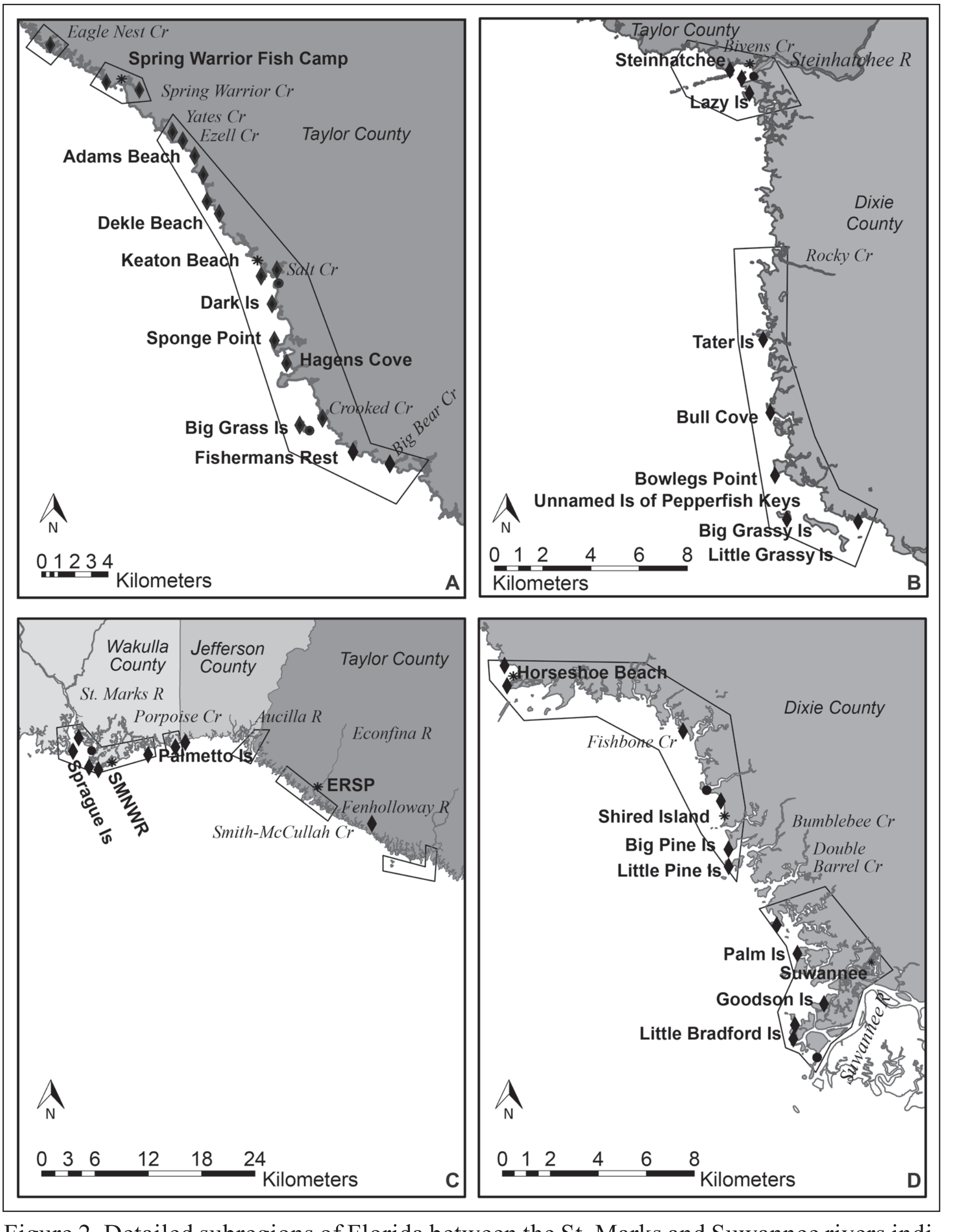

Figure 2. Detailed subregions of Florida between the St. Marks and Suwannee rivers indicating the sites where terrapins or their sign were recorded. (A) region between Eaglenest and Big Bear creeks, (B) region between Steinhatchee and Pepperfish Keys, (C) region between the St. Marks and Fenholloway rivers, and (D) region between Horseshoe Beach and the Suwannee River. Polygons surround creeks, shorelines, and islands surveyed. Legend: ● = museum records, * = launch sites; and ♦ = terrapin sign/records.

We located 6 intact nests: 2 by following terrapin crawls, 1 without a crawl, and 3 when nesting terrapins were captured as described above. We followed terrapin crawls to 2 intact nests at the end of the road at Ezell Creek (Fig. 2A), representing another new site record. We observed another intact nest deposited in tidal wrack on a wooded island at the mouth of the Steinhatchee River (Fig. 2B). In addition to the 2 crawls listed above, we found a third one at Ezell Creek, 1 at another island at the mouth of the Steinhatchee River, and 11 on the unnamed northwestern-most island of the Pepperfish Keys (Fig. 2B). However, these crawls were not associated with identifiable nests.

We found terrapin material at 18 locations representing 48 animals (Table 1); findings varied from a single scute, skulls, bones from shells, and intact shells, to recently dead females. Eleven of these were new sites. We collected single bones on the shoreline of the Cedar Point Trail at the SMNWR boat ramp and on the trail east of the lighthouse (Fig. 2C). We found bones or carcasses from multiple terrapins at Adams Beach, the area between Keaton Beach and Salt Creek, Dark Island (Fig. 2A), the wooded island at the mouth of the Steinhatchee River, Tater Island, Bull Cove (Fig. 2B), the north bank of Double Barrel Creek, and the north shoreline directly across the lagoon from the city park at Horseshoe Beach (Fig. 2D). The latter area produced material of 20 adult female terrapins. The two specimens found at Double Barrel Creek were fairly fresh, apparently the victims of Raccoon predation. This area had numerous Raccoon-depredated terrapin nests, and both turtles were on their backs with flesh torn away from around their hindlimbs (one with eggshells nearby; Seigel 1980a). At Ezell Creek, 1 terrapin had apparently been run over by a vehicle, and eggshells were scattered from the carcass suggesting that a Raccoon had been involved either before or after the automobile incident. We found one dead hatchling at Yates Creek, adjacent to Ezell Creek. Another small terrapin with two annuli was found dead and covered with *Solenopsis invicta* Buren (Red Imported Fire Ant) at Keaton Beach. At the BBWMA**,** Hickory Mound Unit, we found a female terrapin that had been dead for a day or two on Coker Road on the southern border of the impoundment, just west of Smith-McCullah Creek (Fig. 2C).

We found 453 depredated terrapin nests at 39 locations, representing 16 more new site records (Table 1). We did not spend equal time searching at each location. We recorded 17 depredated nests at or near the mouth of the St. Marks River, including the shoreline immediately to the west of the lighthouse, Sprague Island, and a section of eastern shoreline approximately 3.5 km north of the river mouth and east of an unnamed island (Fig. 2C). East of the St. Marks River, we found depredated nests on Palmetto Island and the shoreline from Porpoise Creek east to Little Grooms Creek. Adams Beach yielded 27 depredated nests; the nesting area is about 200 m north of the termination of SR 361 (Fig. 2A). We also located 21 depredated nests on Sponge Point, just south of Keaton Beach. The single-most productive site for depredated nests was Big Grass Island. We visited the island on 30 May 2008, recorded 61 depredated nests, removed all eggshells, and then we returned on 17 June 2008 and recorded 72 new depredated nests. About 3 km south of Big Grass Island, at Fishermans Rest, we logged 12 depredated nests.

We documented 52 depredated nests at the mouth of the Steinhatchee River, most located on Lazy Island along the south shoreline, but we found some on the two easternmost unnamed islands in the center of the mouth and also along the north shoreline of the mouth (Fig. 2B). At Pepperfish Keys, the unnamed northwesternmost island had 3 depredated nests, and the adjacent mainland shoreline had 10 more. We counted an additional 20 depredated nests at Tater Island. A very small unnamed beach, perhaps only 100 m long and 5 m wide, at the end of SR 351 in Horseshoe Beach had 14 depredated nests (Fig. 2D). We found 31 depredated nests on the north shoreline at the mouth of Double Barrel Creek in an area about 75 m long and 20 m wide. At the mouth of the Suwannee River, on its surrounding islands, we recorded 79 more depredated nests.

Nesting beach characteristics

The shrubs most frequently associated with terrapin nesting areas were *Iva frutescens* L. (Marsh Elder) and *Lycium carolinianum* Walt. (Christmas Berry). We used the larger, shrubby vegetation as possible nest-site indicators. Other smaller plants usually found with them were *Batis maritima* L. (Saltwort), *Salicornia perennis* Mill. (Perennial Glasswort), *Borrichia frutescens* L. (Sea-oxeye), and *Distichlis spicata* (L.) Greene (Salt Grass); in areas adjacent to nesting sites Smooth Cordgrass and/or Black Needlerush were always found. At some larger sites we recorded trees such as *Juniperus silicicola* (Small) Bailey (Southern Red Cedar) and *Sabal palmetto* (Walter) Lodd (Sabal Palm), but these did not appear to be necessary for nesting, and indeed most nesting areas did not have them.

Discussion

Our modified crab pots were ineffectual, and we captured no Diamondback Terrapins with them. Because this technique had been used successfully in the past (Butler 2000, 2002; Hoyle and Gibbons 2000; Mann 1995; Roosenburg et al. 1997), we expected similar results. For logistical reasons, primarily storage and transportation, we deployed the pots without information on whether our target species was nearby. The modified crab pots were arduous to build, challenging to transport on land and water, unwieldy to deploy, and time-consuming to check daily. In future surveys we suggest using such modified pots only in areas where terrapins are suspected to occur.

Although 4 of our new site records (10.8%) came from seeing heads at the surface, this technique had an inherent flaw in that head counts are more effective at low tide when terrapins are concentrated in smaller areas (Harden et al. 2009). However, in the Big Bend region most creeks are either too shallow for boat passage or drained at low tide, so we were forced to perform our counts at high tide when, even if terrapins are nearby, they are more dispersed and perhaps feeding in the flooded marshes (Tucker et al. 1995). Many people in the Big Bend region travel the near-shore areas and tidal creeks by airboat, but this would be impractical for counting heads. Head counts would likely be more successful if researchers surveyed from kayaks or canoes at low tide.

Despite the substantial time commitment, it is clear that land surveys were our most successful method of recording terrapin presence. Diamondback Terrapins rarely leave the water except for nesting. Therefore, when terrapin evidence is found on land it often signals the presence of a nesting site. Potential nesting areas can be identified from the boat at some distance (approximately 0.5–1.0 km) if the researcher can see a sandy beach or differentiate the shrubby vegetation from the Smooth Cordgrass and Black Needlerush. Land surveys of these potential sites can then be conducted. Additionally, some coastal nesting areas can be approached by car, which is ideal for days with inclement weather.

Nesting sites offer many indicators of terrapin presence including the most obvious evidence, depredated nests (Auger and Giovannone 1979, Burger 1977, Butler et al. 2004, Feinberg and Burke 2003, Goodwin 1994, Roosenburg 1992). Additionally, predators sometimes kill nesting female terrapins, and carcasses or bones are left at these sites (Seigel 1980a). Terrapin crawls can be identified under appropriate sand conditions, and the crawls can sometimes be followed to intact nests (Butler et al. 2004). Occasionally, researchers may encounter live females that are moving to or from nesting sites, or actually nesting.

We identified 4 significant terrapin sites: Big Grass Island, the mouths of the Suwannee and Steinhatchee rivers, and the St. Marks River east to Palmetto Island and Porpoise Creek. During two separate trips to Big Grass Island (Fig. 2A), we found a live terrapin, terrapin material, and numerous depredated nests. It is noteworthy that one of the three Pepperfish Keys islands is named Big Grassy Island, but it lacks appropriate nesting characteristics. Further, we recorded fairly consistent terrapin presence in surrounding areas all the way to Eaglenest Creek, some 26 km north (records at Eaglenest, Spring Warrior, Yates, and Ezell creeks, Adams, Dekle, and Keaton beaches, Dark Island, Sponge Point, Hagens Cove, and Crooked Creek), and 1.5 km south to Big Bear Creek. This is the longest stretch of coastline where we documented terrapin records. Inclement weather between Big Bear and Bivens creeks to the south hampered our activities on several days, so we were unable to investigate Clay, Dallus, Bayview, Jack, and Salt creeks. It might be valuable to survey these five creeks in the future.

Another important terrapin nesting area is the mouth of the Suwannee River, where we identified depredated nests on most of the islands at its mouth including Goodson, Little Bradford, Palm, and an unnamed one (Fig. 2D). Proceeding north for approximately the next 10 km, we found more terrapin evidence on the north bank of Double Barrel and the south bank of Bumblebee creeks, and on Little Pine, Big Pine, and Shired islands. We surveyed all creeks from Shired Island north to Horseshoe Beach and recorded depredated nests on the shoreline of Fishbone Creek. At Horseshoe Beach, we documented nesting areas on opposite shorelines of a lagoon just north of Horseshoe Point. Time limitations prevented us from searching areas between Horseshoe Beach and Pepperfish Keys to the north.

The mouth of the Steinhatchee River also attracts nesting terrapins (Fig. 2B). We documented terrapin sign on the river mouth's unnamed northern shoreline, its easternmost spoil islands and on Lazy Island, at the southern edge of the river mouth. However, we found no other evidence of terrapins until Tater Island, nearly 10 km south, despite the presence of seemingly good nesting habitat at the mouth of Rocky Creek. From there to the south, we recorded terrapin evidence at Bull Cove, Bowlegs Point, the mainland east of Pepperfish Keys, and the unnamed northwestern-most island of the Pepperfish Keys. This latter island appears to be a bird rookery, and we identified numerous *Eudocimus albus* L. (White Ibis), *Casmerodius albus* L. (Great Egret), *Egretta tricolor* Muller (Tricolored Heron), and *Bubulcus ibis* L. (Cattle Egret) in residence. We have noted terrapin presence at rookery islands in the past at Tarpon Key and Alafia Bank in Tampa Bay (J.A. Butler and G.L. Heinrich, unpubl. data). We found 3 depredated nests on this rookery island, along with 11 crawls and a nesting female and her nest; however, we suspect this island is more important than even these data suggest. The other two Pepperfish islands do not have appropriate habitat for terrapin nesting.

A fourth important terrapin nesting area is the St. Marks River east to Palmetto Island and Porpoise Creek (Fig. 2C). We found nesting sites around the river mouth, on Sprague Island (our westernmost survey area), the shoreline about 3.5 km upriver, and on the Gulf shoreline west of the lighthouse. Further east, Palmetto Island supports nesting, as does the shoreline around Porpoise Creek.

This survey identified 4 important terrapin sites that warrant further study and protection, but areas that we did not cover (Fig. 2), either due to inclement weather or time constraints, are also likely to support terrapins. Conversely, it would be beneficial to determine why terrapins were not found in some areas adjacent to existing populations. One of the crab trappers surveyed indicated that terrapins were so abundant in the region during the late 1940s that they were commercially harvested. He added that some areas formerly known to support terrapins now appear to be devoid of the turtles. Previous anthropogenic threats such as commercial harvest of the species could have contributed to localized extirpations.

Management and research recommendations

The primary objective of the current study was to document previously unknown terrapin populations in the Big Bend region. In addition, during the course of our work we identified specific management and research needs. The four notable terrapin sites identified above (Big Grass Island, the mouths of the Suwannee and Steinhatchee rivers, and the St. Marks River east to Palmetto Island and Porpoise Creek) all are likely to yield valuable data about terrapin populations and would be conducive to further research because of their ease of access, appropriate accommodations, and boat launching facilities.

Predation, habitat loss, and mortality in crab pots are the top 3 threats to Diamondback Terrapin populations in Florida (Butler et al. 2006a), and we documented all of them in the study area. We know from tracks and scat that Raccoons are the major terrapin predators throughout the Big Bend region; over 90% of our observations of terrapin material and depredated nests were attributable to Raccoons. Furthermore, we found 4 Raccoon scats containing terrapin eggshells on Sprague Island; this was our only such observation during the course of this survey. Feinberg and Burke (2003) and Burke et al. (2009) noted this occurrence in New York and claimed that some Raccoons change their eating behavior as the summer progresses, swallowing more eggshells than earlier in the season. This phenomenon could be tested on Sprague Island. Terrapin populations throughout the Big Bend region would benefit from an ongoing Raccoon control program (Munscher et al. 2012).

At Shired Island, we noted excessive habitat damage due to *Sus scrofa* L. (Feral Hog) digging. Although we did not directly associate this with damage to Diamondback Terrapin nests, Feral Hogs are known to destroy sea turtle nests in some areas (Lewis et al. 1994). The Shired Island area was high and sandy, with seemingly appropriate vegetation for terrapin nesting. We noted Feral Hog damage at numerous other areas throughout the study, so their populations are apparently thriving in the Big Bend region. Feral Hogs are opportunistic omnivores, highly prolific, and damaging to many forms of endemic wildlife (Ditchkoff and West 2007). Therefore, we recommend that their dietary habits be studied and that populations be monitored/controlled.

The St. Marks River area would provide a unique opportunity to study potential predation by another Florida mammal. At a site about 3.5 km upriver on the eastern shoreline, we recorded *Lynx rufus* Schreber (Bobcat) bones and scat representing at least two individuals, along with several depredated terrapin nests. Because we observed no Raccoon sign in this area, it would be valuable to determine if Bobcats are terrapin nest predators. Although they have not been implicated as such, Bobcats have been documented as sea turtle nest predators (Martin et al. 2005).

Following predation, habitat loss is the next major threat to Florida Diamondback Terrapin populations. Currently, the Big Bend region is inhabited by a comparatively sparse human population that is centered at higher elevations and along some major rivers, including the towns of St. Marks, Keaton Beach, Horseshoe Beach, Suwannee, and Steinhatchee—the largest town, with a population of 1047 (2010 census; US Census Bureau 2011). Many businesses in the area focus on tourism and recreational fishing (off-shore charters and the summer scallop season). Numerous houses and condominiums in these towns are vacation homes for people living elsewhere. The lack of sandy beaches is the likely reason that this area has not attracted more visitors and development. The limited development in the region at this time provides an opportunity to protect this nearly pristine habitat. As humans move into and develop coastal areas, they usually do so at the higher elevation spots, and we have shown that these are often extremely important nesting areas for Diamondback Terrapins. Also, coastal homeowners frequently protect their property from tidal erosion by depositing rip-rap or otherwise hardening the shoreline. Such coastal armoring prevents aquatic turtles from accessing sandy shorelines for nesting (Mosier 1998). This practice is apparent at Jug Island and Dekle Beach. In such cases, we are uncertain whether terrapins are capable of locating alternate nesting sites. Butler et al. (2004) found that some terrapins in northeastern Florida traveled nearly 10 km from their normal ranges to nest on a specific beach.

In 2007, state and federal agencies rejected plans for the proposed Magnolia Bay Marina and Resort, which would have destroyed approximately 40 ha of saltmarsh and excavated a channel 3 km long and 30 m wide through the BBSAP at Boggy Bay, which is located between Dekle and Keaton beaches. This site is within the shoreline we have identified as the longest continuous stretch of terrapin records in the Big Bend region. The project was abandoned under pressure from local environmental groups, fishermen, and various state and federal environmental agencies. The fact that such a proposal was offered, however, signals that interest in developing the area is expanding. It will be necessary for the environmental community to be vigilant, cautious, and conservative about development along the Big Bend coastline.

Radio telemetry studies are needed to provide information concerning feeding sites, nesting forays, winter behavior, and home range (Butler 2002). These data would be valuable for identifying sites vital to the protection and conservation of coastal aquatic habitats used by Diamondback Terrapins. Because we demonstrated that terrapin distribution in the Big Bend region was not contiguous, both radio telemetry and genetic studies (Hart 2005) would also increase our understanding of terrapin populations, and perhaps allow delineation of more discrete population boundaries.

Although Blue Crab trapping is not extensive in the areas where we worked, we still recommend the use of bycatch reduction devices (BRDs) on crab pots to prevent terrapins from entering the traps and drowning (Butler and Heinrich 2007). Our modified crab pots were unsuccessful at trapping terrapins, but if unmodified pots are placed in areas inhabited by terrapins, then large numbers can enter and drown (Grosse et al. 2009). We know that approximately 73% of terrapins can be prevented from entering crab pots with BRDs and we continue to urge their required use on commercial and recreational crab pots in Florida waters (Butler and Heinrich 2007).

Additionally, when searching on land at Hagens Cove we encountered a man systematically collecting *Uca* sp. (fiddler crabs). He erected a temporary barrier with aluminum flashing and then herded thousands of crabs toward it where they were easily collected. Upon questioning, he informed us that he sold them to bait dealers all along the Atlantic coast as far north as New York City. We are concerned that if he indeed supplies multiple dealers on the east coast, and if take is unlimited, it could have a deleterious effect on Gulf coast fiddler crab populations. Fiddler crabs are prey for numerous fishes, birds, and mammals, and have been identified as a major food item for Diamondback Terrapins (Butler et al. 2012). Although currently legal with a permit, such collecting in state aquatic preserves should be restricted.

This 3-year survey was the initial step toward the development of a conservation plan for this little-known species. We recommend further studies at the sites that we identified as the most important Diamondback Terrapin population centers/nesting sites.

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