Exposure Assessment and Injury Determination for the Northern Diamondback Terrapin

T/B Bouchard 120 Oil Spill

Prepared by:

Bouchard 120 Natural Resource Trustees

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Introduction

On April 27, 2004, the *T/B Bouchard 120* began leaking oil as it approached Buzzards Bay from the south en route to the Cape Cod Canal. Between 22,000 and 98,000 gallons of heavy fuel oil were released into the marine environment. Portions of the shoreline, mudflat, and marsh habitats used by the northern diamondback terrapin (*Malaclemys terrapin terrapin*) for over-wintering, feeding, and breeding were oiled to varying degrees. The northern diamondback terrapin is listed as threatened under the Massachusetts Endangered Species Act and as endangered in Rhode Island. Oil and subsequent cleanup activities within these habitats had the potential to affect diamondback terrapins. These potential effects may have included direct oiling of terrapins, ingestion of oiled prey items, alterations of breeding behavior, mortality due to physical trauma from vehicles or vessels engaged in cleanup activities, and mortality associated with disposal of oiled materials found on the shoreline.

This report assesses available information regarding these possible impacts. Our assessment reviews terrapin life history characteristics, indications of terrapin activity within Buzzards Bay, oiling data, and cleanup information. We conclude that diamondback terrapins were at risk of adverse impacts due to oiling from the *Bouchard 120* spill. While there were no recorded observations of terrapin mortality, oiling of terrapins, or oiled nests, it was determined that diamondback terrapins and corresponding terrapin habitat may have been exposed to oil due to the *Bouchard 120* oil spill in several locations throughout Buzzards Bay. However, the extent of exposure was limited and any associated impacts are expected to be small. Available data do not support quantification of the magnitude of any injury associated with this exposure. Restoration projects considered as compensation for shoreline or intertidal impacts associated with the *Bouchard 120* oil spill should include potential benefits to terrapins as one of the evaluation criteria in project selection.

Life History Characteristics

The diamondback terrapin is named for the diamond-shaped marking on its shell. It ranges in size from four to nine inches in length and is light brown or beige in color. The shell has black concentric rings, grooves, and ridges, from which the terrapin's age can be estimated. The terrapin has light gray skin marked with small black and white color patterns. Its webbed feet are adapted for swimming, and its sharp claws are essential for climbing muddy banks. Diamondback terrapins may live up to 40-50 years.

Although diamondback terrapins live in coastal areas from Massachusetts to the Florida Keys and along the Gulf coast, they are not readily observed in the field. Their habitat includes salt marshes, estuaries, coves, inner edges of barrier beaches, tidal flats, and coastal marshes. Terrapins seldom stray far from brackish water, feeding and basking in the sun during the day, and burying themselves in mud at night. During their first few years, terrapins usually live under flotsam and tidal wrack and are rarely seen. Juvenile terrapins may live upstream in brackish creeks for several years before eventually moving

down into the salt marshes. Terrapins have a varied diet, including crustaceans, gastropods, bivalves, plant material, carrion, fish, and marine worms. Predators include terrestrial (e.g., foxes, skunks, raccoons, and birds) and aquatic animals (e.g., crabs, fish, and shorebirds).

During the winter months (November-April in the northeast U.S.), diamondback terrapins hibernate in the mud in the bottom of an estuary or marsh. Terrapins typically bury themselves in one to two feet of mud in shallow, protected estuarine areas below the low tide line. The covering of water and mud protects the terrapins from predators and provides insulation during the winter months.

In the Northeast, emergence generally occurs in April or May. After emergence, terrapins mate and nest during June and July. Nesting occurs when females leave the water to lay eggs in sandy soil above the high tide line, preferring to nest in dry, sandy areas such as unvegetated dunes, river banks, marsh margins, or other areas with less than five percent vegetative cover. Female terrapins lay clutches of 4 to 22 pinkish-white eggs, with some females laying more than one clutch in a season. Hatching occurs either during late summer, or in the spring, after the eggs have over-wintered in the nests. Diamondback terrapins show nest site fidelity, although nest success is relatively poor due to predation.

Injury Assessment

Diamondback terrapins may have been exposed to oil from the *Bouchard 120* oil spill and experienced adverse health effects. This section of the report describes the methodology and data sources used to evaluate the potential for impacts to diamondback terrapins in Buzzards Bay. Results of the analysis are presented in the Injury Determination.

Methodology

To evaluate exposure and potential injury, information on terrapin activity was compared with data on the incidence and severity of shoreline oiling. Specifically:

- Information on the location and nature of terrapin activity was obtained for the period 1996 to 2004. Terrapin activity includes sighting of adults, juveniles, nests, or tracks. Terrapin activity was recorded on georeferenced maps of Buzzards Bay.
- The incidence and severity of shoreline oiling was determined based on a review of shoreline assessment maps that show the maximum degree of oiling following the incident (SAT 2004).
- The locations of observed terrapin activity were compared with oiling data as reported on the maximum degree of oiling maps.

- For those locations where terrapin activity intersected with habitat that was potentially exposed to oil, SCAT forms, field notes, and IRAC data were evaluated to determine the duration of the potential exposure (MDFW 2003-2004, RPI 2004).

- The potential exposure duration was estimated assuming terrapin emergence on May 1, 2003. Exposure duration was calculated as the midpoint of: (1) the number of days between May 1 and the date of the most recent SCAT form, and (2) the number of days between May 1 and the IRAC sign-off date.

This methodology likely produces an upper bound on terrapin exposure risk. This occurs primarily because shoreline oiling is estimated to persist at its maximum extent from the date of terrapin emergence (assumed to be May 1, 2003) through the point in time that the shoreline was considered to present little to no risk of exposure. However, cleanup activities progressively reduced shoreline oiling immediately following the spill, and many terrapins may have emerged after May 1. In addition, our methodology assumes that in 2003, terrapins utilized all areas in Buzzards Bay and Rhode Island where terrapin activity had been observed on any date from 1996 to 2004. While terrapins are long-lived and exhibit site fidelity, our use of multiple years of terrapin observation data may over- or under-estimate the number of terrapins present in 2003.

Data Sources

The following sources contain information regarding observations of terrapin activity in Buzzards Bay between 1996 and 2004. Records for multiple years were used because there has not been a single synoptic survey of diamondback terrapin activity in Buzzards Bay. The combined data from multiple years were viewed as a better representation of potential activity than data from any single point in time.

- Massachusetts Natural Heritage and Endangered Species Program Element Occurrence Records from 1996 to 2000 (MDFW 1996-2000). Reports of terrapin activity are also available for years prior to 1996, but were not included in this assessment.

- Massachusetts Natural Heritage and Endangered Species Program Rare Animal Observation Forms from May through September 2003 and June through October 2004 (MDFW 2003-2004).

- Survey of Northern Diamondback Terrapin (*Malaclemys terrapin terrapin*) in Plymouth and Bristol Counties (Reid 2000). Surveys were conducted on foot during the 2000 nesting season (June and July). Limited searches for basking or swimming terrapins were also conducted by boat.

- In May of 2003, Don Lewis (Massachusetts Audubon), Carolyn Mostello (Massachusetts Division of Fisheries and Wildlife), and Wayne Kicklighter (ENTRIX) conducted a brief (several hour) terrapin reconnaissance survey of some of the known and potential terrapin habitat in Buzzards Bay. Sites included Sippican Harbor, Aucoot Cove, and West Island. During the survey, the participants did not identify any terrapins or evidence of terrapin activity.

Pathway

Based on their life history characteristics, several pathways exist by which diamondback terrapins may have been exposed to oil from the *Bouchard 120*. Potential pathways include direct contact and ingestion of contaminated water, sediment, and/or prey. For example:

- *Sediment*. Diamondback terrapins burrow into the muddy bottoms of salt marshes and brackish areas during the winter season. Tar balls and patties from the spill have the potential to settle out of the water column as they collect non-buoyant particles and organic matter. These materials could remain on the sediment surface, resulting in possible exposure if they were still present as the terrapins emerge from hibernation.

- *Diet*. The terrapin's diet is composed mainly of marine invertebrates (e.g., bivalves and crustaceans) which may have ingested oil from the water column or have been physically coated with oil. Marine invertebrates (both alive and dead) may have remained oiled through the time when the terrapins emerged from hibernation and began to feed.

- *Shoreline*. Oil from the *Bouchard 120* spill reached both the Massachusetts and Rhode Island shores. When terrapins emerge from hibernation, the females leave the water and make their way to sandy areas on the land-ward side of salt marshes and brackish areas. This may have required them to traverse oiled marsh vegetation or shoreline areas. In addition, juvenile terrapins could have been exposed if they hid under oiled wrack.

Exposure

Between 1996 and 2004, a total of 76 observations of terrapin activity (52 adult terrapin sightings, 3 hatchling sightings, and discovery of 114 nests) were made within 16 IRAC/SCAT segments. Twenty-five of these observations were made in areas that were

not oiled during the *Bouchard 120* incident. Thirty-seven observations were recorded in areas with a maximum oiling severity of very light, and fourteen observations occurred in areas that sustained moderate oiling. No direct oiling of terrapins or terrapin nests was reported in any portion of Buzzards Bay, nor was there any evidence of direct mortality of terrapins due to oiling or cleanup activities (Table 1, Figures 1-6).

Moderate oiling was recorded on a small portion (11 percent) of the western shoreline of Blankenship Cove (W1C-04). Very light oiling occurred over 44 percent of W1C-04 on the eastern shoreline near the mouth of the cove. The remaining 45 percent of Blankenship Cove, the inner cove, was un-oiled. The entire W1C-04 segment passed the IRAC criteria on July 11, 2003. One male terrapin was observed in the area in July 2004 (Tables 1 and 2, Figure 5).

In Aucoot Cove (W1D-01), maximum oiling records indicate 60 percent of the shoreline was very lightly oiled, and 40 percent was moderately oiled. During the May 11, 2003 terrapin survey, approximately 20 feet of oiled wrack was found adjacent to potential habitat in Aucoot Cove (although the entire extent of the habitat was not surveyed). SCAT forms indicate this segment was in maintenance mode as of May 24, 2003; the segment failed an IRAC inspection on June 15, 2003 because of oil on groins, a one meter wide band of oiled cobble, and the presence of oiled wrack. The segment passed the IRAC criteria on June 25, 2003. In 2000, three predated nests and one adult terrapin were observed within this segment. In 2003, 21 terrapin nests were observed, and 20 nests were observed in 2004. The majority of these were false and/or predated nests (Tables 1 and 2, Figure 3).

Demarest-Lloyd State Park consists of two segments (W3C-05 and W3C-06). W3C-05 sustained very light oiling throughout, whereas W3C-06 was un-oiled. Three terrapins and one nest were observed within the area that was very lightly oiled (one terrapin each in 2000 and 2003, and one terrapin and one nest in 2004). A visible coating of oil in marsh areas and intermittent three to five-inch patties were recorded on May 14, 2003; the segment passed the IRAC criteria on June 27, 2003 (Tables 1 and 2, Figure 2). The remaining observations (29 predated nests and 15 adult terrapins) were made in 2004 in interior portions of the park. It is assumed that these terrapins had equal access to the unoiled areas of segment W3C-06 and the oiled areas of segment W3C-05. Potential exposure for these terrapins is estimated as 50 percent very lightly oiled and 50 percent clean.

In Mattapoisett Harbor (W1F-08, W1F-09), one nesting female and three predated nests were observed in 2000, and one nest was recorded in 2004. SCAT forms indicate one to ten percent surface oiling and tarballs in these segments as of May 19, 2003. W1F-08 passed the IRAC criteria on August 27, 2003, and W1F-09 passed the IRAC criteria on August 21, 2003. (Tables 1 and 2, Figure 4).

The north point of West Island (W2A-14) was 100 percent moderately oiled due to the spill. Between 1999 and 2000, eight predated nests were observed in this area. On the May 11, 2003 terrapin survey, oil residue was observed in potential nesting habitat.

SCAT forms report that this segment was in maintenance mode by June 6, 2003. The segment failed an IRAC inspection on August 27, 2003 due to random heavy splatter and subsequently passed the IRAC criteria on September 3, 2003.

One terrapin hatchling was observed in a salt marsh on the north side of Planting Island in 1996. The boundary of SCAT/IRAC segments W1C-2 (50 percent moderately oiled, 50 percent clean) and W1C-3 (100 percent clean) occurs at the northwestern tip of Planting Island. Therefore, this observation is assigned to both segments and potential exposure is estimated at 25 percent moderately oiled, 75 percent clean.

According to diamondback terrapin expert Charlotte Sornborger, Rhode Island terrapins are only found in the Palmer and Barrington Rivers, including the west side near Goddard Park (Sornberger 2004). The only breeding population of diamondback terrapins known to exist in Rhode Island is in Barrington. These terrapins nest at Nockum Hill, a 68-acre raised, sandy-soiled peninsula extending into the Hundred Acre Cove estuary. In 1998, however, one terrapin nested at small beach near White Church Bridge. These areas do not overlap with any areas oiled or potentially oiled by the spill.

Injury Determination

Diamondback terrapins and their habitat were at risk of oil exposure and mortality as a result of the *Bouchard 120* oil spill and associated clean-up activities. Specifically, the spill occurred at the time of year when terrapins emerge from hibernation, and terrapins may have been exposed to oil that stranded on shoreline and marsh habitats used for feeding and traversing to nesting locations. Potential impacts to diamondback terrapins were evaluated based on two lines of evidence. These include: (1) direct observations of terrapin oiling and mortality, and (2) evaluation of the relationship between shoreline oiling and potential terrapin activity.

During the *Bouchard 120* oil spill and the subsequent cleanup, no observations of oiled terrapins or terrapin mortality were reported despite several informal surveys and the presence of SCAT and Wildlife Reconnaissance teams. If terrapin mortality occurred in shoreline areas, these efforts probably would have located at least some dead terrapins. However, it is unlikely these efforts would be effective means of locating live, oiled terrapins in marsh habitats. Therefore, the possibility that terrapin oiling or mortality occurred cannot be eliminated. If mortality did occur, it was likely limited in magnitude and duration.

Other impacts from oiling, including risk of adverse health effects and loss of habitat services were also evaluated. The following factors were considered in determining the potential impacts of oiled shoreline on terrapins and their habitat:

- *Relationship between terrapin emergence and the timing of the spill.* The spill occurred on April 27, 2003, which is approximately the time that terrapins may first begin to emerge from hibernation. On May 11, 2003, Don Lewis (Massachusetts Audubon), Carolyn Mostello

(Massachusetts Division of Fisheries and Wildlife), and Wayne Kicklighter (ENTRIX) conducted a brief (several hour) terrapin reconnaissance survey of some of the known and potential terrapin habitat in Buzzards Bay. During the survey, the participants did not identify any terrapins or evidence of terrapin activity. For those terrapins that emerged prior to mid-May, risk of exposure would be characterized by analysis of maximum shoreline oiling and any recorded observations of terrapin impacts. Terrapins that emerged in mid-May or later likely encountered very limited oiling due to the progression of cleanup activities.

- *Magnitude of oiling*. The maximum magnitude of oiling was determined by a review of shoreline assessment data. Of the segments in which both terrapin activity and oiling were recorded, three were very lightly oiled (W1F-08, W1F-09, W3C-05), three were moderately oiled (W1C-2, W1C-3, and W2A-14), and two were characterized by areas of both light and moderate oiling (W1C-04, W1D-01). Areas of un-oiled shoreline were also located within several of these segments. Since cleanup activity decreased the degree of oiling as terrapin activity increased, exposure risk for many terrapins would be less than reported in this assessment.

- *Duration of oiling*. Of the segments in which both terrapin activity and oiling were recorded, three passed IRAC criteria in June (W1D-01, W2A-14, W3C-05), one in July (W1C-04), two in August (W1F-08, W1F-09), and one in September (W1C-2). However, many of these areas were relatively clean for some period of time before the actual IRAC sign-off, indicating a fairly short time frame within which terrapins or their habitats could be exposed to oil. For example, SCAT forms indicate that Aucoot Cove was in maintenance mode on May 24, and West Island North Point on June 6, and Blankenship Cove, Mattapoisett Harbor, Planting Island, and Demarest-Lloyd State Park all had minimal oiling as of May 3-28, 2003. Table 1 summarizes the location, magnitude, and duration of potential risk of oil exposure to terrapins.

- *Prey Observations*. Terrapins may have consumed oiled prey, although no data regarding terrapin prey oiling was collected. However, efforts to remove oil and oiled material likely reduced any exposure associated with consumption of oiled prey.

The proximity of terrapins to the oiled areas as identified in Table 1 indicates the potential for exposure to oil upon emergence from hibernation or during feeding, breeding, or nesting. Based on the magnitude, extent, and duration of oiling, it was determined that terrapins and corresponding terrapin habitat may have been adversely affected by the *Bouchard 120* oil spill. However, the extent and duration of any exposure is expected to be limited for several reasons. First, in cases where terrapin

activity was observed near oiled areas, the oiling was interspersed with clean areas, reducing exposure risk. Second, when oiling was present near areas of terrapin activity, it didn't always occur in the specific locations most likely to be used by terrapins. For example, oiling may have occurred on the seaward side of marsh shoreline but not within the interior of the marsh or backing dunes where terrapin activity primarily occurs. Existing data are not sufficient to allow refinement of this injury determination or quantification of the lost services.

Conclusion

During the *Bouchard 120* oil spill, there were no recorded observations of terrapin mortality, oiling of terrapins, or oiled nests. However, diamondback terrapins and their habitats were at risk of adverse impacts due to shoreline oiling. Exposure may have occurred upon emergence from hibernation, while feeding, or during breeding and nesting activities. To assess these impacts, oiling data and observed terrapin activity for 1996 to 2004 were reviewed and exposure risk documented. Based on the results of this assessment, it was determined that terrapins and corresponding terrapin habitat may have been exposed to oil due to the *Bouchard 120* oil spill in several locations throughout Buzzards Bay. However, the extent of exposure was limited and any associated impacts are expected to be small. Available data do not support quantification of the magnitude of any injury associated with this exposure. Restoration projects considered as compensation for shoreline or intertidal impacts associated with the *Bouchard 120* oil spill should include potential benefits to terrapins as one of the evaluation criteria in project selection.

References

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Table 1
Diamondback Terrapin Exposure Risk

Oiled Segment		Total Number of Terrapin Observations and Activities (1996-2004) [a]			Percent Oiling [b,c]		SCAT		IRAC Sign-Off Date (2003)	Number of Days of Potential Risk [d]
IRAC Code	Name	Observations	Activity	Year	Very Light	Moderate	Condition	Date		
W1C-04	Blankenship Cove	1	1 terrapin	2004	44%	11%	Very light oiling (1-10%) on < 3 foot band on short segment of eastern shore; no oiling on inner cove, oiling on Allens Point not described.	May 3	July 11	37.5
W1D-01	Aucoot Cove	9	1 terrapin, 44 nests	2000 2003 2004	60%	40%	Maintenance Mode	May 24	June 25	40
W1F-08 W1F-09	Mattapoisett Neck East and Harbor North	3	1 terrapin, 4 nests	2000 2004	100%	--	Still 1-10% surface oil, tarballs and patties.	May 19	August 27/21[e]	69
W1C-2 W1C-3	Planting Island	1	1 hatchling	1996	--	25%	Vegetation oiled at tips in some locations but all appears healthy.	May 28	September 9	80
W2A-14	West Island – North Point	3	8 nests	1999 2000	--	100%	Maintenance Mode	June 6	September 3	80
W3C-05	Demarest-Lloyd State Park Beach	4	3 terrapins 1 nest	2000 2003 2004	100%	--	"pea to quarter size blobs on rack. Frequency lessens from south to north. Few tarballs/patties on beach adjacent to State Park"	May 14	June 27	36
W3C-05 W3C-06	Demarest-Lloyd State Park Beach and Marsh [f]	30	30 nests	2003 2004	50%	--	Beach: as noted above. Marsh: <1% stain and coat on band 0.25 feet wide; "visible coating of vegetation... in flats" tar patties also noted intermittently."	May 14	June 27	36

Notes:

[a] MDFW (2003-2004, 1996-2000), Reid (2000).

[b] Percent oiling is calculated based on length of shoreline classified as it appears on the maximum oiling maps from Shoreline Assessment Team (2004).

[c] Shoreline oiling category definitions (Shoreline Assessment Team 2004).

Trace: "[A]reas where minimal amounts of oil were reported. Oiling in these areas was typically limited to a few tarballs or pieces of oiled debris."

Very Light: <1% cover on oiled bands 0-9 feet wide

Light: 1-10% cover on oiled bands 0-6 feet wide

<1% cover on oiled bands > 9 feet wide

Moderate: 1-10% cover on oiled bands > 6 feet wide

10-50% cover on oiled bands 0-9 feet wide

51-90% cover on oiled bands 0-3 feet wide

[d] Assuming emergence on May 1, 2003, this is the midpoint of: 1) the number of days between May 1 and the date of the most recent SCAT form, and 2) the number of days between May 1 and the IRAC sign-off date.

[e] W1F-08 passed the IRAC criteria on August 27, 2003, and W1F-09 passed the IRAC criteria on August 21, 2003.

[f] Terrapin observations occurred in two general locations within the park: 1) parking lot and picnic areas of Demarest-Lloyd State Park, in the vicinity of small creeks that flow into Giles Creek, and 2) the peninsula on the northern-eastern portion of the park adjacent to the Slocum River.

Table 2
Summary of Terrapin Activity (Observed June-October 2003 and May-August 2004) and Maximum Shoreline Oiling (through mid-May 2003) [a,b]

Segment ID [c]	Segment Name [c]	Amount of Oiling [b,c]	Terrapin Observation [a]	Number of Locations on Map (Figures 1-6)	Terrapin Location [a]	Terrapin Observation Date [a]	Date of most recent SCAT [d]	Condition at most recent SCAT [d]	Notes from previous SCATs	Date when 'Passed' IRAC Criteria [e]	Terrapin Observation Notes [a]	Previous Terrapin Observations at location [a]
N/A	N/A	None	2 terrapins and 1 nest	1	Buttermilk Bay: Queen Sewell Cove	27-Jun-03	None	None	none	23-Aug-03	Viable nest; female terrapins of unknown age; landowner saw nest being laid	Not noted in previous years
			1 adult female (>10 yrs) and 8 young	1	Little Buttermilk Bay	1-Jul-04			"		Nesting area on small sandy beach susceptible to high tidal overwash	In 2003 a nesting female was observed in area -- the eggs overwintered at Buttonwood Zoo.
N/A	N/A	None	1 female terrapin	1	East of Wareham Center take Main St to Narrows Rd to Stillman memorial Drive, Left onto Great Neck Road	11-Jul-03	None	None	none	24-Aug-03	Found next to cranberry bog, turtle may have nested on sandy areas of the bog	Not noted in previous years
W1B-09	Little Harbor, Little Harbor Beach	Clean	1 predated nest	1	Great Neck Road next to Little Harbor Beach, from parking lot, walk West to end of sandspit	22-Jul-03	15-May-03	Maintenance mode except for 300 yards which was a current work site [g]		22-Aug-03		Not noted in previous years
W1C-2 W1C-3	Planting Island	75% Clean: 25% Moderate	1 hatchling	1	Planting Island, salt march on north side of island	Jul-96	28-May-03	Vegetation oiled at tips in some locations but all appears healthy		09-Sep-03		
W1C-04	Blankenship Cove		1 male terrapin	1	Sippican Harbor, Blankenship Cove	7-Jul-04	3-May-03	Very light oiling (1-10%) on < 3 feet on short segment of eastern shore; no oiling on inner cove, oiling on Allens Point not described.	none	11-Jul-03	Trapped in crab trap on rising tide (spotted by campers at Tabor Academy camp and saved)	
W1C-05	Sippican Harbor East	Clean	Multiple predated nests	3	Sippican Harbor, Hammett's Cove, on point on East mouth of cove	2-Sep-03	12-May-03	No visible oil	5/9/2003 no oil observed	11-Jul-03, 7-Aug-03	9-12 eggs in each nest	Observed earlier in 2003
W1C-06	Hammett's Cove Beach	Clean	> 6 adult terrapins	1	Hammett's Cove, on low tide exposed rocks near Creek Road	22-Jul-03	12-May-03	No visible oil	5/9/2003 no oil observed	22-Aug-03	Female and male terrapins were basking, when approached they began snorkeling in the same creek; site heavily polluted with nitrogen loading; predated nests found nearby	Not noted in previous years
			Multiple predated nests	3	Hammett's Cove, Hammett's Cove Road, on point on East mouth of cove	22-Jul-03			"		Shredded and desiccated eggs	Not noted in previous years
			Multiple nest sites, many predated	18	Sippican Harbor, Hammett's Cove, inlet by Creek Road	29-Sep-03			"			Species previously noted in location only in 2003
			1 female adult terrapin	1 [h]	Sippican Harbor, Hammett's Cove	24-Jun-04			"		Nesting on/near pathway	
			1 female adult terrapin	1 [h]	Sippican Harbor, Hammett's Cove	6-Jul-04			"		Nesting in gravel driveway, extra tiny scute, gravid	

Table 2
Summary of Terrapin Activity (Observed June-October 2003 and May-August 2004) and Maximum Shoreline Oiling (through mid-May 2003) [a,b]

Segment ID [c]	Segment Name [c]	Amount of Oiling [b,c]	Terrapin Observation [a]	Number of Locations on Map (Figures 1-6)	Terrapin Location [a]	Terrapin Observation Date [a]	Date of most recent SCAT [d]	Condition at most recent SCAT [d]	Notes from previous SCATs	Date when 'Passed' IRAC Criteria [e]	Terrapin Observation Notes [a]	Previous Terrapin Observations at location [a]
W1C-07, W1C-08	Little Neck, Tabor Academy Beach	Clean	1 female adult terrapin	1	Sippican Harbor; head of harbor	15-May-04	12-May-03	No visible oil	5/5/2003 "No oil observed"	22-Aug-03	Swimming	
			1 female adult terrapin	1	Sippican Harbor; head of harbor	9-Jun-04			"		Swimming; trauma to 30 marginal, perhaps boat strike; possible tiny eggs	
			1 female adult terrapin	1	Sippican Harbor; head of harbor	9-Jun-04			"		Swimming	
			1 female terrapin	1	Sippican Harbor; head of harbor	7-Jul-04			"		Swimming; prepubescent	
W1C-08, W1C-09	Tabor Academy Beach, Marion Town Beach	Clean	1 hatchling	1	Sippican Harbor, West side of Harbor by Schaeffer Marine lot	1-Jul-03	12-May-03	No visible oil	5/5/2003 also "No oil observed"	22-Aug-03	Hatchling likely last year's (2002) co-hort; hatchling walking through marsh	Not noted in previous years
			Viable nest	N/A [i]	Sippican Harbor, Schaefer Lab	6-Jul-04			"		Eggs relocated from Aucoot barrier strip	
			1 female laying eggs	1	Sippican Harbor; Tenbrook Beach	10-Jul-04			"		Terrapin spotted laying eggs below highest flood tide; 12 freshly laid eggs were relocated to Schaefer Lab at Tabor Academy with nest protector and flag	
				N/A [i]	Sippican Harbor, Schaefer Lab				"			
W1D-01	Aucoot Cove	60% Very Light; 40% Moderate [i]	1 predated nest	1	Aucoot Cove, Northeast part of cove, nest is halfway down path to beach on right	23-Jun-03	24-May-03	Maintenance mode[g]	5/16/2003 patchy to sporadic oiling	15-Jun-03, 25-Jun-03		Not noted in previous years
			1 predated nest	1	Aucoot Cove, Northeast part of cove, nest is halfway down path to beach on right	5-Aug-03			"			Not noted in previous years
			Multiple nest sites, many predated	19	Aucoot Cove, along beach on Northeast side of cove	2-Oct-03			"			Not noted in previous years
			3 predated nests	1 [h]	Aucoot Cove, barrier strip	18-Jun-04			"		1 nest with about 12 predated eggs; other two nests had 2+ eggs each	
			Vulnerable nest	1 [h]	Aucoot Cove, barrier strip	6-Jul-04			"		Tracks from 22:00 high tide previous night; 12 eggs = 95 grams, relocated to protected spot at Schaefer Lab at Tabor Academy	
			15 predated nests	1 [h]	Aucoot Cove, barrier strip	12-Jul-04			"		Nests with 2-15+ predated eggs; 2 nests were "blown in the wind"	
			1 predated nest	1 [h]	Aucoot Cove, path	12-Jul-04			"		Nest on causeway path to barrier strip	
W1F-08, W1F-09	Mattapoisett Neck East, Mattapoisett Harbor North	[illegible]	Predated nest	1	Mattapoisett River, at YMCA, after pool, near river and tidal marsh	29-Jul-04	19-May-03	1-10% surface oil		27-Aug-03, 21-Aug-03	Sandy area with cord grass and scrubs and thorny primrose, eggs taken to Lloyd Center	A nesting female was observed at this site in 2000.
W2A-14	West Island - North Point	Moderate	2 predated nests	1	North beach	1999	06-Jun-03	Maintenance mode.		03-Sep-03		
		Moderate	4 predated nests	1	North beach	07-Jul-00						
		Moderate	2 predated nests	1	North beach	09-Jul-00						

Table 2
Summary of Terrapin Activity (Observed June-October 2003 and May-August 2004) and Maximum Shoreline Oiling (through mid-May 2003) [a,b]

Segment ID [c]	Segment Name [c]	Amount of Oiling [b,c]	Terrapin Observation [a]	Number of Locations on Map (Figures 1-6)	Terrapin Location [a]	Terrapin Observation Date [a]	Date of most recent SCAT [d]	Condition at most recent SCAT [d]	Notes from previous SCATs	Date when 'Passed' IRAC Criteria [e]	Terrapin Observation Notes [a]	Previous Terrapin Observations at location [a]
N/A	N/A	None	1 adult terrapin	1	Allen's Pond	15-May-04	31-May-03	"Staining was observed... very minimal splatter"	4/30/03 Pond closed by town; 5/2/03 oil buildup at entrance to Allen's Pond	9-Jul-03	Observer was in kayak, terrapin spotted in middle of Allen's Pond; Mass Audubon land	
W3C-05	Demarest Loyd State Park Beach		1 female terrapin	1	Walk north to sandspit (Deepwater Point)	16-Jul-03	14-May-03	"pea to quarter size blobs on rack. Frequency lessens from south to north. Few tarballs/patties on beach adjacent to State Park"	5/10/03 "minimal impact if used as recreation under current conditions" Very light sporadic oil	27-Jun-03	About 40 years old; predated nests found	Not noted in previous years
			Terrapin (probably female)	1	On beach front	3-Jul-04			5/10/03 "minimal impact if used as recreation under current conditions" Very light sporadic oil		Spotted walking on sand in beach grass by life guard chair on beach; beach go-er took photo (included with field report)	In 2003 a female was seen crawling on sand spit and one predated nest was found; there is anecdotal evidence of terrapins in Slocum River
			Predated nest #2	1	Area close to high tide wrack line	6-Jul-04			5/10/03 "minimal impact if used as recreation under current conditions" Very light sporadic oil		Nest in thick cord grass but sandy substrate; predated eggs taken to Lloyd Center	
W3C-05, W3C-06	Demarest-Lloyd State Park Beach and Demarest-Lloyd State Park Marsh		1 predated nest	1	Near picnic area on north side of parking lot	24-Jun-03	14-May-03	"pea to quarter size blobs on rack. Frequency lessens from south to north. Few tarballs/patties on beach adjacent to State Park"	5/10/03 "minimal impact if used as recreation under current conditions" Very light sporadic oil	27-Jun-03		Not noted in previous years
			Predated nest #1	1	Picnic area--open sandy soil	6-Jul-04			"		Predated eggs taken to Lloyd Center	In 2003 a female was seen crawling on sand spit and one predated nest was found; there is anecdotal evidence of terrapins in Slocum River
			Predated nest #3	1	Soil under tree stump	6-Jul-04			"		Very poor habitat for nesting, predated eggs taken to Lloyd Center	
			Predated nest #4	1	Picnic area, in between grass and sand	6-Jul-04					Predated eggs taken to Lloyd Center	
W3C-05, W3C-06	Demarest-Lloyd State Park Beach and Demarest-Lloyd State Park Marsh		Predated nest #5	1	In heavy grass, but with good sandy soil for nesting site	6-Jul-04	14-May-03	Beach: "pea to quarter size blobs on rack. Frequency lessens from south to north. Few tarballs/ patties on beach adjacent to State Park" Marsh: <1% stain and coat on band 0.25 feet wide; marsh had "visible coating of vegetation... in flats exposed by the low tide. 3-5" diameter tar patties also noted intermittently."	"	27-Jun-03	"Eggs most likely laid on 7/20 night because the area was checked the previous day;" predated eggs taken to Lloyd Center	
			Predated nest #6	1	Near cut-down tree	6-Jul-04			"		Poor quality nesting site, primarily soil and low sand, predated eggs taken to Lloyd Center	
			Predated nest #7	1	Next to bush in picnic area, before house park entrance	13-Jul-04			"		Possibly second wave of nesting as nest found in same area 1 week before; 8-10 eggs; predated eggs taken to Lloyd Center	
			Predated nest #8	1	Large picnic area	14-Jul-04			"		Nest in sandy soil at picnic area; predated eggs taken to Lloyd Center	
			Predated nest #11	1	Near picnic area, very close to tidal salt marsh and Giles Creek	19-Jul-04			"		Nest in sandy soil; predated eggs taken to Lloyd Center	
			Predated nest #12	1	Picnic area	20-Jul-04			"		Nest in grass and sand; predated eggs taken to Lloyd Center	
			Predated nest #13	1	Picnic area	20-Jul-04			"		Nest in sandy soil	

Table 2
Summary of Terrapin Activity (Observed June-October 2003 and May-August 2004) and Maximum Shoreline Oiling (through mid-May 2003) [a,b]

Segment ID [c]	Segment Name [c]	Amount of Oiling [b,c]	Terrapin Observation [a]	Number of Locations on Map (Figures 1-6)	Terrapin Location [a]	Terrapin Observation Date [a]	Date of most recent SCAT [d]	Condition at most recent SCAT [d]	Notes from previous SCATs	Date when 'Passed' IRAC Criteria [e]	Terrapin Observation Notes [a]	Previous Terrapin Observations at location [a]
			Predated nest #15	1	North of picnic area	21-Jul-04			"		7+ eggs predated; eggs taken to Lloyd Center; nest in sandy soil	
			Predated nest #17	1	Picnic area	2-Aug-04			"		Nest under tree stump, primarily in sandy soil	
			Predated nest #18	1	Picnic area	2-Aug-04			"		About 5 predated eggs in nest with lots of salt marsh cord grass and sandy soil	
			Predated nest #19	1	Right of Demarest-Lloyd Entrance House in sandy area	2-Aug-04			"		Nest is in promising area in tidal salt marsh, close (20m) to Slocums River but in danger because of succession	
			3 egg shells -- "nest #32"	1	Picnic area (sandy soil)	13-Aug-04			"		Solitary 3 egg shells; not near any dug up nest and also in an area absent of any predated nests; possible predator or baby hatching	
			Predated nest #9	1	Across from spit in beach grass	14-Jul-04			"		3 total nests in close vicinity; many false nests and predator digs in area; predated eggs taken to Lloyd Center	
			Predated nest #10	1	Close to tidal salt marsh, sandy soil	14-Jul-04			"		Excellent nesting site with sandy soil and lots of salt marsh cord grass	
			Predated nest #16	1	Inlet between Deepwater Point and marsh	2-Aug-04			"		5-6 predated eggs from nest with lots of dune/salt marsh cord grass and cobble to sandy soil; very fresh nest	
			Predated nest #20	1	On marsh promontory	3-Aug-04	14-May-03	Beach: "pea to quarter size blobs on rack. Frequency lessens from south to north. Few tarballs/ patties on beach adjacent to State Park" Marsh: <1% stain and coat on band 0.25 feet wide; marsh had "visible coating of vegetation... in flats exposed by the low tide. 3-5" diameter tar patties also noted intermittently."	"	27-Jun-03	This small area had a minimum of 8 predated nests, with as many as 12 or more predated nests. The small area and recent tidal overwash made it difficult to discern total number of nests. Predated eggs taken to Lloyd Center.	
			Predated nest #21	1								
			Predated nest #22	1								
			Predated nest #23	1								
			Predated nest #24	1								
			Predated nest #25	1								
			Predated nest #26	1								
			Predated nest #27	1								
			Predated nest #28	1					"			
			Predated nest #30	1	Between marsh land, very small nesting habitat	6-Aug-04			"		Sandy soil, susceptible to tidal over wash	
			Predated nest #31	1								

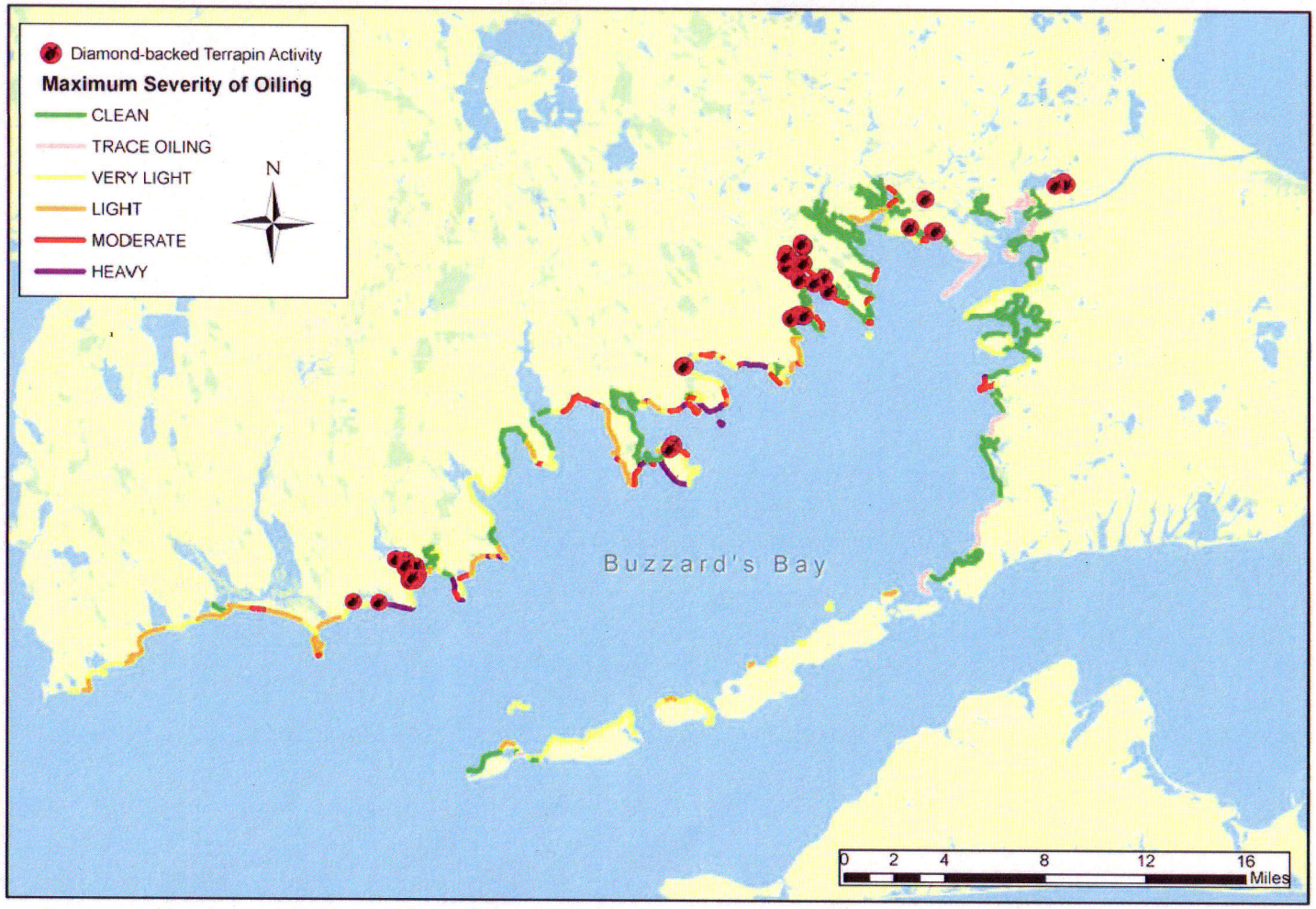
Table 2
Summary of Terrapin Activity (Observed June-October 2003 and May-August 2004) and Maximum Shoreline Oiling (through mid-May 2003) [a,b]

Segment ID [c]	Segment Name [c]	Amount of Oiling [b,c]	Terrapin Observation [a]	Number of Locations on Map (Figures 1-6)	Terrapin Location [a]	Terrapin Observation Date [a]	Date of most recent SCAT [d]	Condition at most recent SCAT [d]	Notes from previous SCATs	Date when 'Passed' IRAC Criteria [e]	Terrapin Observation Notes [a]	Previous Terrapin Observations at location [a]
W3C-06	Demarest-Lloyd State Park Marsh	Clean [f]	At least 4 terrapin	1	At 2nd mouth of Giles Creek	30-Jun-04	14-May-03	<1% stain and coat on band 0.25 feet wide; marsh had "visible coating of vegetation... in flats exposed by the low tide. 3-5" diameter tar patties also noted intermittently."	5/10/03 "minimal impact if used as recreation under current conditions" Very light sporadic oil	27-Jun-03	Swimming at low tide, seen by kayaker	In 2003 a female was seen crawling on sand spit and one predated nest was found; there is anecdotal evidence of terrapins in Slocum River
			At least 2 terrapin	1	At Giles Creek Slocum River mouth	30-Jun-04			"		Swimming at low tide	
			1 terrapin	1	Giles Creek	6-Jul-04			"		Swimming in Giles Creek; observer was in kayak	In 2003 a female was seen crawling on sand spit and one predated nest was found; there is anecdotal evidence of terrapins in Slocum River
			1 adult terrapin	1	In Giles Creek near a mosquito ditch	20-Jul-04			"		Swimming in creek in tidal salt marsh habitat; much nesting activity in area	In 2003 seen swimming and in July 1 adult seen crawling in dunes of State Park
			7+ terrapin	1	Giles Creek	17-Aug-04			"		Terrapin were swimming in Giles Creek as tide went out; observer was in kayak and wading in tidal salt marsh	In 2003 a female was seen crawling on sand spit and one predated nest was found; there is anecdotal evidence of terrapins in Slocum River; Some terrapins seen here on 30-Jun-04

a) Source: Field Reports provided by Carolyn Mostello, MA Division of Fisheries and Wildlife, 2004.
b) – Source: SAT (2004). The reported "Amount of Oiling" is based on complied maximum oiling maps for all oiled shoreline based on daily clean-up maps through mid-May 2003.
– The Scale of Maximum Oiling has 6 classifications along a continuous range: Clean, Trace Oiling, Very Light, Light, Moderate, and Heavy. 'None' has been added for locations whose shoreline was not designated as an IRAC segment and therefore did not appear on the Maximum Oiling Maps.
– Percentage oiling is calculated for each IRAC segment (or segments) associated with a terrapin observation based on length of shoreline classified in each oiling category (SAT 2004).
c) Some terrapin observation locations are reported as a general area rather than a specific point. These observations are therefore reported as exposed to the maximum oiling for the closest IRAC segments (up to two segments). Some segments are not close to any IRAC segment and therefore Segment Name and ID are reported as "N/A."
d) Source: SCAT forms provided by Heidi Hinkeldey of Research Planning, Inc. (RPI), October 2004.
e) Source: IRAC data provided by Carolyn Mostello, MA Division of Fisheries and Wildlife, 2004.
f) Giles Creek is within portion of Segment W3C-06 that is Clean.
g) Maintenance mode is described as two people walking the beach and picking up new patties that float in every 24-48 hours at the wrack line (SCAT form for W1D-01, 24-May-03).
h) Because specific locations or GPS coordinates were not available or conflicted with qualitative descriptions for these observations, the location on the associated maps (Figures 1-6) is estimated.
i) Terrapin eggs were relocated to these locations; they are not the original locations of the terrapin activity.
j) Terrapins were noted in the Northeastern portion of Aucoot Cove along the shoreline referred to as the "barrier strip." The maximum oiling of the barrier strip shoreline was either very light or moderate.
k) Terrapin observations occurred in two general locations within the Park: 1) parking lot and picnic areas of Demarest Lloyd State Park, in the vicinity of small creeks that flow into Giles Creek, and 2) the peninsula on the northern-eastern portion of the Park adjacent to the Slocum River.

Figure 1

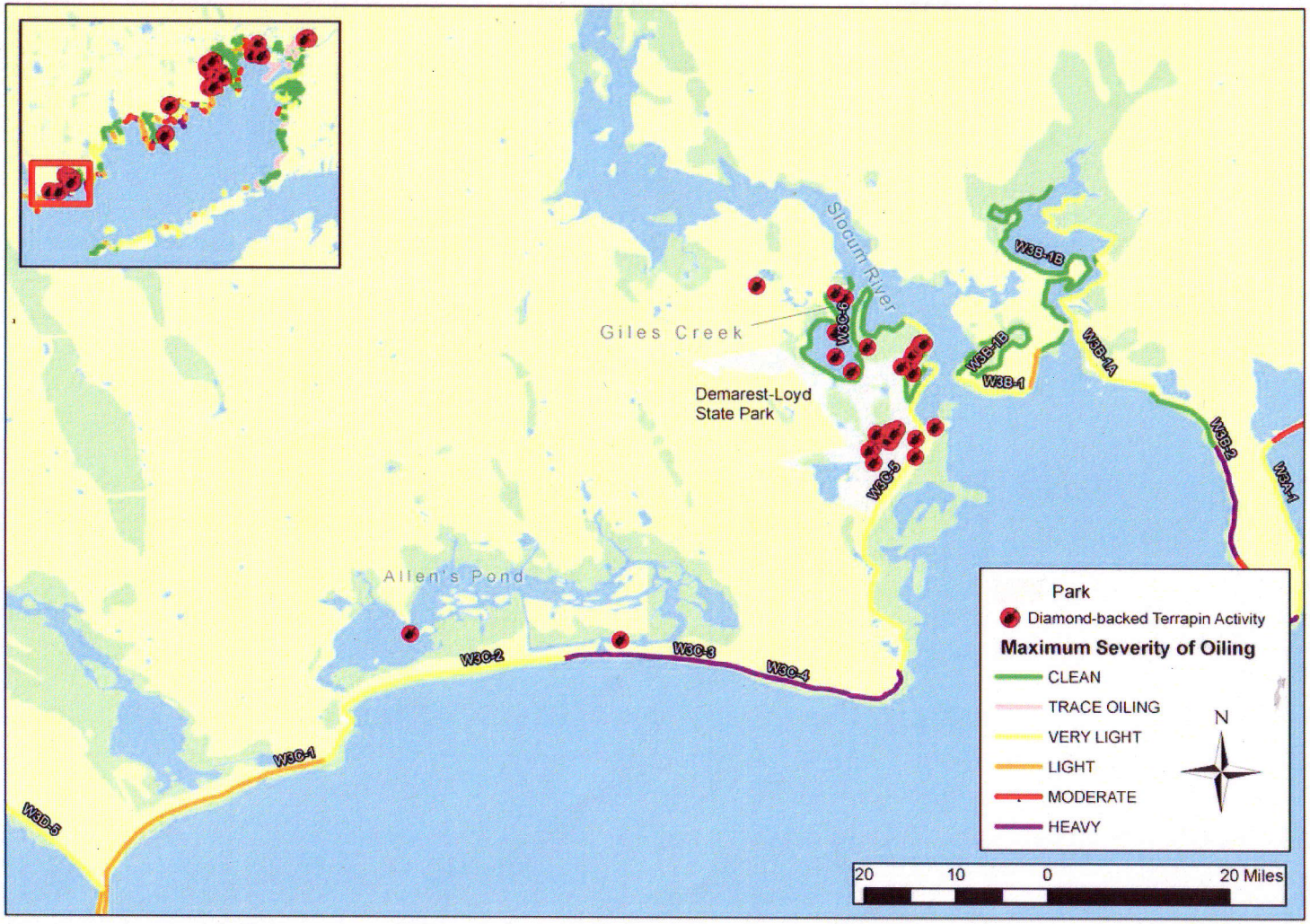
Diamondback Terrapin Activity (1996 and 2004) and Maximum Severity Oiling by IRAC Segments



Sources: Oiling (RPI 2005). Terrapin Activity (MDFW 2003-2004, 1996-2000, Reid 2000).

Figure 2

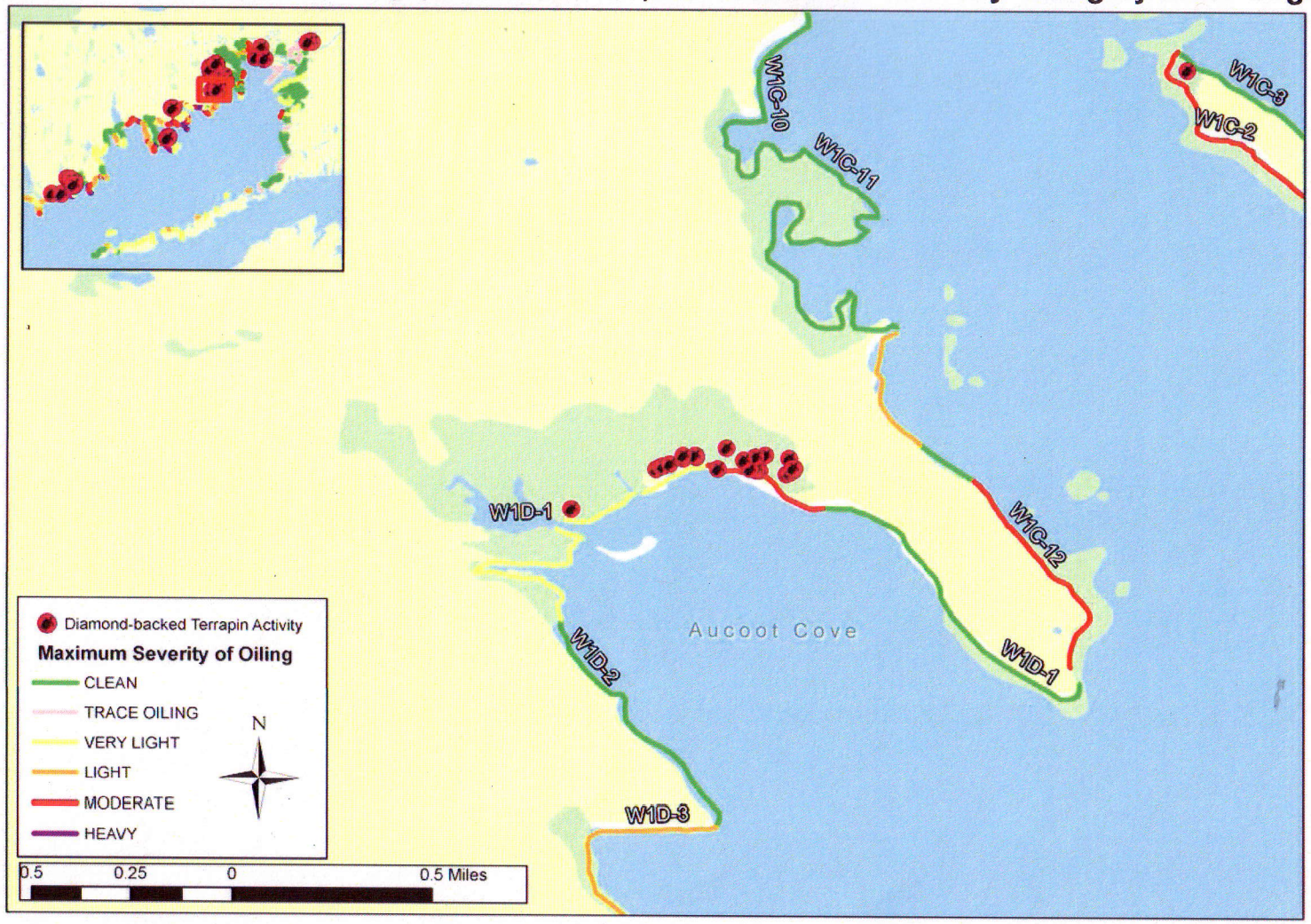
Diamondback Terrapin Activity (1996 and 2004) and Maximum Severity Oiling by IRAC Segments



Sources: Oiling (RPI 2005). Terrapin Activity (MDFW 2003-2004, 1996-2000, Reid 2000).

Figure 3

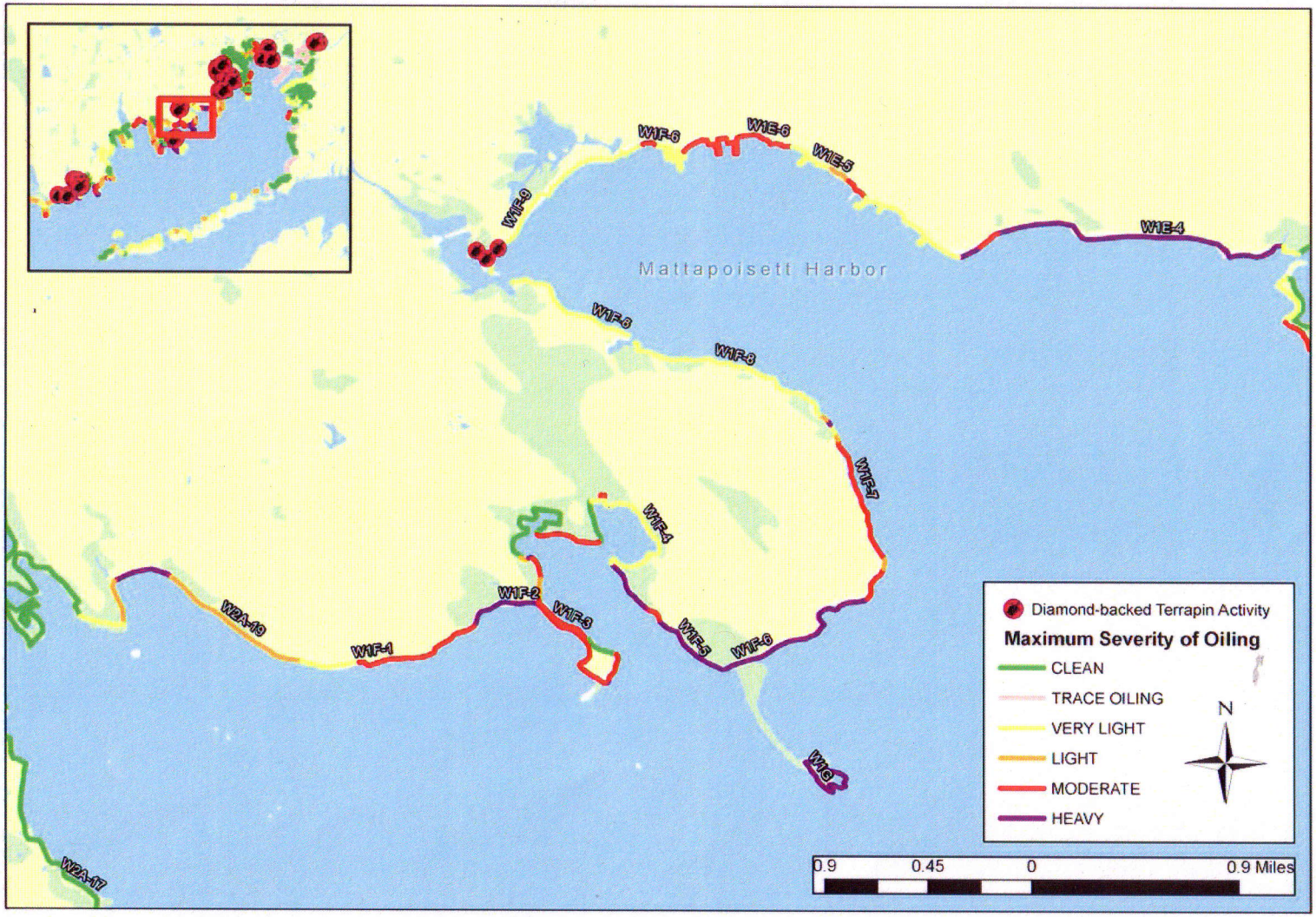
Diamondback Terrapin Activity (1996 and 2004) and Maximum Severity Oiling by IRAC Segments



Sources: Oiling (RPI 2005). Terrapin Activity (MDFW 2003-2004, 1996-2000, Reid 2000).

Figure 4

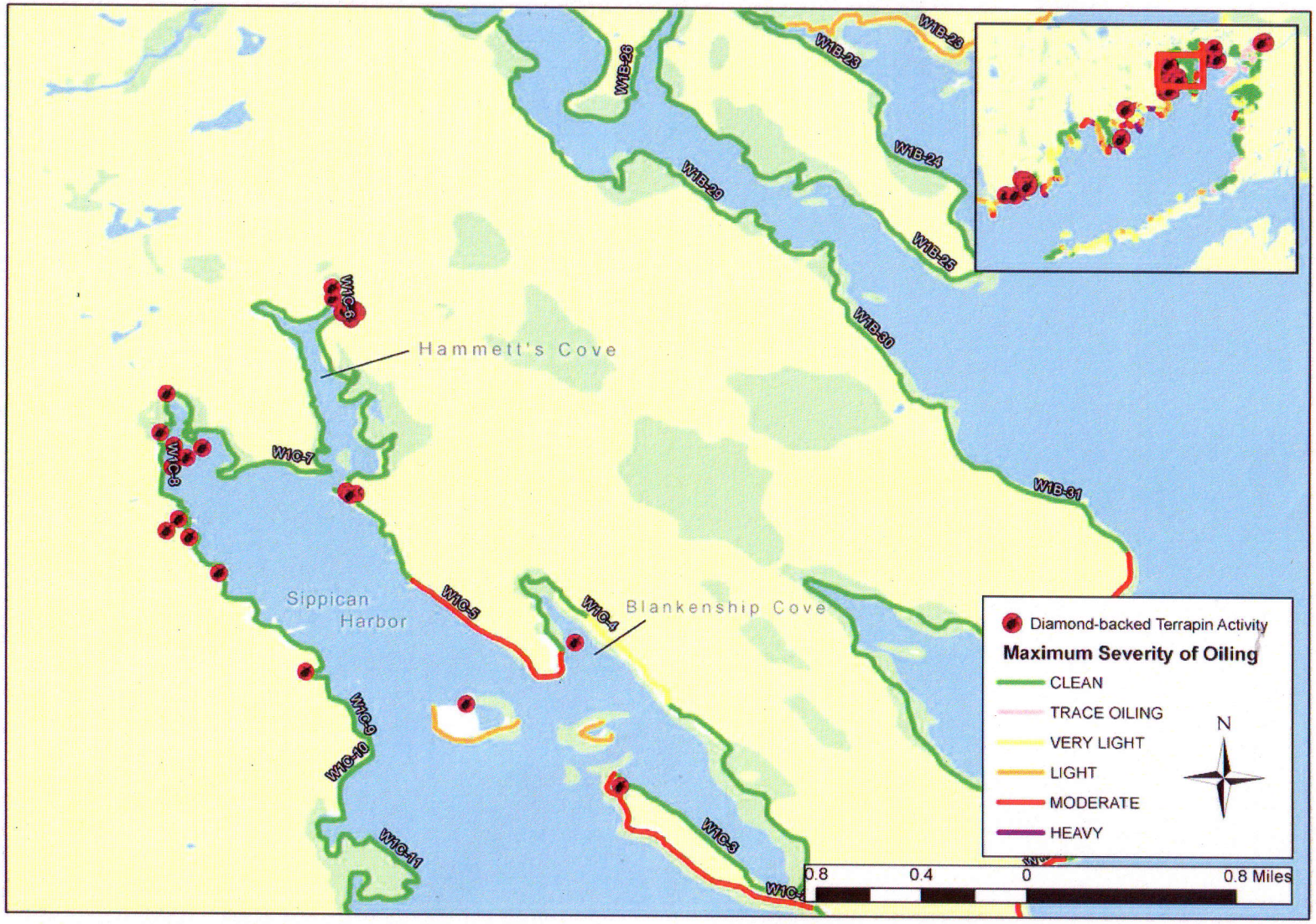
Diamondback Terrapin Activity (1996 and 2004) and Maximum Severity Oiling by IRAC Segments



Sources: Oiling (RPI 2005). Terrapin Activity (MDFW 2003-2004, 1996-2000, Reid 2000).

Figure 5

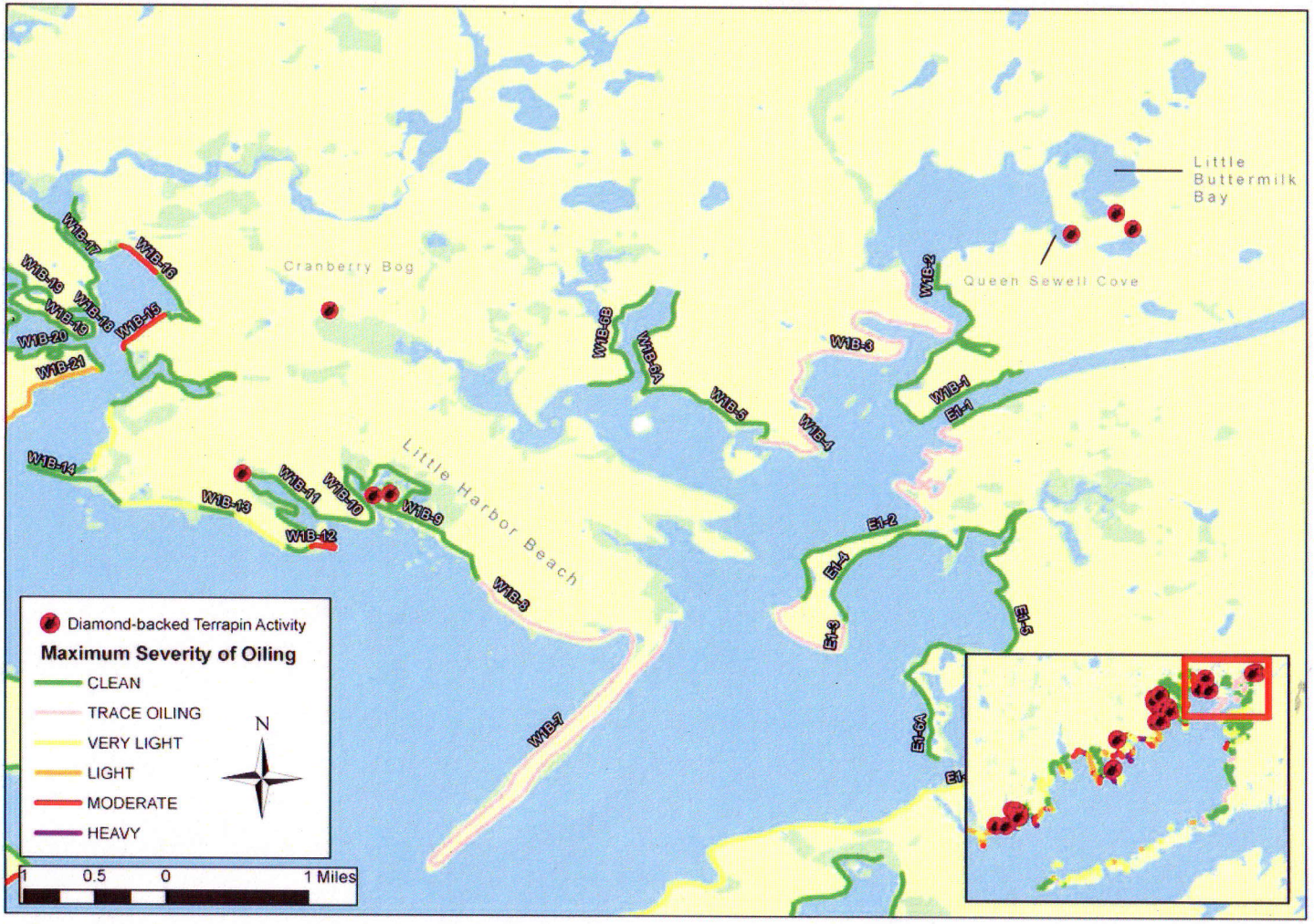
Diamondback Terrapin Activity (1996 and 2004) and Maximum Severity Oiling by IRAC Segments



Sources: Oiling (RPI 2005). Terrapin Activity (MDFW 2003-2004, 1996-2000, Reid 2000).

Figure 6

Diamondback Terrapin Activity (1996 and 2004) and Maximum Severity Oiling by IRAC Segments



Sources: Oiling (RPI 2005). Terrapin Activity (MDFW 2003-2004, 1996-2000, Reid 2000).