6.0 SUMMARY OF RESULTS

Ten of the 47 possible species to occur in the Study Area were detected visually and/or acoustically during the baseline study period. Detected species include the following five federally threatened or endangered species: North Atlantic right whale, fin whale, humpback whale, leatherback turtle, and loggerhead turtle. The minke whale, bottlenose dolphin, short-beaked common dolphin, harbor porpoise, and harbor seal were also detected.

Some clear seasonal patterns in distribution were evident from our study. Although all of the 10 species detected during this study could occur in the Study Area at any time, only the North Atlantic right whale, fin whale, humpback whale, and bottlenose dolphin were detected during all seasons. The occurrence of dolphins and porpoises, as well as turtles, is largely seasonal. Bottlenose dolphins, loggerheads, and leatherbacks mostly occur in the Study Area in the summer, while short-beaked common dolphins and harbor porpoises are common in the Study Area during the winter and spring. The fall season appears to be a transitional period for seasonal cetacean species. Few sightings of bottlenose dolphins and short-beaked common dolphins were recorded during the fall despite the large amount of survey effort. It is likely that most bottlenose dolphins move south of the Study Area, and most short-beaked common dolphins and harbor porpoises are farther north during this time of year.

Of particular ecologic importance are the sightings/acoustic detections of endangered large whale species, the North Atlantic right whale, fin whale, and humpback whale. Each of these species was detected during all seasons, including those seasons during which North Atlantic right and humpback whales are known to occupy feeding grounds north of the Study Area or breeding/calving grounds farther south of the Study Area. Cow-calf pairs of each of these species were also observed in the Study Area. Two North Atlantic right whales exhibited possible feeding behavior, and one humpback whale was observed lunge feeding off the coast of Atlantic City. Based on these occurrences and behavioral observations, the nearshore waters off New Jersey may provide important feeding and nursery habitat for these endangered species. Peak densities were predicted throughout the Study Area for these species and, although the overall abundance estimates of the whale species were relatively low, the Study Area is only a very small portion of the known ranges of these species. These species may use the waters of the Study Area for short periods of time as they migrate or follow prey movements or they may remain in the Study Area for extended periods of time. High concentrations of these species were not documented in the Study Area at any time during the study period; however, the presence of these endangered large whale species in New Jersey waters indicates that these animals are utilizing the area as habitat. The detections of these species in the Study Area, particularly during times of the year when they are thought to be in other areas, demonstrate the potential importance of the Study Area. The occurrence of these endangered species provides critical information on the distribution of the species in this region.

The density and abundance of the dolphin and porpoise species were relatively high for the Study Area. The highest abundances of marine mammals in the Study Area were estimated for the bottlenose dolphin during spring and summer. These bottlenose dolphins are thought to belong to the coastal northern migratory stock which occupies a small range between Long Island, New York and southern North Carolina. The high abundances of bottlenose dolphins in the Study Area coincide with the known movement of this stock into the northern portion of their range. High abundances of short-beaked common dolphins in the Study Area coincided with their known movement patterns south of 40ºN in the winter/spring. High abundances of harbor porpoises also occurred during the winter when the New Jersey waters and the waters of the New York Bight provide an important habitat for this species.

More information on the results of this baseline study is summarized below for each species.

6.1 ENDANGERED MARINE MAMMALS

6.1.1 North Atlantic Right Whale

There is little information on the geographic and temporal extent of the North Atlantic right whale's migratory corridor (Winn et al. 1986); however, our sightings data of females in the Study Area and

subsequent confirmations of these same individuals in the breeding/calving grounds a month or less later indicate that the nearshore waters of New Jersey are part of the migratory corridor between feeding grounds in the northeast and breeding/calving grounds in the southeast. The cow-calf pair sighted in the Study Area in May 2008 was previously confirmed in the southeast in January and February and subsequently sighted in the Bay of Fundy in August. Our observations and acoustic detections are consistent with the known migration time periods. Between mid-January and mid-March 2009, North Atlantic right whale calls were detected on the pop-up located 21.4 km (11.6 NM) from shore. All North Atlantic right whale sightings in the Study Area were recorded within 32 km (17 NM) from shore, and high densities of endangered marine mammals were predicted throughout the Study Area between 2 and 37 km (1 and 20 NM) from shore. These distances from shore are consistent with a review of previous sightings data collected in the mid-Atlantic that found that 94% of all sightings of North Atlantic right whales were within 56 km (30 NM) from shore (Knowlton et al. 2002).

The seasonal movement patterns of North Atlantic right whales are well-defined along the U.S. Atlantic coast; however, not all individuals adhere to these patterns and the seasonal distribution of these individuals is unknown. For example, a majority of the population is not accounted for on the breeding/calving grounds during winter, and not all reproductively-active females return to these grounds each year (Kraus et al. 1986). Some individuals, as well as cow-calf pairs, can be seen throughout the fall and winter on the northern feeding grounds with feeding observed (e.g., Sardi et al. 2005), and about half of the population may reside in the Gulf of Maine between November and January based on recent aerial survey data (Cole et al. 2009). Right whale sightings and acoustic detections in the Study Area provide additional evidence of occurrence outside of the typical seasonal migration periods. Although actual feeding could not be confirmed during our study, the January 2009 sighting of two adult males exhibiting skim feeding behavior off Barnegat Light suggests that feeding may occur outside the typical feeding period of spring through early fall and in areas farther south than the main feeding grounds (Winn et al. 1986; Gaskin 1987; Hamilton and Mayo 1990; Gaskin 1991; Kenney et al. 1995). Acoustic detections of North Atlantic right whale calls confirm the occurrence of this species in the Study Area during all seasons with a peak number of detection days in March through June. The documented detections and sightings of North Atlantic right whales in the Study Area suggest that some individuals occur in the nearshore waters off New Jersey either transiently or regularly.

Due to the low number of sightings recorded during the study period, no estimates of abundance could be generated for this species. The pooled year-round abundance of endangered marine mammals, including North Atlantic right whales, in the Study Area was three individuals which should be considered an underestimate due to perception bias and availability bias for large whales which can make long dives. However, based on the migratory nature of this species, a low abundance of this species could be expected for the Study Area, particularly if the North Atlantic right whales mainly use the nearshore waters of New Jersey as a migratory corridor and are not spending a significant amount of time in the region. This estimate is also reasonable due to the low overall abundance (438 individuals) of this stock of North Atlantic right whales (NARWC 2009). Based on the endangered status and low overall abundance of this species, the detection of even one right whale in the Study Area is an important occurrence. We recommend the inclusion of nearshore waters off New Jersey in future North Atlantic right whale studies to better understand the importance of these waters to this species, particularly during the winter months when migrating individuals and possible feeding were documented in the Study Area.

6.1.2 Humpback Whale

Humpback whales were recorded in the Study Area during all seasons. Seven of the 17 sightings were recorded during the winter when many individuals are known to occur on breeding/calving grounds in the West Indies (Whitehead and Moore 1982; Smith et al. 1999; Stevick et al. 2003b). Our winter sightings are consistent with other observations of this species in mid- and high latitudes during this time of year (Clapham et al. 1993; Swingle et al. 1993; Charif et al. 2001). Humpback whales could not be acoustically detected during our study period because of the lack of call detection software for this species which has highly variable vocalizations.

Humpback whale feeding grounds are typically over shallow banks or ledges with high sea-floor relief (Payne et al. 1990; Hamazaki 2002). The main feeding locations off the northeastern U.S. are north of the Study Area in waters off Massachusetts, in the Gulf of Maine, in the Bay of Fundy and surrounding areas (CETAP 1982; Whitehead 1982; Kenney and Winn 1986; Weinrich et al. 1997). There are documented feeding areas for this species south of the Study Area near the mouth of Chesapeake Bay, as well (Clapham et al. 1993; Swingle et al. 1993; Wiley et al. 1995; Laerm et al. 1997; Barco et al. 2002). The lunge feeding behavior observed by one individual humpback whale in September indicates that New Jersey nearshore waters may also be an alternate feeding area for this species. This humpback whale was lunge feeding in the vicinity of an individual fin whale; multi-species feeding aggregations that include humpback whales have also been observed over the shelf break on the southern edge of Georges Bank (CETAP 1982; Kenney and Winn 1987) and in shelf break waters off the U.S. mid-Atlantic coast (Smith et al. 1996).

An abundance estimate for the humpback whale in the Study Area was generated using the pooled detection function for the endangered marine mammals group. The year-round abundance of this species was estimated at one individual; however, this should be considered an underestimate due to perception and availability bias (i.e., diving). The humpback whales occurring in the Study Area are most likely part of the Gulf of Maine stock. In fact, one individual photographed in the Study Area in August 2009 was previously sighted in the Gulf of Maine the year before. Due to the migratory nature of the humpback whale, the relative low estimated abundance in the Study Area is not unexpected.

6.1.3 Fin Whale

The fin whale was the most commonly-detected baleen whale species in the Study Area during the study period. This is the most commonly sighted large whale in shelf waters of the U.S. north of the mid-Atlantic region (CETAP 1982; Hain et al. 1992; Hamazaki 2002). Fin whales were visually detected in the Study Area during all seasons which is consistent with previous sightings of fin whales year-round in the mid-Atlantic region (CETAP 1982; Hain et al. 1992). Fin whale pulses and downsweeps were detected in every month of acoustic monitoring during this baseline study. Fin whales are believed to follow the typical baleen whale migratory pattern consisting of movement between northern summer feeding grounds and southern winter breeding/calving grounds (Clark 1995; Aguilar 2009); however, not all individuals in the western North Atlantic stock undergo this seasonal migration (Aguilar 2009). Our year-round sightings and acoustic detections further support the occurrence of fin whales in this region outside of the typical migratory periods.

Habitat prediction models demonstrate that preferred fin whale habitat in the mid-Atlantic includes the nearshore and shelf waters from south of the Chesapeake Bay north to the Gulf of Maine (Hamazaki 2002). Relatively high densities of fin whales were predicted throughout most of the Study Area including in waters as shallow as 12 m (39 ft) and very close to shore (2 km [1 NM]). The year-round estimated abundance (two individuals) is low for the Study Area; however, abundance should be considered an underestimate due to perception and availability bias in large whales (i.e., whales making long dives are not available for detection at the surface). The occurrence of fin whales in the Study Area is important due to the endangered status of this species. In addition, the occurrence of a fin whale calf with an adult in August 2008 suggests that nearshore waters off New Jersey may provide important habitat for fin whale calves.

6.2 NON-THREATENED OR ENDANGERED MARINE MAMMALS

6.2.1 Minke Whale

Minke whales are most likely to occur in the mid-Atlantic region during winter, but this species is widespread in U.S. waters. Sightings of this species in the Study Area during winter are consistent with the known movement of minke whales southward from New England waters from November through March (Mitchell 1991; Mellinger et al. 2000). Occurrence of minke whales in New England waters increases during the spring and summer and peaks from July through September (Murphy 1995; Risch et al. 2009; Waring et al. 2009). The June sightings recorded during our study period may have been of

individuals moving back to New England waters for the summer. Because only four sightings of minke whales were recorded during the study period, no abundance estimates could be generated for this species.

6.2.2 Bottlenose Dolphin

The bottlenose dolphin was the most frequently-sighted species in the Study Area. Although this species was sighted during all seasons, bottlenose dolphin distribution was highly seasonal with most sightings occurring during the spring and summer months, particularly May through August. These sightings data are consistent with the known seasonal distribution patterns of the coastal northern migratory stock of bottlenose dolphins which occur in waters from New York to North Carolina in the summer and are found from southern Virginia to Cape Lookout, North Carolina in the winter (CETAP 1982; Kenney 1990; Garrison et al. 2003; Hohn and Hansen 2009; Waring et al. 2009; Toth et al. in press). Based on our sightings data, bottlenose dolphins move into the Study Area as early as the beginning of March and occur there until at least mid-October. The delphinid whistles detected between March and October are most likely of bottlenose dolphins. The estimated abundances of bottlenose dolphins in the Study Area during the spring (mostly June; 722) and summer (289 ship analysis, 1,297 aerial analysis) are comparable to the estimated abundance of the coastal northern migratory stock (7,789) (Waring et al. 2009). A peak number of days (69) with delphinids whistle detections were also recorded during spring and summer. Only seven sightings were recorded during the fall/winter; therefore, abundance is likely much lower during this time of year when most of the coastal northern migratory stock is farther south off the coasts of Virginia and North Carolina. The seasonal occurrence of bottlenose dolphins off New Jersey is thought to be due to the presence of preferred prey species that also occur seasonally in New Jersey waters (Able and Fahay 1998; Gannon and Waples 2004).

Bottlenose dolphins are known to have a fine-scale distribution within the Study Area based on research by Toth-Brown et al. (2007) who found a significant break in the habitat usage of bottlenose dolphins in New Jersey's nearshore waters (out to 6 km [3.2 NM] from shore). One group appeared to utilize waters within 2 km (1.1 NM) of the shore while the other group occupied waters outside of 2 km (1.1 NM) of shore. Due to limitations obtaining high quality photo-identification data during the baseline study, this fine-scale distribution pattern was not evident from our results; however, our results emphasize the importance of New Jersey's nearshore waters to bottlenose dolphins. Sightings were recorded close to shore (minimum 0.3 km [0.16 NM]), and peak densities were predicted in state waters (0 to 5.5 km [0 to 3 NM] from shore) off Atlantic City north to Brigantine and Little Egg Inlet during spring and farther north off Barnegat Light and Barnegat Bay during summer. Toth et al. (in press) identified higher levels of use and increased presence of young individuals in the very nearshore waters off Brigantine, just north of Atlantic City.

Several bottlenose dolphin sightings were also recorded in deeper waters (34 m [112] ft) of the Study Area and farther offshore (maximum 38 km [21 NM] from shore), suggesting that their distribution within the Study Area is not limited to a particular depth range or distance from shore. High densities were predicted in some regions of the Study Area up to 28 km (15 NM) from shore in the spring and 36 km (19 NM) from shore in the summer. Predicted densities were more interspersed throughout the northern/ southern range of the Study Area during summer, indicating that higher densities of bottlenose dolphins extend into the northern portion of the Study Area (north of Barnegat Light) during this time of year. Peak densities were predicted from the shoreline to 36 km (19 NM) offshore of Barnegat Light/Barnegat Bay and along the federal/state boundary (5.5 km [3 NM] from shore).

6.2.3 Short-beaked Common Dolphin

The occurrence of this species in the Study Area was strongly seasonal; sightings were only recorded during fall and winter, specifically late November through mid-March. The short-beaked common dolphin was the only delphinid species sighted during the winter, except for one bottlenose dolphin sighting recorded in early March. Therefore, the delphinid whistles recorded from December through at least February were likely of short-beaked common dolphins. This occurrence pattern is consistent with the

known seasonal movements of short-beaked common dolphins offshore of the mid-Atlantic in colder months (Payne et al. 1984; Jefferson et al. 2009; Waring et al. 2009).

Although short-beaked common dolphins primarily occur offshore (>37 km [20 NM]) in waters of 200 to 2,000 m in depth (656 to 6,562 ft; Ulmer 1981; CETAP 1982; Canadian Wildlife Service 2006; Jefferson et al. 2009), our sightings data support the occurrence of this species in shallower waters close to shore. Short-beaked common dolphins were sighted throughout the Study Area in waters 3 to 37 km (2 to 20 NM) from shore and 10 to 31 m (33 to 102 ft) in depth. Almost all of the sightings of delphinids recorded during winter were of short-beaked common dolphins. High densities of delphinids were predicted south of Barnegat Light during the winter. Peak densities were predicted in nearshore waters (0 to 5.5 km [0 to 3 NM] from shore) from Brigantine to Little Egg Inlet and 30 km (16 NM) offshore of Little Egg Harbor. Peak densities were also predicted between 21 and 32 km (11 to 17 NM) from shore in the southeastern portion of the Study Area.

A winter abundance estimate was generated for this species using the pooled detection function of all delphinids during this season. The abundance was estimated at 82 individuals. This estimate may be high due to the attraction of delphinids to the ship (e.g., bowriding); however, because perception and availability bias were not accounted for, the abundance estimate should be considered underestimated. Only eight short-beaked common dolphin sightings were recorded during the fall. Although abundance estimates could not be generated for this season, the abundance of this species is expected to be lower during this time of year. No sightings of short-beaked common dolphins were recorded during spring or summer. Although this species has been recorded near the Study Area during these seasons (CETAP 1982; Canadian Wildlife Service 2006), abundance in the Study Area is expected to be very low during this time of year.

6.2.4 Harbor Porpoise

Harbor porpoise distribution in the western North Atlantic is seasonal, and New Jersey waters are a known important habitat for harbor porpoises from January through March (Westgate et al. 1998). The sightings of harbor porpoises recorded during the study period support this statement with over 90% of sightings recorded during winter (mainly February and March). Few sightings were also recorded in April, May, and July which indicates that this species could occur in the Study Area during other times of the year. No harbor porpoise sightings were recorded during the fall surveys; however, weather conditions were often above a BSS 2 which makes sighting this species very difficult. The densest concentrations of harbor porpoises are thought to occur from New Jersey to Maine from October through December (NMFS 2001). Therefore, harbor porpoises are likely to occur in the Study Area throughout the fall. Due to the low number of sightings throughout the year, an abundance estimate for the harbor porpoise could only be generated for the winter. The winter abundance of harbor porpoises in the Study Area was estimated at 98 individuals. Abundance is likely underestimated due to this species' known responsive movement away from ships and perception and availability bias (Barlow 1988; Polacheck and Thorpe 1990; Palka and Hammond 2001).

Harbor porpoises are known to occur most frequently over the continental shelf and are most often found in waters cooler than 17°C (Read 1999). Sightings data from the study period provide support for these habitat associations of the harbor porpoise. Sightings of this species were recorded between 1.5 and 37 km (1 and 20 NM) from shore in waters ranging from 12 to 30 m (39 to 98 ft). SSTs for the harbor porpoise ranged from 4.5 to 18.7°C (40.1 to 65.7°F) which is just slightly higher than the typical maximum SST of 17°C (Read 1999). High densities of harbor porpoises were predicted in the center of the Study Area between 39°04'10"N and 39°45'34"N and between -74°26'41"W and -73°53'36"W. Peak densities were predicted between 5.5 and 15 km (3 and 8 NM) from shore and also 34 km (18 NM) from shore north of Brigantine.

6.2.5 Harbor Seal

Only one harbor seal was recorded in the Study Area during the study period. This seal was sighted in shallow waters east of Little Egg Inlet in June. Other unidentified pinnipeds recorded near Ocean City in

April were likely also harbor seals but could not be confirmed. Harbor seals regularly haul out near Great Bay inshore of the Study Area and along the northern shore of the New York Bight, including Sandy Hook and the coasts of Rhode Island, Connecticut, and Massachusetts (Payne and Selzer 1989; Barlas 1999; Schroeder 2000; DeHart 2002; Di Giovanni et al. 2009; Antonucci et al. n.d.). The harbor seal observed in June was likely from one of these haulout regions. No haulout sites were detected along the beach adjacent to the Study Area during the shoreline aerial surveys. Although harbor seals could be found in the Study Area during any time of year, they are known to make seasonal movements in New Jersey waters during the winter (Slocum et al. 1999). Although no sightings of harbor seals were confirmed in the Study Area during winter, one probable harbor seal was sighted south of the Study Area near Lewes, Delaware, where the survey vessel was docked in March 2008.

6.3 SEA TURTLES

6.3.1 Leatherback Turtle

Leatherback turtles have a seasonal occurrence in the mid-Atlantic; they are most common off the mid-Atlantic and southern New England coasts in the spring and summer (CETAP 1982; Shoop and Kenney 1992; Thompson et al. 2001; James et al. 2006b). All 12 sightings of this species were recorded in the Study Area during summer. Sightings were recorded in deeper, offshore waters of the Study Area ranging from 10 to 36 km (5 to 19 NM) from shore and water depths of 18 to 30 m (59 to 98 ft). Leatherbacks foraging in the western North Atlantic are known to associate with waters between 16 to 18°C (60 to 64°F) (Thompson et al. 2001; James et al. 2006b), and SSTs between 10 to 12°C (50 to 54°F) may represent the lower thermal limit of this species (Witt et al. 2007). The sightings recorded during the study period had a mean SST of 19.0°C (66°F) which is only slightly higher than the preferred SST for foraging leatherbacks; the lack of sightings during the colder months is consistent with this species preference for warmer SST. Abundance of leatherback turtles in the Study Area is unknown because abundance estimates could not be generated for this species.

6.3.2 Loggerhead Turtle

Loggerhead turtle occurrence along the U.S. Atlantic coast is strongly seasonal. Although sightings are recorded in mid-Atlantic and northeast waters year-round, loggerheads occur mainly north of Cape Hatteras between May and October (CETAP 1982; Lutcavage and Musick 1985; Shoop and Kenney 1992). Loggerheads sighted during the study period were consistent with this seasonal occurrence pattern; sightings were recorded between June and October. The mean SST associated with these sightings was 18.5°C (65.3°F) which is within the preferred SST range for this species (13 to 28ºC [55 to 82°F]; Mrosovsky 1980). Sightings were recorded throughout the Study Area from 1.5 to 38 km (1 to 21 NM) from shore and in water depths ranging from 9 to 34 m (30 to 112 ft). Due to difficulties in measuring the perpendicular distances of the loggerhead sightings from the aerial survey tracklines, abundance estimates could not be generated for the Study Area.