NOAA's National Marine Fisheries Service
Endangered Species Act Section 7 Consultation

Biological Opinion

Agencies: NOAA's National Marine Fisheries Service-Office of Protected Resources-Permits, Conservation, and Education Division

Activities Considered: Issuance of permit to André Landry, Texas A&M University at Galveston (Permit number 15606)

Consultation Conducted by: NOAA's National Marine Fisheries Service-Office of Protected Resources-Endangered Species Division

Approved by: _____

MAR 3 0 2011

Date: _____

Section 7(a)(2) of the Endangered Species Act (ESA)(16 U.S.C. 1531 *et seq.*) requires that each federal agency shall ensure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of such species. When the action of a federal agency "may affect" a listed species or critical habitat designated for them, that agency is required to consult with either the NOAA's National Marine Fisheries Service (NMFS) or the U.S. Fish and Wildlife Service, depending upon the listed resources that may be affected. For the actions described in this document, the action agency is the NMFS' Office of Protected Resources-Permits, Conservation, and Education Division (Permits Division), which proposes to authorize capture, tagging, and biological sampling of green, hawksbill, Kemp's ridley, and loggerhead sea turtles in the northwestern and north central Gulf of Mexico. The consulting agency for these proposals is the NMFS' Office of Protected Resources – Endangered Species Division (Endangered Species Division).

This document represents the NMFS' biological opinion (Opinion) of the effects of the proposed actions on endangered and threatened species and designated critical habitat and has been prepared in accordance with section 7 of the ESA. This Opinion is based on information provided in the application, draft permit, recovery plans for green, hawksbill, Kemp's ridley, and loggerhead sea turtles, monitoring reports from prior research, other information provided by the applicant, and other biological opinions involving similar sea turtle research.

Consultation history

On November 24, 2010, the Permits Division published a notice in the Federal Register soliciting public comment on their intent to issue the proposed permit.

On January 31, 2011, NMFS' Endangered Species Division received a request for formal consultation from the Permits Division to authorize Permit Number 15606, André Landry, Texas A&M University at Galveston.

Description of the proposed actions

The proposed action is the issuance of a scientific research permit (File No. 15606) to André Landry, Texas A&M University at Galveston, pursuant to section 10(a)(1)(a) of the Endangered Species Act of 1973, as amended (ESA; 16 U.S.C. 1531 *et seq*.), to conduct scientific research on green sea turtles (*Chelonia mydas*), hawksbill sea turtles (*Eretmochelys imbricate*), Kemp's ridley sea turtles (*Lepidochelys kempii*), and loggerhead sea turtles (*Caretta caretta*). The purposes of the proposed permit are to conduct four research projects: monitor green sea turtles population growth in the Laguna Madre, characterize sea turtle habitat use of estuarine and nearshore waters of the northwestern Gulf of Mexico, assess risks of environmental estrogen uptake to sea turtles near a Lavaca Bay Superfund site, and evaluate the impacts of the *Deepwater Horizon* oil spill on sea turtles.

The proposed actions include:

- Capture of sea turtles in entanglement (all projects) or cast nets (Laguna Madre project only), handling of captured sea turtles, and subsequent release where they were caught for all turtles in all areas (except *Deepwater Horizon* project, in which oiled turtles will be transferred to onshore locations or possibly released in locations designated by NRDA administrators; an action exempt from consultation here under §222.310 U.S.C. 1539 (a)(1)(A)).
- Morphometric measurement, fecal sampling, skin and scute biopsy as well as flipper, passive integrated transponder (PIT) and satellite tagging for all projects except Lavaca Bay estrogen monitoring, which will also include blood sampling, but will not involve satellite tagging and biopsy. *Deepwater Horizon* captures will also entail blood sampling.

Table 1 summarizes the actions to which individual sea turtles will be exposed. We anticipate individual sea turtles will usually be exposed to all actions, except in cases outlined above.

Table 1. Actions to which listed species will be exposed on an annual basis. Some capture/handling/restraint is proposed to occur different permit authority (see capture section on next page). Mortality estimates in the response analysis differ from those proposed in the application.

Sea turtle species	Capture/handling /restraint	Flipper tag	PIT tagging	Morpho-metrics	Blood collection	Epiphyte sampling	Satellite tagging	Biopsy	Mortality
Green	217	330	330	330	52	330	148	318	See response analysis
Hawksbill	10	50	50	50	10	50	50	50	See response analysis
Kemp's ridley	377	420	420	420	212	420	243	378	See response analysis
Loggerhead	70	240	240	240	40	240	150	220	See response analysis

Capture

Sea turtles will be captured in one of two ways: entanglement in gill nets or cast nest. Cast netting will be used exclusively in capturing green sea turtles in the Laguna Madre. This would involve a researcher casting a two-meter-wide net onto small, post-pelagic green sea turtles as they surface to breathe from jetties along Brazos Santiago Pass (South Padre Island) and Mansfield Channel (Port Mansfield). Entanglement netting is not possible at these locations. Captured turtles would be immediately retrieved from the water and brought ashore for processing. It is worth noting that captures are not authorized under this permit for all sea turtles that will be exposed to subsequent activities. Many sea turtles may be captured by Texas Parks and Wildlife Department, Louisiana Wildlife and Fish Department, and the United States Army Corps of Engineers and transferred to the applicant for authorized activities.

Entanglement netting would be employed in all other locations. The nets themselves would be roughly 91.4 m long, vertically stretch 2.5 to 4 m from their buoys on the surface, and utilize mesh bars separated by 12.7 cm. Nets would be deployed for a minimum of six hours at randomly selected locations within the study area (estuarine and nearshore waters of the Texas and Louisiana coasts) during daylight hours. Timing of capture is dependent upon project, with green sea turtle captures in Laguna Madre occurring in January, April, July, August, October, and November of a given year; sea turtle captures to study habitat use any time of year; Superfund site impacts during April, May, August, and early September; and captures any time of year related to the Natural Resources Damage Assessment.

Following net deployment, two boat crews will monitor nets for captures (Fig. 1). Crews will pull nets out of the water every 30 minutes or less to check for captures. Crews will also monitor nets for indications of entanglement, such as buoy movement or submersion.

Fig. 1. Boat crew checking nets for captured animals. Photo courtesy of André Landry.

Handling, restraint, and release

Once captured, sea turtles would be removed from entanglement nets. All the investigators and personnel involved would be experienced in capturing and handling sea turtles and would undertake a number of precautions. Antiseptic methods such as disinfecting equipment, use of Betadine© at tag sights, and surgical scrub (three alternating applications of 70% ethanol and iodine soap) would be standard protocol to prevent the transmission of disease and prevent infection. To facilitate expeditious processing of captured turtles, boat crews would perform authorized activities on capture boats as long as this does not hamper net checks or removing other turtles from entanglement nets. If boat processing is not possible, captured turtles would be transferred to on-shore locations for processing. Regardless, captured sea turtles would be

placed on foam pads (cleaned/disinfected between turtles), kept moist, and protected from temperature extremes (shade for heat, covered/kept out of wind for cold). Researchers would initially examine captured sea turtles for signs of injury, vigor, and behavior. Injured and abnormally-behaving sea turtles would be immediately transferred to a rehabilitation facility for veterinary care. Otherwise, captured sea turtles would begin to be processed for activities described in subsequent sections. All sea turtles not receiving a satellite transmitter would be released into the waters in which they were captured within four hours of capture. While the majority of all turtles will be processed onboard the netting vessel and released immediately thereafter (~one hour post-capture), delays due to capture of other turtles, satellite tagging, rough sea state, etc. may necessitate short-term (≤ four hours) holding. Consequently, each netting boat will be equipped with a two-meter diameter holding tank in which a turtle is held for short periods. The bottom of this tank will be lined with a foam pad to prevent injury to appendages and plastron as well as to provide insulation from a warm boat deck. Approximately two to three cm of sea water from the capture site will be placed in the tank to prevent desiccation of the turtle's lower extremities while a moistened towel will be placed on its carapace for similar protection to dorsal regions. Every effort will be made to maintain a temperature in the tank approximating that of the columnar water temperature from which the turtle was taken. Satellite-tagged individuals would be held for between 12 and 24 hours to allow for epoxy cure time before release into waters where they were captured. Sea turtles captured in association with NRDA assessment showing evidence of oiling or turtles captured in oil-contaminated areas may be held longer, transferred to rehabilitation facilities, or transported to other locations for release upon consultation with NRDA administrators and under authority outside the scope of actions considered here (§222.310 U.S.C. 1539 (a)(1)(A)). Release would be accomplished by lowering sea turtles into the water followed by release and subsequent monitoring of swimming and diving ability. If turtles are still visible and not swimming or diving normally one hour post-release, they would be recaptured and transferred to a rehabilitation facility under separate authority (§222.310 U.S.C. 1539 (a)(1)(A)).

Flipper and PIT Tagging

All captured sea turtles would be examined for the presence of a flipper or PIT tag. If absent, turtles would be equipped with flipper tags attached to the trailing edge of both right and left front flippers and/or a PIT tag inserted intramuscularly into the foreflipper, enabling future identification of the individual. Tags will be disinfected prior to implantation. The anticipated duration of flipper tag attachment is three to five years while the PIT tag is permanent baring amputation. Flipper and PIT tag information will be submitted to the Cooperative Marine Turtle Tagging Program at the Archie Carr Center for Sea Turtle Research (University of Florida at Gainesville).

Morphometrics

Morphometrics may be recorded for all captured sea turtles. Morphometrics will be taken via measurement of straight and curved carapace length and width as well as total mass via a hanging scale. Photographs may also be taken.

Blood sampling

To facilitate analysis of estrogenic compounds in sea turtles at the Port Lavaca Superfund site, blood samples would be taken from sea turtles captured at sites in this area. This will involve veinipuncture of the bilateral cervical sinus via a sterile 21-gauge needle using methods

developed by Owens and Ruiz (1980). No more than four attempts (two on right and left sides, respectively) will be attempted on a given individual. The cumulative amount of blood drawn from each turtle will not exceed 6% of the turtle's total blood volume.

Epiphyte sampling

All captured sea turtles may be exposed to epiphyte removal. Epiphytes (barnacles and algae) will be removed from all sea turtles captured or retrieved by the applicant to characterize species host associations and as biological markers indicating sea turtle distribution.

Satellite tagging

Any captured sea turtle may be satellite tagged. Turtles would initially be placed on a foam pad in a well-ventilated area to allow the carapace to dry. Scutes to which the satellite transmitter would be attached would be sanded, as would the bottom of the satellite transmitter; both would then be cleaned with acetone (Fig 2). A SirTrack KiwiSat 101, 202, or similar package would then be affixed to the sanded area (first and second vertebral scutes) with epoxy as described in Seney and Landry (2008) and Seney et al. (2010) (Fig 3). Satellite-tagged sea turtles would be held at on-shore facilities for 12-24 hours, allowing the epoxy to cure and health observations to be undertaken before release at the original capture site (barring oil presence or NRDA administrative direction).

Fig. 2. Sanding scutes prior to satellite tag attachment. Photo courtesy of André Landry.

Fig. 3. Satellite tag attached to captured sea turtle. Photo courtesy of André Landry.

Approach to the assessment

The NMFS approaches its Section 7 analyses of agency actions through a series of steps. The first step identifies those aspects of proposed actions that are likely to have direct and indirect physical, chemical, and biotic effects on listed species or on the physical, chemical, and biotic environment of an action area. As part of this step, we identify the spatial extent of these direct and indirect effects, including changes in that spatial extent over time. The result of this step includes defining the *action area* for the consultation. The second step of our analyses identifies the listed resources that are likely to co-occur with these effects in space and time and the nature of that co-occurrence (these represent our *exposure analyses*). In this step of our analyses, we try to identify the number, age (or life stage), and gender of the individuals that are likely to be exposed to an action's effects and the populations or subpopulations those individuals represent. Once we identify which listed resources are likely to be exposed to an action's effects and the nature of that exposure, we examine the scientific and commercial data available to determine whether and how those listed resources are likely to respond given their exposure (these represent our *response analyses*).

The final steps of our analyses – establishing the risks those responses pose to listed resources – are different for listed species and designated critical habitat (these represent our *risk analyses*). Our jeopardy determinations must be based on an action's effects on the continued existence of threatened or endangered species as those "species" have been listed, which can include true biological species, subspecies, or distinct population segments of vertebrate species. The continued existence of these "species" depends on the fate of the populations that comprise them. Similarly, the continued existence of populations are determined by the fate of the individuals that comprise them – populations grow or decline as the individuals that comprise the population live, die, grow, mature, migrate, and reproduce (or fail to do so).

Our risk analyses reflect these relationships between listed species, the populations that comprise that species, and the individuals that comprise those populations. Our risk analyses begin by identifying the probable risks actions pose to listed individuals that are likely to be exposed to an

action's effects. Our analyses then integrate those individual risks to identify consequences to the populations those individuals represent. Our analyses conclude by determining the consequences of those population-level risks to the species those populations comprise.

We measure risks to listed individuals using the individuals' "fitness," or the individual's growth, survival, annual reproductive success, and lifetime reproductive success. In particular, we examine the scientific and commercial data available to determine if an individual's probable lethal, sub-lethal, or behavioral responses to an action's effect on the environment (which we identify during our response analyses) are likely to have consequences for the individual's fitness.

When individual, listed plants or animals are expected to experience reductions in fitness in response to an action, those fitness reductions are likely to reduce the abundance, reproduction, or growth rates (or increase the variance in these measures) of the populations those individuals represent (see Stearns, 1992). Reductions in at least one of these variables (or one of the variables we derive from them) is a *necessary* condition for reductions in a population's viability, which is itself a *necessary* condition for reductions in a species' viability. As a result, when listed plants or animals exposed to an action's effects are *not* expected to experience reductions in fitness, we would not expect the action to have adverse consequences on the viability of the populations those individuals represent or the species those populations comprise (e.g., Anderson, 2000; Brandon, 1978; Mills and Beatty, 1979; Stearns, 1992). As a result, if we conclude that listed plants or animals are *not* likely to experience reductions in their fitness, we would conclude our assessment.

Although reductions in fitness of individuals is a *necessary* condition for reductions in a population's viability, reducing the fitness of individuals in a population is not always *sufficient* to reduce the viability of the population(s) those individuals represent. Therefore, if we conclude that listed plants or animals are likely to experience reductions in their fitness, we determine whether those fitness reductions are likely to reduce the viability of the populations the individuals represent (measured using changes in the populations' abundance, reproduction, spatial structure and connectivity, growth rates, variance in these measures, or measures of extinction risk). In this step of our analyses, we use the population's base condition (established in the *Environmental baseline* and *Status of listed resources* sections of this Opinion) as our point of reference. If we conclude that reductions in individual fitness are not likely to reduce the viability of the populations those individuals represent, we would conclude our assessment.

Reducing the viability of a population is not always *sufficient* to reduce the viability of the species those populations comprise. Therefore, in the final step of our analyses, we determine if reductions in a population's viability are likely to reduce the viability of the species those populations comprise using changes in a species' reproduction, numbers, distribution, estimates of extinction risk, or probability of being conserved. In this step of our analyses, we use the species' status (established in the *Status of listed resources* section of this Opinion) as our point of reference. Our final determinations are based on whether threatened or endangered species are likely to experience reductions in their viability and whether such reductions are likely to be appreciable.

To conduct these analyses, we rely on all of the evidence available to us. This evidence consists of monitoring reports submitted by past and present permit holders, reports from NMFS Science Centers; reports prepared by natural resource agencies in States and other countries, reports from

non-governmental organizations involved in marine conservation issues, the information provided by the Permits Division when it initiates formal consultation, and the general scientific literature.

We supplement this evidence with reports and other documents – environmental assessments, environmental impact statements, and monitoring reports – prepared by other federal and state agencies like the Minerals Management Service, U.S. Coast Guard, and U.S. Navy whose operations extend into the marine environment.

During the consultation, we conducted electronic searches of the general scientific literature using search engines, including Agricola, Ingenta Connect, Aquatic Sciences and Fisheries Abstracts, JSTOR, Conference Papers Index, First Search (Article First, ECO, WorldCat), Web of Science, Oceanic Abstracts, Google Scholar, and Science Direct.

We supplement these searches with electronic searches of doctoral dissertations and master's theses. These searches specifically try to identify data or other information that supports a particular conclusion as well as data that do not support that conclusion. When data were equivocal or when faced with substantial uncertainty, our decisions are designed to avoid the risks of incorrectly concluding that an action would not have an adverse effect on listed species when, in fact, such adverse effects are likely (i.e., Type II error).

In this particular assessment, we identified the stressors associated with the action and evaluated which had a significant possibility of occurring based upon previous research. Of the probable stressors, we identified the species that were expected to co-occur with the effects of the action.

Action area

The proposed research under File No. 1526 would take place in estuaries, bays, and nearshore waters of the Gulf of Mexico from South Texas to Louisiana west of the Mississippi River. The animals that would be captured by entanglement net, cast net, and encircle net would come from the lower Laguna Madre, Texas and from the upper and middle Texas coast estuaries.

Status of listed resources

The NMFS has determined that the actions considered in this Opinion may affect species listed in Table 2, which are provided protection under the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq*.).

Table 2. Listed species in the action area.

Common name	Scientific name	Status
Green sea turtle	*Chelonia mydas*	Endangered/ Threatened
Hawksbill sea turtle	*Eretmochelys imbricate*	Threatened
Kemp's ridley sea turtle	*Lepidochelys kempii*	Endangered
Loggerhead sea turtle Northwestern DPS	*Caretta caretta*	Threatened Proposed Endangered

Critical habitat has not been established in the region of the proposed action area. We conclude that critical habitat will not be impacted by the proposed actions.

The biology and ecology of species with anticipated exposure below informs the effects analysis for this Opinion. Summaries of the global status and trends of each species presented provide a foundation for the analysis of species as a whole.

Green sea turtle

Distribution. Green sea turtles have a circumglobal distribution, occurring throughout tropical, subtropical waters, and, to a lesser extent, temperate waters.

Population designation. Populations are distinguished generally by ocean basin and more specifically by nesting location (Table 3).

Based upon genetic differences, two or three distinct regional clades may exist in the Pacific: western Pacific and South Pacific islands, eastern Pacific, and central Pacific, including the rookery at French Frigate Shoals, Hawaii (Dutton and Balazs, In review; Dutton et al., 1996). In the eastern Pacific, green sea turtles forage from San Diego Bay, California to Mejillones, Chile. Individuals along the southern foraging area originate from Galapagos Islands nesting beaches, while those in the Gulf of California originate primarily from Michoacán. Green turtles foraging in San Diego Bay and along the Pacific coast of Baja California originate primarily from rookeries of the Islas Revillagigedos (Dutton, 2003).

Table 3. Locations and most recent abundance estimates of threatened green sea turtles as annual nesting females (AF), annual nests (AN), annual egg production (EP), and annual egg harvest (EH).

Location	Most recent abundance	Reference
Western Atlantic Ocean		
Tortuguero, Costa Rica	17,402-37,290 AF	(Troëng and Rankin, 2005)
Aves Island, Venezuela	335-443 AF	(Vera, 2007)
Galibi Reserve, Suriname	1,803 AF	(Weijerman et al., 1998)
Isla Trindade, Brazil	1,500-2,000 AF	(Moreira and Bjorndal, 2006)
Central Atlantic Ocean		
Ascension Island, UK	3,500 AF	(Broderick et al., 2006)
Eastern Atlantic Ocean		
Poilao Island, Guinea-Bissau	7,000-29,000 AN	(Catry et al., 2009)
Bioko Island, Equatorial Guinea	1,255-1,681 AN	(Tomas et al., 1999)
Mediterranean Sea		
Turkey	214-231 AF	(Broderick et al., 2002)
Cyprus	121-127 AF	(Broderick et al., 2002)
Israel / Palestine	1-3 AF	(Kuller, 1999)
Syria	100 AN	(Rees et al., 2005)
Western Indian Ocean		
Eparces Islands	2,000-11,000 AF	(Le Gall et al., 1986)
Comoros Islands	5,000 AF	S. Ahamada, pers. comm. 2001
Seychelles Islands	3,535-4,755 AF	J. Mortimer, pers. comm. 2002
Kenya	200-300 AF	(Okemwa and Wamukota, 2006)
Northern Indian Ocean		

Ras al Hadd, Oman	44,000 AN	S. Al-Saady, pers. comm. 2007
Sharma, Yemen	15 AF	(Saad, 1999)
Karan Island, Saudi Arabia	408-559 AF	(Pilcher, 2000)
Jana and Juraid Islands, Saudi Arabia	643 AN	(Pilcher, 2000)
Hawkes Bay and Sandspit, Pakistan	600 AN	(Asrar, 1999)
Gujarat, India	461 AN	(Sunderraj et al., 2006)
Sri Lanka	184 AF	(Kapurisinghe, 2006)
Eastern Indian Ocean		
Thamihla Kyun, Myanmar	<250,000 EH	(Thorbjarnarson et al., 2000)
Pangumbahan, Indonesia	400,000 EH	(Schulz, 1987)
Suka Made, Indonesia	395 AN	C. Limpus, pers. comm. 2002
Western Australia	3,000-30,000 AN	R. Prince, pers. comm. 2001
Southeast Asia		
Gulf of Thailand	250 AN	Charuchinda pers. comm. 2001
Vietnam	239 AF	(Hamann et al., 2006)
Berau Islands, Indonesia	4,000-5,000 AF	(Schulz, 1984)
Turtle Islands, Philippines	1.4 million EP	(Cruz, 2002)
Sabah Turtle Islands, Malaysia	8,000 AN	(Chan, 2006)
Sipadan, Malaysia	800 AN	(Chan, 2006)
Sarawak, Malaysia	2,000 AN	(Liew, 2002)
Enu Island (Aru Islands)	540 AF	Dethmers, in preparation
Terengganu, Malaysia	2,200 AN	(Chan, 2006)
Western Pacific Ocean		
Heron Island, Australia	560 AF	(Limpus et al., 2002)
Raine Island, Australia	25,000 AF	(Limpus et al., 2003)

Guam	45 AF	(Cummings, 2002)
Ogasawara Islands, Japan	500 AF	(Chaloupka et al., 2007)
Central and Eastern Pacific Ocean		
French Frigate Shoals, Hawaii	400 AF	(Balazs and Chaloupka, 2006)
Michoacán, Mexico	1,395 AF	C. Delgado, pers. comm. 2006
Central American Coast	184-344 AN	(López and Arauz, 2003)
Galapagos Islands, Ecuador	1,650 AF	(Zárate et al., 2006)

Growth and reproduction. Most green sea turtles exhibit particularly slow growth rates, which have been attributed to their largely plant-eating diet (Bjorndal, 1982). Growth rates of juveniles vary substantially among populations, ranging from <1 cm/year (Green 1993) to >5 cm/year (McDonald Dutton and Dutton, 1998), likely due to differences in diet quality, duration of foraging season (Chaloupka et al., 2004), and density of turtles in foraging areas (Balazs and Chaloupka, 2004; Bjorndal et al., 2000; Seminoff et al., 2002b). If individuals do not feed sufficiently, growth is stunted and apparently does not compensate even when greater-than-needed resources are available (Roark et al., 2009). In general, there is a tendency for green sea turtles to exhibit monotonic growth (declining growth rate with size) in the Atlantic and non-monotonic growth (growth spurt in mid size classes) in the Pacific, although this is not always the case (Balazs and Chaloupka, 2004; Chaloupka and Musick, 1997; Seminoff et al., 2002b). It is estimated that green sea turtles reach a maximum size just under 100 cm in carapace length (Tanaka, 2009). A female-bias has been identified from studies of green sea turtles (Wibbels, 2003).

Consistent with slow growth, age-to-maturity for green sea turtles appears to be the longest of any sea turtle species and ranges from ~20-40 years or more (Chaloupka et al., 2004; Chaloupka and Musick, 1997; Hirth, 1997; Limpus and Chaloupka, 1997; Seminoff et al., 2002b; Zug et al., 2002; Zug and Glor, 1998). Estimates of reproductive longevity range from 17 to 23 years (Carr et al., 1978; Chaloupka et al., 2004; Fitzsimmons et al., 1995). Considering that mean duration between females returning to nest ranges from 2 to 5 years (Hirth, 1997), these reproductive longevity estimates suggest that a female may nest 3 to 11 seasons over the course of her life. Based on reasonable means of three nests per season and 100 eggs per nest (Hirth, 1997), a female may deposit 9 to 33 clutches, or about 900 to 3,300 eggs, during her lifetime.

Once hatched, sea turtles emerge and orient towards a light source, such as light shining off the ocean. They enter the sea in a “frenzy” of swimming activity, which decreases rapidly in the first few hours and gradually over the first several weeks (Ischer et al., 2009; Okuyama et al., 2009). Factors in the ocean environment have a major influence on reproduction (Chaloupka, 2001; Limpus and Nicholls, 1988; Solow et al., 2002). It is also apparent that during years of heavy nesting activity, density dependent factors (beach crowding and digging up of eggs by nesting females) may impact hatchling production (Tiwari et al., 2005, 2006). Precipitation, proximity to the high tide line, and nest depth can also significantly affect nesting success (Cheng et al., 2009). Precipitation can also be significant in sex determination, with greater nest

moisture resulting in a higher proportion of males (Leblanc and Wibbels, 2009). Green sea turtles often return to the same foraging areas following nesting migrations (Broderick et al., 2006; Godley et al., 2002). Once there, they move within specific areas, or home ranges, where they routinely visit specific localities to forage and rest (Godley et al., 2003; Makowski et al., 2006; Seminoff and Jones, 2006; Seminoff et al., 2002a; Taquet et al., 2006). It is also apparent that some green sea turtles remain in pelagic habitats for extended periods, perhaps never recruiting to coastal foraging sites (Pelletier et al., 2003).

In general, survivorship tends to be lower for juveniles and subadults than for adults. Adult survivorship has been calculated to range from 0.82-0.97 versus 0.58-0.89 for juveniles (Chaloupka and Limpus, 2005; Seminoff et al., 2003; Troëng and Chaloupka, 2007), with lower values coinciding with areas of human impact on green sea turtles and their habitats (Bjorndal et al., 2003; Campbell and Lagueux, 2005).

Migration and movement. Green sea turtles are highly mobile and undertake complex movements through geographically disparate habitats during their lifetimes (Musick and Limpus, 1997; Plotkin, 2003). The periodic migration between nesting sites and foraging areas by adults is a prominent feature of their life history. After departing as hatchlings and residing in a variety of marine habitats for 40 or more years (Limpus and Chaloupka, 1997), green sea turtles make their way back to the same beach from which they hatched (Carr et al., 1978; Meylan et al., 1990). Green sea turtles spend the majority of their lives in coastal foraging grounds. These areas include both open coastline and protected bays and lagoons. While in these areas, green sea turtles rely on marine algae and seagrass as their primary dietary constituents, although some populations also forage heavily on invertebrates. There is some evidence that individuals move from shallow seagrass beds during the day to deeper areas at night (Hazel, 2009).

Habitat. Green turtles appear to prefer waters that usually remain around 20º C in the coldest month, but may occur considerably north of these regions during warm-water events, such as El Niño. Stinson (1984) found green turtles to appear most frequently in U.S. coastal waters with temperatures exceeding 18º C. Further, green sea turtles seem to occur preferentially in drift lines or surface current convergences, probably because of the prevalence of cover and higher prey densities that associate with flotsam. For example, in the western Atlantic Ocean, drift lines commonly containing floating *Sargassum* spp. are capable of providing juveniles with shelter (NMFS and USFWS, 1998a). Underwater resting sites include coral recesses, the underside of ledges, and sand bottom areas that are relatively free of strong currents and disturbance. Available information indicates that green turtle resting areas are near feeding areas (Bjorndal and Bolten, 2000). Strong site fidelity appears to be a characteristic of juveniles green sea turtles along the Pacific Baja coast (Senko et al., 2010).

Green sea turtles in the Gulf of Mexico tend to remain along the coast (lagoons, channels, inlets, and bays), with nesting primarily occurring in Florida and Mexico and infrequent nesting in all other areas (Landry and Costa, 1999; Meylan et al., 1995; NMFS and USFWS, 1991a; USAF, 1996). Foraging areas seem to be based upon seagrass and macroalgae abundance, such as in the Laguna Madre of Texas. However, green sea turtles may also occur in offshore regions, particularly during migration and development.

Feeding. While offshore and sometimes in coastal habitats, green sea turtles are not obligate plant-eaters as widely believed, and instead consume invertebrates such as jellyfish, sponges, sea pens, and pelagic prey (Godley et al., 1998; Hatase et al., 2006; Heithaus et al., 2002; Parker and

Balazs, in press; Seminoff et al., 2002a). A shift to a more herbivorous diet occurs when individuals move into neritic habitats, as vegetable mater replaces an omnivorous diet at around 59 cm in carapace length off Mauritania (Cardona et al., 2009).

Diving. Based on the behavior of post-hatchlings and juvenile green turtles raised in captivity, we presume that those in pelagic habitats live and feed at or near the ocean surface, and that their dives do not normally exceed several meters in depth (Hazel et al., 2009; NMFS and USFWS, 1998a). Recent data from Australia indicate green sea turtles rarely dive deep, staying in upper 8 m of the water column (Hazel et al., 2009). Here, daytime dives were shorter and shallower than were nighttime dives. Also, time spent resting and dive duration increased significantly with decreases in seasonal water temperatures. The maximum recorded dive depth for an adult green turtle was just over 106 m (Berkson, 1967), while subadults routinely dive to 20 m for 9-23 min, with a maximum recorded dive of over 1 h (Brill et al., 1995; I-Jiunn, 2009). Green sea turtles along Taiwan may rest during long, shallow dives (I-Jiunn, 2009). Dives by females may be shorter in the period leading up to nesting (I-Jiunn, 2009).

Status and trends. Federal listing of the green sea turtle occurred on July 28, 1978, with all populations listed as threatened except for the Florida and Pacific coast of Mexico breeding populations, which are endangered (43 FR 32800). The International Union for Conservation of Nature (IUCN) has classified the green turtle as "endangered."

No trend data are available for almost half of the important nesting sites, where numbers are based on recent trends and do not span a full green sea turtle generation, and impacts occurring over four decades ago that caused a change in juvenile recruitment rates may have yet to be manifested as a change in nesting abundance. The numbers also only reflect one segment of the population (nesting females), who are the only segment of the population for which reasonably good data are available and are cautiously used as one measure of the possible trend of populations.

Table 9 summarizes nesting abundance for 46 nesting sites worldwide. These include both large and small rookeries believed to be representative of the overall trends for their respective regions. Based on the mean annual reproductive effort, 108,761-150,521 females nest each year among the 46 sites. Overall, of the 26 sites for which data enable an assessment of current trends, 12 nesting populations are increasing, 10 are stable, and four are decreasing. Long-term continuous datasets of 20 years are available for 11 sites, all of which are either increasing or stable. Despite the apparent global increase in numbers, the positive overall trend should be viewed cautiously because trend data are available for just over half of all sites examined and very few data sets span a full green sea turtle generation (Seminoff, 2004).

Pacific Ocean. Green turtles are thought to be declining throughout the Pacific Ocean, with the exception of Hawaii, from a combination of overexploitation and habitat loss (Eckert, 1993; Seminoff et al., 2002a). In the western Pacific, the only major (>2,000 nesting females) populations of green turtles occur in Australia and Malaysia, with smaller colonies throughout the area. Indonesian nesting is widely distributed, but has experienced large declines over the past 50 years. Hawaii green turtles are genetically distinct and geographically isolated, and the population appears to be increasing in size despite the prevalence of fibropapillomatosis and spirochidiasis (Aguirre et al., 1998).

All other areas. Nesting populations are doing relatively well in the western Atlantic and central Atlantic Ocean. In contrast, populations are doing relatively poorly in Southeast Asia, the eastern Indian Ocean, and perhaps the Mediterranean.

Natural threats. Herons, gulls, dogfish, and sharks prey upon hatchlings. Adults face predation primarily by sharks and to a lesser extent by killer whales. All sea turtles except leatherbacks can undergo "cold stunning" if water temperatures drop below a threshold level, which can be lethal. For unknown reasons, the frequency of a disease called fibropapillomatosis is much higher in green sea turtles than in other species and threatens a large number of existing subpopulations. Extremely high incidence has been reported in Hawaii, where affliction rates peaked at 47-69% in some foraging areas (Murakawa et al., 2000). A to-date unidentified virus may aid in the development of fibropapillomatosis (Work et al., 2009). Predators (primarily of eggs and hatchlings) also include dogs, pigs, rats, crabs, sea birds, reef fishes, and groupers (Bell et al., 1994; Witzell, 1981). Green sea turtles with an abundance of barnacles have been found to have a much greater probability of having health issues (Flint et al., 2009).

Anthropogenic threats. Major anthropogenic impacts to the nesting and marine environment affect green sea turtle survival and recovery. At nesting beaches, green sea turtles rely on intact dune structures, native vegetation, and normal beach temperatures for nesting (Ackerman, 1997). Structural impacts to nesting habitat include the construction of buildings and pilings, beach armoring and renourishment, and sand extraction (Bouchard et al., 1998; Lutcavage et al., 1997b). These factors may directly, through loss of beach habitat, or indirectly, through changing thermal profiles and increasing erosion, serve to decrease the amount of nesting area available to nesting females, and may evoke a change in the natural behaviors of adults and hatchlings (Ackerman, 1997; Witherington et al., 2003, 2007). The presence of lights on or adjacent to nesting beaches alters the behavior of nesting adults (Witherington, 1992) and is often fatal to emerging hatchlings as they are attracted to light sources and drawn away from the water (Witherington and Bjorndal, 1991). In addition to impacting the terrestrial zone, anthropogenic disturbances also threaten coastal marine habitats, particularly areas rich in seagrass and marine algae. These impacts include contamination from herbicides, pesticides, oil spills, and other chemicals, as well as structural degradation from excessive boat anchoring and dredging (Francour et al., 1999; Lee Long et al., 2000; Waycott et al., 2005). Ingestion of plastic and other marine debris is another source of morbidity and mortality (Stamper et al., 2009). Green sea turtles stranded in Brazil were all found to have ingested plastics or fishing debris (n=34), although mortality appears to have results in three cases (Tourinho et al., 2009). Low-level bycatch has also been documented in longline fisheries (Petersen et al., 2009). Further, the introduction of alien algae species threatens the stability of some coastal ecosystems and may lead to the elimination of preferred dietary species of green sea turtles (De Weede, 1996).

Sea level rise may have significant impacts upon green turtle nesting on Pacific atolls. These low-lying, isolated locations could be inundated by rising water levels associated with global warming, eliminating nesting habitat (Baker et al., 2006; Fuentes et al., 2010). Fuentes et al. (2010) predicted that rising temperatures would be a much greater threat in the long term to the hatching success of sea turtle turtles in general and green sea turtles along northeastern Australia particularly. Green sea turtles emerging from nests at cooler temperatures likely absorb more yolk that is converted to body tissue than do hatchlings from warmer nests (Ischer et al., 2009). Predicted temperature rises may approach or exceed the upper thermal tolerance limit of sea turtle incubation, causing widespread failure of nests (Fuentes et al., 2010). Although the timing

of loggerhead nesting depends upon sea-surface temperature, green sea turtles do not appear to be affected (Pike, 2009).

Green sea turtles have been found to contain the organochlorines chlordane, lindane, endrin, endosulfan, dieldrin, DDT and PCB (Gardner et al., 2003; Miao et al., 2001). Levels of PCBs found in eggs are considered far higher than what is fit for human consumption (van de Merwe et al., 2009). The heavy metals copper, lead, manganese, cadmium, and nickel have also been found in various tissues and life stages (Barbieri, 2009). Arsenic also occurs in very high levels in green sea turtle eggs (van de Merwe et al., 2009). These contaminants have the potential to cause deficiencies in endocrine, developmental, and reproductive health, and depress immune function in loggerhead sea turtles (Keller et al. 2006; Storelli et al. 2007). Exposure to sewage effluent may also result in green sea turtle eggs harboring antibiotic-resistant strains of bacteria (Al-Bahry et al., 2009). DDE has not been found to influence sex determination at levels below cytotoxicity (Keller and McClellan-Green, 2004; Podreka et al., 1998). To date, no tie has been found between pesticide concentration and susceptibility to fibropapillomatosis, although degraded habitat and pollution have been tied to the incidence of the disease (Aguirre et al., 1994; Foley et al., 2005). Flame retardants have been measured from healthy individuals (Hermanussen et al., 2008). It has been theorized that exposure to tumor-promoting compounds produced by the cyanobacteria *Lyngbya majuscule* could promote the development of fibropapillomatosis (Arthur et al., 2008). It has also been theorized that dinoflagellates of the genus *Prorocentrum* that produce the tumorogenic compound okadoic acid may influence the development of fibropapillomatosis (Landsberg et al., 1999).

Critical habitat. On September 2, 1998, critical habitat for green sea turtles was designated in coastal waters surrounding Culebra Island, Puerto Rico (63 FR 46693). Aspects of these areas that are important for green sea turtle survival and recovery include important natal development habitat, refuge from predation, shelter between foraging periods, and food for green sea turtle prey.

Hawksbill sea turtle

Distribution. The hawksbill has a circumglobal distribution throughout tropical and, to a lesser extent, subtropical waters of the Atlantic, Indian, and Pacific oceans. Satellite tagged turtles have shown significant variation in movement and migration patterns. In the Caribbean, distance traveled between nesting and foraging locations ranges from a few kilometers to a few hundred kilometers (Byles and Swimmer, 1994; Hillis-Starr et al., 2000; Horrocks et al., 2001; Lagueux et al., 2003; Miller et al., 1998; Prieto et al., 2001).

Population designation. Populations are distinguished generally by ocean basin and more specifically by nesting location. Our understanding of population structure is relatively poor. For example, genetic analysis of hawksbill sea turtles foraging off the Cape Verde Islands identified three closely-related haplotypes in a large majority of individuals sampled that did not match those of any known nesting population in the Western Atlantic, where the vast majority of nesting has been documented (McClellan et al., 2010; Monzon-Arguello et al., 2010).

Migration and movement. Upon first entering the sea, neonatal hawksbills in the Caribbean are believed to enter an oceanic phase that may involve long distance travel and eventual recruitment to nearshore foraging habitat (Boulon, 1994). In the marine environment, the oceanic phase of juveniles (i.e., the "lost years") remains one of the most poorly understood aspects of hawksbill life history, both in terms of where turtles occur and how long they remain oceanic.

Habitat. Hawksbill sea turtles are highly migratory and use a wide range of broadly separated localities and habitats during their lifetimes (Musick and Limpus, 1997; Plotkin, 2003). Small juvenile hawksbills (5-21 cm straight carapace length) have been found in association with *Sargassum* spp. in both the Atlantic and Pacific oceans (Musick and Limpus, 1997) and observations of newly hatched hawksbills attracted to floating weed have been made (Hornell, 1927; Mellgren and Mann, 1996; Mellgren et al., 1994). Post-oceanic hawksbills may occupy a range of habitats that include coral reefs or other hard-bottom habitats, sea grass, algal beds, mangrove bays and creeks (Bjorndal and Bolten, 2010; Musick and Limpus, 1997), and mud flats (R. von Brandis, unpublished data in NMFS and USFWS, 2007b). Individuals of multiple breeding locations can occupy the same foraging habitat (Bass, 1999; Bowen et al., 1996; Bowen et al., 2007; Diaz-Fernandez et al., 1999; Velez-Zuazo et al., 2008). As larger juveniles, some individuals may associate with the same feeding locality for more than a decade, while others apparently migrate from one site to another (Blumenthal et al., 2009a; Mortimer et al., 2003; Musick and Limpus, 1997). Larger individuals may prefer deeper habitats than their smaller counterparts (Blumenthal et al., 2009a).

Hawksbill sea turtles appear to be rare visitors to the Gulf of Mexico, with Florida being the only Gulf state with regular sightings (Hildebrand, 1983; NMFS and USFWS, 1993; Rabalais and Rabalais, 1980; Rester and Condrey, 1996; Witzell, 1983). Individuals stranded in Texas are generally young (hatchlings or yearlings) originating from Mexican nesting beaches (Amos, 1989; Collard and Ogren, 1990; Hildebrand, 1983; Landry and Costa, 1999).

Feeding. Dietary data from oceanic stage hawksbills are limited, but indicate a combination of plant and animal material (Bjorndal, 1997).

Diving. Hawksbill diving ability varies with age and body size. As individuals increase with age, diving ability in terms of duration and depth increases (Blumenthal et al., 2009b). Studies of hawksbills in the Caribbean have found diurnal diving behavior, with dive duration nearly twice as long during nighttime (35-47 min) compared to daytime (19-26 min Blumenthal et al., 2009b; Van Dam and Diez, 1997). Daytime dives averaged 5 m, while nighttime dives averaged 43 m (Blumenthal et al., 2009b)

Hawksbills have long dive durations, although dive depths are not particularly deep. Adult females along St. Croix reportedly have average dive times of 56 min, with a maximum time of 73.5 min (Starbird et al., 1999). Average day and night dive times were 34–65 and 42–74 min, respectively. Immature individuals have much shorter dives of 8.6–14 min to a mean depth of 4.7 m while foraging (Van Dam and Diez, 1997).

Status and trends. Hawksbill sea turtles received protection on June 2, 1970 (35 FR 8495) under the Endangered Species Conservation Act and since 1973 have been listed as endangered under the ESA. Although no historical records of abundance are known, hawksbill sea turtles are considered to be severely depleted due to the fragmentation and low use of current nesting beaches (NMFS and USFWS, 2007b). Worldwide, an estimated 21,212-28,138 hawksbills nest each year among 83 sites. Among the 58 sites for with historic trends, all show a decline during the past 20 to 100 years. Among 42 sites for which recent trend data are available, 10 (24%) are increasing, three (7%) are stable and 29 (69%) are decreasing.

Atlantic Ocean. Atlantic nesting sites include: Antigua (Jumby Bay), the Turks and Caicos, Barbados, the Bahamas, Puerto Rico (Mona Island), the U.S. Virgin Islands, the Dominican Republic, Sao Tome, Guadaloupe, Trinidad and Tobago, Jamaica, Martinique, Cuba

(Doce Leguas Cays), Mexico (Yucatan Peninsula), Costa Rica (Tortuguero National Park), Guatemala, Venezuela, Bijagos Archipelago, Guinea-Bissau, and Brazil.

Population increase has been greater in the Insular Caribbean than along the Western Caribbean Mainland or the eastern Atlantic (including Sao Tomé and Equatorial Guinea). Nesting populations of Puerto Rico appeared to be in decline until the early 1990s, but have universally increased during the survey periods. Mona Island now hosts 199-332 nesting females annually, and the other sites combined host 51-85 nesting females annually (R.P. van Dam and C.E. Diez, unpublished data in NMFS and USFWS, 2007b) C.E. Diez, Chelonia, Inc., in litt. to J. Mortimer 2006). The U.S. Virgin Islands have a long history of tortoiseshell trade (Schmidt, 1916). At Buck Island Reef National Monument, protection has been in force since 1988, and during that time, hawksbill nesting has increased by 143% to 56 nesting females annually, with apparent spill over to beaches on adjacent St. Croix (Z. Hillis-Starr, National Park Service, in litt. to J. Mortimer 2006). However, St. John populations did not increase, perhaps due to the proximity of the legal turtle harvest in the British Virgin Islands (Z. Hillis-Starr, National Park Service, in litt. to J. Mortimer 2006). Populations have also been identified in Belize and Brazil as genetically unique (Hutchinson and Dutton, 2007). An estimated 50-200 nests are laid per year in the Guinea-Bissau (Catry et al., 2009).

Pacific Ocean. American Samoa and Western Samoa host fewer than 30 females annually (Grant et al., 1997; Tuato'o-Bartley et al., 1993). In Guam, only 5-10 females are estimated to nest annually (G. Balazs, NMFS, in litt. to J. Mortimer 2007; G. Davis, NMFS, in litt. to J. Mortimer 2007) and the same is true for Hawaii, but there are indications that this population is increasing (G. Balazs, pers. comm. in NMFS and USFWS, 2007b). Additional populations are known from the eastern Pacific (potentially extending from Mexico through Panama), northeastern Australia, and Malaysia (Hutchinson and Dutton, 2007).

Indian Ocean. The Indian Ocean hosts several populations of hawksbill sea turtles (Hutchinson and Dutton, 2007; Spotila, 2004a). These include western Australian, Andaman and Nicobar islands, Maldives, Seychelles, Burma, East Africa, Egypt, Oman, Saudi Arabia, Sudan, and Yemen.

Natural threats. Sea turtles face predation primarily by sharks and to a lesser extent by killer whales. All sea turtles except leatherbacks can undergo “cold stunning” if water temperatures drop below a threshold level, which can be lethal. The only other significant natural threat to hawksbill sea turtles is from hybridization of hawksbills with other species of sea turtles. This is especially problematic at certain sites where hawksbill numbers are particularly low (Mortimer and Donnelly, in review). Predators (primarily of eggs and hatchlings) include dogs, pigs, rats, crabs, sea birds, reef fishes, groupers, feral cats, and foxes (Bell et al., 1994; Ficetola, 2008). In some areas, nesting beaches can be almost completely destroyed and all nests can sustain some level of depredation (Ficetola, 2008).

Anthropogenic threats. Threats to hawksbill sea turtles are largely anthropogenic, both historically and currently. Impacts to nesting beaches include the construction of buildings and pilings, beach armoring and renourishment, and sand extraction (Bouchard et al., 1998; Lutcavage et al., 1997b). Because hawksbills prefer to nest under vegetation (Horrocks and Scott, 1991; Mortimer, 1982), they are particularly impacted by beachfront development and clearing of dune vegetation (Mortimer and Donnelly, in review). The presence of lights on or adjacent to nesting beaches alters the behavior of nesting adults (Witherington, 1992) and is

often fatal to emerging hatchlings as they are attracted to light sources and drawn away from the water (Witherington and Bjorndal, 1991). One of the most detrimental human threats to hawksbill sea turtles is the intensive harvest of eggs from nesting beaches.

In addition to impacting the terrestrial zone, anthropogenic disturbances also threaten coastal marine habitats. These impacts include contamination from herbicides, pesticides, oil spills, and other chemicals, as well as structural degradation from excessive boat anchoring and dredging (Francour et al., 1999; Lee Long et al., 2000; Waycott et al., 2005). Hawksbills are typically associated with coral reefs, which are among the world's most endangered marine ecosystems (Wilkinson, 2000). Although primarily spongivorous, bycatch of hawksbill sea turtles in the swordfish fishery off South Africa occurs (Petersen et al., 2009).

Future impacts from climate change and global warming may result in significant changes in hatchling sex ratios. The fact that hawksbill turtles exhibit temperature-dependent sex determination (Wibbels, 2003) suggests that there may be a skewing of future hawksbill cohorts toward strong female bias (since warmer temperatures produce more female embryos).

Critical habitat. On September 2, 1998, the NMFS established critical habitat for hawksbill sea turtles around Mona and Monito Islands, Puerto Rico (63 FR 46693). Aspects of these areas that are important for hawksbill sea turtle survival and recovery include important natal development habitat, refuge from predation, shelter between foraging periods, and food for hawksbill sea turtle prey.

Kemp's ridley sea turtle

Distribution. The Kemp's ridley was formerly known only from the Gulf of Mexico and along the Atlantic coast of the U.S. (TEWG, 2000). However, recent records support Kemp's ridley sea turtles distribution extending into the Mediterranean Sea on occasion (Tomas and Raga, 2008). The vast majority of individuals stem from breeding beaches at Rancho Nuevo on the Gulf of Mexico coast of Mexico.

Movement and migration. Tracking of post-nesting females from Rancho Nuevo and Texas beaches indicates that turtles move along coastal migratory corridors either to the north or south from the nesting beach (Byles, 1989b; Byles and Plotkin, 1994; Renaud, 1995b; Renaud et al., 1996; Shaver, 1999, 2002). These migratory corridors appear to extend throughout the coastal areas of the Gulf of Mexico and most turtles appear to travel in waters less than roughly 164 feet in depth. Turtles that headed north and east traveled as far as southwest Florida, whereas those that headed south and east traveled as far as the Yucatan Peninsula, Mexico (Morreale et al., 2007).

Following migration, Kemp's ridley sea turtles settle into resident feeding areas for several months (Byles and Plotkin, 1994; Morreale et al., 2007). Females may begin returning along relatively shallow migratory corridors toward the nesting beach in the winter in order to arrive at the nesting beach by early spring.

Reproduction. Mating is believed to occur about three to four weeks prior to the first nesting (Rostal, 2007), or late March through early to mid April. It is presumed that most mating takes place near the nesting beach (Morreale et al., 2007; Rostal, 2007). Females initially ovulate within a few days after successful mating and lay the first clutch approximately two to four weeks later; if a turtle nests more than once per season, subsequent ovulations occur within approximately 48 hours after each nesting (Rostal, 2007).

Approximately 60% of Kemp's ridley nesting occurs along an approximate 25-mile stretch of beach near Rancho Nuevo, Tamaulipas, Mexico from April to July, with limited nesting to the north (100 nests along Texas in 2006) and south (several hundred nests near Tampico, Mexico in 2006 USFWS, 2006). Nesting at this location may be particularly important because hatchlings can more easily migrate to foraging grounds (Putman et al., 2010). The Kemp's ridley sea turtle tends to nest in large aggregations or arribadas (Bernardo and Plotkin, 2007). The period between Kemp's ridley arribadas averages approximately 25 days, but the precise timing of the arribadas is unpredictable (Bernardo and Plotkin, 2007; Rostal et al., 1997). Like all sea turtles, Kemp's ridley sea turtles nest multiple times in a single nesting season. The most recent analysis suggests approximately 3.075 nests per nesting season per female (Rostal, 2007). The annual average number of eggs per nest (clutch size) is 94 to 100 and eggs typically take 45 to 58 days to hatch, depending on temperatures (Marquez-M., 1994; Rostal, 2007; USFWS, 2000, 2001, 2002, 2003, 2004, 2005, 2006). The period between nesting seasons for each female is approximately 1.8 to 2.0 years (Marquez et al., 1989; Rostal, 2007; TEWG, 2000). The nesting beach at Rancho Nuevo may produce a "natural" hatchling sex ratio that is female-biased, which can potentially increase egg production as those turtles reach sexual maturity (Coyne and Landry Jr., 2007; Wibbels, 2007).

Growth. Kemp's ridleys require approximately 1.5 to two years to grow from a hatchling to a size of approximately 7.9 inches long, at which size they are capable of making a transition to a benthic coastal immature stage, but can range from one to four years or more (Caillouet et al., 1995; Ogren, 1989; Schmid, 1998; Schmid and Witzell, 1997; Snover et al., 2007; TEWG, 2000; Zug et al., 1997). Based on the size of nesting females, it is assumed that turtles must attain a size of approximately 23.6 inches long prior to maturing (Marquez-M., 1994). Growth models based on mark-recapture data suggest that a time period of seven to nine years would be required for this growth from benthic immature to mature size (Schmid and Witzell, 1997; Snover et al., 2007). Currently, age to sexual maturity is believed to range from approximately 10 to 17 years for Kemp's ridleys (Snover et al., 2007). However, estimates of 10 to 13 years predominate in previous studies (Caillouet et al., 1995; Schmid and Witzell, 1997; TEWG, 2000).

Habitat. Stranding data indicate that immature turtles in this benthic stage are found in coastal habitats of the entire Gulf of Mexico and U.S. Atlantic coast (Morreale et al., 2007; TEWG, 2000). Developmental habitats for juveniles occur throughout the entire coastal Gulf of Mexico and U.S. Atlantic coast northward to New England (Morreale et al., 2007; Schmid, 1998; Wibbels et al., 2005). Key foraging areas in the Gulf of Mexico include Sabine Pass, Texas; Caillou Bay and Calcasieu Pass, Louisiana; Big Gulley, Alabama; Cedar Keys, Florida; and Ten Thousand Islands, Florida (Carr and Caldwell, 1956; Coyne et al., 1995; Ogren, 1989; Schmid, 1998; Schmid et al., 2002; Witzell et al., 2005). Foraging areas studied along the Atlantic coast include Pamlico Sound, Chesapeake Bay, Long Island Sound, Charleston Harbor, and Delaware Bay. Near-shore waters of 120 feet or less provide the primary marine habitat for adults, although it is not uncommon for adults to venture into deeper waters (Byles, 1989a; Mysing and Vanselous, 1989; Renaud et al., 1996; Shaver et al., 2005; Shaver and Wibbels, 2007b).

Benthic coastal waters of Louisiana and Texas seem to be preferred foraging areas for Kemp’s ridley sea turtles (particularly passes and beachfronts), although individuals may travel along the entire coastal margin of the Gulf of Mexico (Landry and Costa, 1999; Landry et al., 1996; Renaud, 1995a). Sightings are less frequent during winter and spring, but this is likely due to lesser sighting effort during these times (Keinath et al., 1996; Shoop and Kenney, 1992).

Feeding. Kemp's ridley diet consists mainly of swimming crabs, but may also include fish, jellyfish, and an array of mollusks.

Diving. Kemp's ridley sea turtles can dive from a few seconds in duration to well over two and a half hours, although most dives are from 16 to 34 minutes (Mendonca and Pritchard, 1986; Renaud, 1995b). Individuals spend the vast majority of their time underwater; over 12-hour periods, 89% to 96% of their time is spent below the surface (Byles, 1989b; Gitschlag, 1996).

Status and trends. The Kemp's ridley sea turtle was listed as endangered on December 2, 1970 (35 FR 18319). Internationally, the Kemp's ridley is considered the most endangered sea turtle (NRC, 1990b; USFWS, 1999).

During the mid 20th century, the Kemp's ridley was abundant in the Gulf of Mexico. Historic information indicates that tens of thousands of Kemp's ridleys nested near Rancho Nuevo, Mexico, during the late 1940s (Hildebrand, 1963). From 1978 through the 1980s, arribadas were 200 turtles or less, and by 1985, the total number of nests at Rancho Nuevo had dropped to approximately 740 for the entire nesting season, or a projection of roughly 234 turtles (TEWG, 2000; USFWS and NMFS, 1992). Beginning in the 1990s, an increasing number of beaches in Mexico were being monitored for nesting, and the total number of nests on all beaches in Tamaulipas and Veracruz in 2002 was over 6,000; the rate of increase from 1985 to 1999 was 11.3% annually (TEWG, 2000; USFWS, 2002). In 2006, approximately 7,866 nests were laid at Rancho Nuevo with the total number of nests for all the beaches in Mexico estimated at about 12,000 nests, which amounted to about 4,000 nesting females based upon three nests per female per season (Rostal, 2007; Rostal et al., 1997; USFWS, 2006). Considering remigration rates, the population included approximately 7,000 to 8,000 adult female turtles at that time (Marquez et al., 1989; Rostal, 2007; TEWG, 2000). The 2007 nesting season included an arribada of over 4,000 turtles over a three-day period at Rancho Nuevo (P. Burchfield, pers. comm. in NMFS and USFWS, 2007a). A noticeable drop in nesting occurred in 2010, but it is unknown if this was an anomaly or the start of a new trend. The increased recruitment of new adults is illustrated in the proportion of first time nesters, which has increased from 6% in 1981 to 41% in 1994. Average population growth was estimated at 13% per year between 1991 and 1995 (TEWG, 1998a). Nesting has also expanded geographically, with a headstart program reestablishing nesting on South Padre Island starting in 1978. Growth remained slow until 1988, when rates of return started to grow slowly (Shaver and Wibbels, 2007a). In 2006, 101 nests were laid compared to 51 the year before (NPS, 2006).

Natural threats. Sea turtles face predation primarily by sharks and to a lesser extent by killer whales. All sea turtles except leatherbacks can undergo "cold stunning" if water temperatures drop below a threshold level, which can pose lethal effects. Kemp's ridley sea turtles are particularly prone to this phenomenon along Cape Cod (Innis et al., 2009).

Anthropogenic threats. Population decline has been curtailed due to the virtual elimination of sea turtle and egg harvesting, as well as assistance in hatching and raising hatchlings (head-start). However, habitat destruction remains a concern in the form of bottom trawling and shoreline development. Trawling destroys habitat utilized by Kemp's ridley sea turtles for feeding and construction activities can produce hazardous runoff. Bycatch is also a source of mortality for Kemp's ridley sea turtles (McClellan et al., 2009).

Toxin burdens in Kemp's ridley sea turtles include DDT, DDE, PCBs, PFOA, PFOS, chlordane, and other organochlorines (Keller et al., 2005; Keller et al., 2004a; Lake et al., 1994; Rybitski et

al., 1995). These contaminants have the potential to cause deficiencies in endocrine, developmental and reproductive health, and are known to depress immune function in loggerhead sea turtles (Keller et al., 2006; Storelli et al., 2007b). Along with loggerheads, Kemp's ridley sea turtles have higher levels of PCB and DDT than leatherback and green sea turtles (Pugh and Becker, 2001b). Organochlorines, including DDT, DDE, DDD, and PCBs have been identified as bioaccumulative agents and in greatest concentration in subcutaneous lipid tissue (Rybitski et al., 1995). Concentrations ranged from 7.46 mu g/kg to 607 mu g/kg, with a mean of 252 mu g/kg in lipid tissue. Five PCB congeners composed most of the contaminants: 153/132, 138/158, 180, 118, and 187 in order of concentration. PCBs have also been identified in the liver, ranging in concentration from 272 ng/g to 655 ng/g of wet weight, values that are several fold higher than in other sea turtle species (Lake et al., 1994). However, concentrations are reportedly 5% of that which causes reproductive failure in snapping turtles. DDE was identified to range from 137 ng/g to 386 ng/g wet weight. Trans-nonachlor was found at levels between 129 ng/g and 275 ng/g wet weight. Blood samples may be appropriate proxies for organochlorines in other body tissues (Keller et al., 2004a).

Perfluorinated compounds in the forms of PFOA and PFOS have been identified in the blood of Kemp's ridley turtles at concentrations of 39.4 ng/mL and 3.57 ng/mL, respectively (Keller et al., 2005). PFCAs have also been detected. It is likely that age and habitat are linked to PFC bioaccumulation.

Oil can also be hazardous to Kemp's ridley turtles, with fresh oil causing significant mortality and morphological changes in hatchlings, but aged oil having no detectable effects (Fritts and McGehee, 1981). Blood levels of metals are lower in Kemp's ridley sea turtles than in other sea turtles species or similar to them, with copper (215 ng/g to 1,300 ng/g), lead (0 to 34.3 ng/g), mercury (0.5 ng/g to 67.3 ng/g), silver (0.042 ng/g to 2.74 ng/g), and zinc (3,280 ng/g to 18,900 ng/g) having been identified (Innis et al., 2008; Orvik, 1997). It is likely that blood samples can be used as an indicator of metal concentration. Mercury has been identified in all turtle species studied, but are generally an order of magnitude lower than toothed whales. The higher level of contaminants found in Kemp's ridley sea turtles are likely due to this species tendency to feed higher on the food chain than other sea turtles. Females from sexual maturity through reproductive life should have lower levels of contaminants than males because contaminants are shared with progeny through egg formation.

Critical habitat. NMFS has not designated critical habitat for Kemp's ridley sea turtle.

Loggerhead Sea Turtle

Distribution. Loggerheads are circumglobal occurring throughout the temperate and tropical regions of the Atlantic, Pacific, and Indian oceans. Loggerheads are the most abundant species of sea turtle found in U.S. coastal waters.

Population designations. On March 16, 2010, the NMFS proposed to designate nine distinct population segments (DPSs) of loggerhead sea turtles: South Atlantic Ocean and southwest Indian Ocean as threatened as well as Mediterranean Sea, North Indian Ocean, North Pacific Ocean, northeast Atlantic Ocean, northwest Atlantic Ocean, South Pacific Ocean, and southeast Indo-Pacific Ocean as endangered (75 FR 12598). Only the endangered northwest Atlantic Ocean DPS is likely to occur in the action area.

Atlantic Ocean. Western Atlantic nesting locations include The Bahamas, Brazil, and

numerous locations from the Yucatán Peninsula to North Carolina (Addison, 1997; Addison and Morford, 1996; Marcovaldi and Chaloupka, 2007). This group comprises five nesting subpopulations: Northern, Southern, Dry Tortugas, Florida Panhandle, and Yucatán. Additional nesting occurs on Cay Sal Bank (Bahamas), Cuba, the Bahamian Archipelago, Quintana Roo (Yucatan Peninsula), Colombia, Brazil, Caribbean Central America, Venezuela, and the eastern Caribbean Islands. Genetic studies indicate that, although females routinely return to natal beaches, males may breed with females from multiple populations and facilitate gene flow Bowen et al. (2005). In the eastern Atlantic, we know of five rookeries from Cape Verde, Greece, Libya, Turkey, and the western Africa coast.

Indian Ocean. Loggerhead sea turtles nest along the Indian Ocean in Oman, Yemen, Sri Lanka, Madagascar, South Africa, and possibly Mozambique.

Pacific Ocean. Pacific Ocean rookeries are limited to the western portion of the basin. These sites include Australia, New Caledonia, New Zealand, Indonesia, Japan, and the Solomon Islands.

Population structure in the Pacific is comprised of a northwestern Pacific nesting aggregation in Japan and a smaller southwestern nesting aggregation in Australia and New Caledonia (NMFS, 2006e). Genetics of Japanese nesters suggest that this subpopulation is comprised of genetically distinct nesting colonies (Hatase et al., 2002a). Almost all loggerheads in the North Pacific seem to stem from Japanese nesting beaches (Bowen et al. 1995; Resendiz et al. 1998). The fidelity of nesting females to their nesting beach allowed differentiation of these subpopulations and the loss of nesting at a beach means a significant loss of diversity and the beach is unlikely to be recolonized (NMFS, 2006e).

Reproduction and growth. Loggerhead nesting is confined to lower latitudes temperate and subtropic zones but absent from tropical areas (NMFS and USFWS, 1991b; NRC, 1990c; Witherington et al., 2006). The life cycle of loggerhead sea turtles can be divided into seven stages: eggs and hatchlings, small juveniles, large juveniles, subadults, novice breeders, first year emigrants, and mature breeders (Crouse et al., 1987). Hatchling loggerheads migrate to the ocean (to which they are drawn by near ultraviolet light Kawamura et al., 2009), where they are generally believed to lead a pelagic existence for as long as 7-12 years (NMFS, 2005). Loggerheads in the Mediterranean, similar to those in the Atlantic, grow at roughly 11.8 cm/yr for the first six months and slow to roughly 3.6 cm/yr at age 2.5-3.5. As adults, individuals may experience a secondary growth pulse associated with shifting into neritic habitats, although growth is generally monotypic (declines with age Casale et al., 2009a; Casale et al., 2009b). Individually-based variables likely have a high impact on individual-to-individual growth rates (Casale et al., 2009b). At 15-38 years, loggerhead sea turtles become sexually mature, although the age at which they reach maturity varies widely among populations (Casale et al., 2009b; Frazer and Ehrhart, 1985; NMFS, 2001; Witherington et al., 2006).

Loggerhead mating likely occurs along migration routes to nesting beaches, as well as in offshore from nesting beaches several weeks prior to the onset of nesting (Dodd, 1988a; NMFS and USFWS, 1998d). Females usually breed every 2-3 years, but can vary from 1-7 years (Dodd, 1988a; Richardson et al., 1978). Females lay an average of 4.1 nests per season (Murphy and Hopkins, 1984) , although recent satellite telemetry from nesting females along southwest Florida support 5.4 nests per female per season, with increasing numbers of eggs per nest during the course of the season (Tucker, 2009). The authors suggest that this finding warrants revision

of the number of females nesting in the region. The western Atlantic breeding season is March-August.

The Japanese rookeries are the most significant nesting sites for loggerheads in the North Pacific, with nesting occurring on the Japanese mainland, except for Hokkaido, as well as the Ryukyu Islands to the south (Kamezaki, 1989; Kamezaki et al., 2003; Sea Turtle Association of Japan, 2010; Uchida and Nishiwaki, 1995). Nesting generally occurs through summer and fall (April-August, peaking in July), with females returning every two to three years (Iwamoto et al., 1985). Nesting females lay at least three nests of 60-115 eggs per nest each season, with roughly two weeks between nests (Eckert, 1993; Iwamoto et al., 1985; Nishimura, 1994). Between nests, females appear to swim offshore into the Kuroshio Current, possibly to speed egg development (NMFS and USFWS, 1998b; Sato et al., 1998).

Nesting in the Gulf of Mexico does occur, although primarily in Florida, with rare nests do occur along North and South Padre Island in Texas (Dodd, 1988b; Hildebrand, 1983).

Migration and movement. Loggerhead hatchlings migrate offshore and become associated with *Sargassum* spp. habitats, driftlines, and other convergence zones (Carr, 1986). After 14-32 years of age, they shift to a benthic habitat, where immature individuals forage in the open ocean and coastal areas along continental shelves, bays, lagoons, and estuaries (Bowen et al., 2004; NMFS, 2001). Adult loggerheads make lengthy migrations from nesting beaches to foraging grounds (TEWG, 1998b). In the Gulf of Mexico, larger females tend to disperse more broadly after nesting than smaller individuals, which tend to stay closer the nesting location (Girard et al., 2009). In the North Atlantic, loggerheads travel north during spring and summer as water temperatures warm and return south in fall and winter, but occur offshore year-round assuming adequate temperature. For immature individuals, this movement occurs in two patterns: a north-south movement over the continental shelf with migration south of Cape Hatteras in winter and movement north along Virginia for summer foraging, and a not-so-seasonal oceanic dispersal into the Gulf Stream as far north as the 10-15˚ C isotherm (Mansfield et al., 2009). Wallace et al. (2009) suggested differences in growth rate based upon these foraging strategies. There is conflicting evidence that immature loggerheads roam the oceans in currents and eddies and mix from different natal origins or distribute on a latitudinal basis that corresponds with their natal beaches (Monzon-Arguello et al., 2009; Wallace et al., 2009). McCarthy et al. (2010) found that movement patterns of loggerhead sea turtles were more convoluted when sea surface temperatures were higher, ocean depths shallower, ocean currents stronger, and chlorophyll a levels lower.

Individuals in the western Pacific also show wide-ranging movements. Loggerheads hatched on beaches in the southwest Pacific travel have been found to range widely in the southern portion of the basin, with individuals from populations nesting in Australia found as far east as Peruvian coast foraging areas still in the juvenile stage (Boyle et al., 2009). Individuals hatched along Japanese coasts have been found to migrate to waters off Baja California via the North Pacific Subtropical Gyre (and the Kuroshio Extension) to feed for several years before migrating back to western Pacific waters to breed (Bowen et al., 1995; Nichols, 2005; Polovina et al., 2006; Polovina et al., 2000; Resendiz et al., 1998). Adult loggerheads also reside in oceanic waters off Japan (Hatase et al., 2002b). Habitat use off Japan may further be partitioned by sex and size (Hatase et al., 2002b; Hatase and Sakamoto, 2004; Hatase et al., 2002c). Loggerheads returning to Japanese waters seem to migrate along nutrient-rich oceanic fronts (Kobayashi et al., 2008; Nichols et al., 2000; Polovina et al., 2000). Individuals bycaught and satellite tracked in Hawaii

longline fisheries show individual movement north and south within a thermal range of 15-25º C, or 28-40º N, with juveniles following the 17-20º C isotherm (Kobayashi et al., 2008; Nichols et al., 2000; Polovina et al., 2004). The Transition Zone Chlorophyll Front and Kuroshio Extension Current are likely important foraging areas for juvenile loggerheads (Polovina et al., 2004). The Kuroshio Current off Japan may be significant for juvenile and adult loggerheads as a wintering areas for those individuals not migrating south (Hatase et al., 2002c).

Sighting and stranding records support loggerhead sea turtles to be common, year-round residents of the Gulf of Mexico, although their abundance is much greater in the northeastern region versus the northwestern (Davis et al., 2000; Fritts et al., 1983; Landry and Costa, 1999). Loggerheads may occur in both offshore habitats (particularly around oil platforms and reefs, where prey and shelter are available; (Davis et al., 2000; Fritts et al., 1983; Gitschlag and Herczeg, 1994; Lohoefener et al., 1990; Rosman et al., 1987), as well as shallow bays and sounds (which may be important developmental habitat for late juveniles in the eastern Gulf of Mexico; (Davis et al., 2000; Lohoefener et al., 1990; USAF, 1996). Offshore abundance in continental slope waters increases during the winter in the eastern Gulf of Mexico, as cooler inshore waters force individuals into warmer offshore areas (Davis et al., 2000).

Gender, age, and survivorship. Although information on males is limited, several studies identified a female bias, although a single study has found a strong male bias to be possible (Dodd, 1988a; NMFS, 2001; Rees and Margaritoulis, 2004).

Additionally, little is known about longevity, although Dodd (1988a) estimated the maximum female life span at 47-62 years. Heppell et al. (2003) estimated annual survivorship to be 0.81 (southeast U.S. adult females), 0.78-0.91 (Australia adult females), 0.68-0.89 (southeast U.S. benthic juveniles, and 0.92 (Australia benthic juveniles). Survival rates for hatchlings during their first year are likely very low (Heppell et al., 2003).

Feeding. Loggerhead sea turtles are omnivorous and opportunistic feeders through their lifetimes (Parker et al., 2005). Hatchling loggerheads feed on macroplankton associated with *Sargassum* spp. communities (NMFS and USFWS, 1991b). Pelagic and benthic juveniles forage on crabs, mollusks, jellyfish, and vegetation at or near the surface (Dodd, 1988a; Wallace et al., 2009). Loggerheads in the deep, offshore waters of the western North Pacific feed on jellyfish, salps, and other gelatinous animals (Dodd Jr., 1988; Hatase et al., 2002b). Sub-adult and adult loggerheads prey on benthic invertebrates such as gastropods, mollusks, and decapod crustaceans in hard-bottom habitats, although fish and plants are also occasionally eaten (NMFS and USFWS, 1998d). Stable isotope analysis and study of organisms on turtle shells has recently shown that although a loggerhead population may feed on a variety of prey, individuals composing the population have specialized diets (Reich et al., 2010; Vander Zanden et al., 2010).

Diving. Loggerhead diving behavior varies based upon habitat, with longer surface stays in deeper habitats than in coastal ones. Off Japan, dives were shallower than 30 m (Sakamoto et al., 1993). Routine dives can last 4–172 min (Byles, 1988; Renaud and Carpenter, 1994; Sakamoto et al., 1990). The maximum-recorded dive depth for a post-nesting female was over 230 m, although most dives are far shallower (9-21 m(Sakamoto et al., 1990). Loggerheads tagged in the Pacific over the course of 5 months showed that about 70% of dives are very shallow (<5 m) and 40% of their time was spent within 1 m of the surface (Polovina et al., 2003; Spotila, 2004a). During these dives, there were also several strong surface temperature fronts that individuals were associated with, one of 20° C at 28° N latitude and another of 17° C at 32°

N latitude.

Status and trends. Loggerhead sea turtles were listed as threatened under the ESA of 1973 on July 28, 1978 (43 FR 32800). The NMFS completed a status review of loggerhead sea turtles in 2009 and as a result, published a proposed rule in 2010 to establish nine distinct population segments of loggerhead sea turtles worldwide, two of them as threatened and seven as endangered (75 FR 12598).

There is general agreement that the number of nesting females provides a useful index of the species' population size and stability at this life stage, even though there are doubts about the ability to estimate the overall population size (Bjorndal et al., 2005). An important caveat for population trends analysis based on nesting beach data is that this may reflect trends in adult nesting females, but it may not reflect overall population growth rates well. Adult nesting females often account for less than 1% of total population numbers. The global abundance of nesting female loggerhead turtles is estimated at 43,320–44,560 (Spotila, 2004b).

Atlantic Ocean. In the eastern Atlantic, the Cape Verde Islands support the only known loggerhead nesting assemblage, which is of at least intermediate size (Fretey, 2001). In 2000, researchers tagged over 1,000 nesting females (Erhart et al., 2003). Annual data from monitoring projects in Cyprus, Greece, Israel, Tunisia, and Turkey reveal total annual nesting in the Mediterranean ranging of 3,375-7,085 nests per season (Margaritoulis et al., 2003). Libya and the West African coast host genetically-unique breeding populations of loggerhead sea turtles as well (Hutchinson and Dutton, 2007). A recently discovered nesting site along the southern Italian shores of the Ionian Sea found particularly high genetic diversity amongst nesting females (Garofalo et al., 2009). Nesting at Dalyan Beach, Turkey does not have an apparent trend, with between 50 and 286 nests laid annually for the past 19 years (Turkozan and Yilmaz, 2008).

The greatest concentration of loggerheads occurs in the northwestern DPS, ranging in the Atlantic Ocean and the adjacent Caribbean Sea, primarily on the Atlantic coast of Florida, with other major nesting areas located on the Yucatán Peninsula of Mexico, Columbia, Cuba, South Africa (EuroTurtle 2006 as cited in LGL Ltd., 2007; Márquez, 1990).

Among the five subpopulations, loggerhead females lay 53,000-92,000 nests per year in the southeastern U.S. and the Gulf of Mexico, and the total number of nesting females is 32,000-56,000. All of these are currently in decline or data are insufficient to access trends (NMFS, 2001; TEWG, 1998a). Loggerheads from western North Atlantic nesting aggregations may or may not feed in the same regions from which they hatch. Loggerhead sea turtles from the northern nesting aggregation, which represents about 9% of the loggerhead nests in the western North Atlantic, comprise 25-59% of individuals foraging from Georgia up to the northeast U.S. (Bass et al., 1998; Norrgard, 1995; Rankin-Baransky, 1997; Sears, 1994; Sears et al., 1995). Loggerheads associated with the South Florida nesting aggregation occur in higher frequencies in the Gulf of Mexico (where they represent ~10% of the loggerhead captures) and the Mediterranean Sea (where they represent ~45% of loggerhead sea turtles captured). About 4,000 nests per year are laid along the Brazilian coast (Ehrhart et al., 2003).

Because of its size, the south Florida subpopulation of loggerheads may be critical to the survival of the species in the Atlantic, and in the past it was considered second in size only to the Oman nesting aggregation (NMFS, 2006e; NMFS and USFWS, 1991b). The South Florida population increased at ~5.3% per year from 1978-1990, and was initially increasing at 3.9-4.2% after 1990.

An analysis of nesting data from 1989-2005, a period of more consistent and accurate surveys than in previous years, showed a detectable trend and, more recently (1998-2005), has shown evidence of a declining trend of approximately 22.3% (FFWCC, 2007a, b; Witherington et al., 2009). This is likely due to a decline in the number of nesting females within the population (Witherington et al., 2009). Nesting data from the Archie Carr Refuge (one of the most important nesting locations in southeast Florida) over the last 6 years shows nests declined from approximately 17,629 in 1998 to 7,599 in 2004, also suggesting a decrease in population size[1]. Loggerhead nesting is thought to consist of just 60 nesting females in the Caribbean and Gulf of Mexico (NMFS, 2006f). Based upon the small sizes of almost all nesting aggregations in the Atlantic, the large numbers of individuals killed in fisheries, and the decline of the only large nesting aggregation, we suspect that the extinction probabilities of loggerhead sea turtle populations in the Atlantic are only slightly lower than those of populations in the Pacific.

Pacific Ocean. Abundance has declined dramatically over the past 10-20 years, although loggerheads range widely from Alaska to Chile (NMFS and USFWS, 1998d). Pacific nesting is limited to two major locations, Australia and Japan. Eastern Australia supported one of the major global loggerhead nesting assemblages until recently (Limpus, 1985). Now, less than 500 females nest annually, an 86% reduction in the size of the annual nesting population in 23 years (Limpus and Limpus, 2003). The status of loggerhead nesting colonies in southern Japan and the surrounding region is uncertain, but approximately 1,000 female loggerhead turtles may nest there; a 50-90% decline compared to historical estimates (Bolten et al., 1996; Dodd Jr., 1988; Kamezaki et al., 2003; STAJ, 2002). In addition, loggerheads uncommonly occur in U.S. Pacific waters, and there have been no documented strandings of loggerheads on the Hawaiian Islands in nearly 20 years (1982-1999 stranding data). There are very few records of loggerheads nesting on any of the many islands of the central Pacific, and the species is considered rare or vagrant in this region (USFWS, 1998). Overall, Gilman (2009) estimated that the number of loggerheads nesting the Pacific has declined by 80% in the past 20 years.

Indian Ocean. The largest known nesting aggregation occurs on Masirah and Kuria Muria Islands in Oman (Ross and Barwani, 1982). Extrapolations resulting from partial surveys and tagging in 1977-1978 provided broad estimates of 19,000-60,000 females nesting annually at Masirah Island, while a more recent partial survey in 1991 provided an estimate of 23,000 nesting females (Baldwin, 1992; Ross, 1979, 1998; Ross and Barwani, 1982). Over 3,000 nests per year have been recorded on the Al-Halaniyat Islands, while along the Oman mainland of the Arabian Sea, about 2,000 nests are deposited per year (Salm, 1991; Salm et al., 1993). Based upon genetic analyses, additional populations nest in Yemen, Sri Lanka, and Madagascar (Hutchinson and Dutton 2007). In the southwestern Indian Ocean, the highest concentration of nesting occurs on the coast of Tongaland, South Africa (Baldwin et al. 2003). The total number of females nesting annually in South Africa is estimated to be between 500-2,000 (Baldwin et al., 2003). An estimated 800-1,500 loggerheads nest annually on Dirk Hartog Island beaches along Western Australia (Baldwin et al., 2003).

Natural threats. Sea turtles face predation primarily by sharks and to a lesser extent by killer whales. All sea turtles except leatherbacks can undergo "cold stunning" if water temperatures

1 While this is a long period of decline relative to the past observed nesting pattern at this location, aberrant ocean surface temperatures complicate the analysis and interpretation of these data. Although caution is warranted in interpreting the decreasing nesting trend given inherent annual fluctuations in nesting and the short time period over which the decline has been noted, the recent nesting decline at this nesting beach is reason for concern.

drop below a threshold level, which can pose lethal effects. Eggs are commonly eaten by raccoons and ghost crabs along the eastern U.S. (Barton and Roth, 2008). In the water, hatchlings are hunted by herons, gulls, dogfish, and sharks. Heavy loads of barnacles are associated with unhealthy or dead stranded loggerheads (Deem et al., 2009).

Anthropogenic threats. Anthropogenic threats impacting loggerhead nesting habitat are numerous: coastal development and construction, placement of erosion control structures, beachfront lighting, vehicular and pedestrian traffic, sand extraction, beach erosion, beach nourishment, beach pollution, removal of native vegetation, and planting of non-native vegetation (Baldwin, 1992; Margaritoulis et al., 2003; Mazaris et al., 2009b; USFWS, 1998). Surprisingly, beach nourishment also hampers nesting success, but only in the first year post-nourishment before hatching success increases (Brock et al., 2009). Loggerhead sea turtles face numerous threats in the marine environment as well, including oil and gas exploration, marine pollution, trawl, purse seine, hook and line, gill net, pound net, longline, and trap fisheries, underwater explosions, dredging, offshore artificial lighting, power plant entrapment, entanglement in debris, ingestion of marine debris, marina and dock construction and operation, boat collisions, and poaching.

The major factors inhibiting their recovery include mortalities caused by fishery interactions and degradation of the beaches on which they nest. Shrimp trawl fisheries account for the highest number of captured and killed loggerhead sea turtles. Along the Atlantic coast of the U.S., the NMFS estimated that shrimp trawls capture almost 163,000 loggerhead sea turtles each year in the Gulf of Mexico, of which 3,948 die. Each year, various fisheries capture about 2,000 loggerhead sea turtles in Pamlico Sound, of which almost 700 die. Along Baja California, it is estimated that 1,500-2,950 loggerheads are killed annually by local fishing fleets (Peckham et al., 2008). Offshore longline tuna and swordfish longline fisheries are also a serious concern for the survival and recovery of loggerhead sea turtles and appear to affect the largest individuals more than younger age classes (Aguilar et al., 1995; Bolten et al., 1994; Carruthers et al., 2009; Howell et al., 2008; Marshall et al., 2009; Petersen et al., 2009; Tomás et al., 2008). Deliberate hunting of loggerheads for their meat, shells, and eggs has declined from previous exploitation levels, but still exists and hampers recovery efforts. In the Pacific, loggerhead turtles are captured, injured, or killed in numerous Pacific fisheries including

- Japanese longline fisheries in the western Pacific Ocean and South China Seas
- direct harvest and commercial fisheries off Baja California, Mexico
- commercial and artisanal swordfish fisheries off Chile, Columbia, Ecuador, and Peru
- purse seine fisheries for tuna in the eastern tropical Pacific Ocean
- California/Oregon drift gillnet fisheries (NMFS, 2006e)

Wallace et al. (2010) estimated that between 1990 and 2008, at least 85,000 sea turtles were captured as bycatch in fisheries worldwide. This estimate is likely at least two orders of magnitude low, resulting in a likely bycatch of nearly half a million sea turtles annually (Wallace et al., 2010); many of these are expected to be loggerhead sea turtles.

Climate change may also have significant implications on loggerhead populations worldwide. In addition to potential loss of nesting habitat due to sea level rise, loggerhead sea turtles are very sensitive to temperature as a determinant of sex while incubating. Ambient temperature increase

by just 1º-2º C can potentially change hatchling sex ratios to all or nearly all female in tropical and subtropical areas (Hawkes et al., 2007). Over time, this can reduce genetic diversity, or even population viability, if males become a small proportion of populations (Hulin et al., 2009). Sea surface temperatures on loggerhead foraging grounds correlate to the timing of nesting, with higher temperatures leading to earlier nesting (Mazaris et al., 2009a; Schofield et al., 2009). Increasing ocean temperatures may also lead to reduced primary productivity and eventual food availability. This has been proposed as partial support for reduced nesting abundance for loggerhead sea turtles in Japan; a finding that could have broader implications for other populations in the future if individuals do not shift feeding habitat (Chaloupka et al., 2008). Warmer temperatures may also decrease the energy needs of a developing embryo (Reid et al., 2009).

Tissues taken from loggerheads sometimes contain very high levels of organochlorines chlorobiphenyl, chlordanes, lindane, endrin, endosulfan, dieldrin, PFOS, PFOA, DDT, and PCB (Alava et al., 2006; Corsolini et al., 2000; Gardner et al., 2003; Keller et al., 2005; Keller et al., 2004a; Keller et al., 2004b; McKenzie et al., 1999; Monagas et al., 2008; Oros et al., 2009; Perugini et al., 2006; Rybitski et al., 1995; Storelli et al., 2007a). It appears that levels of organochlorines have the potential to suppress the immune system of loggerhead sea turtles and may affect metabolic regulation (Keller et al., 2004c; Keller et al., 2006; Oros et al., 2009). These contaminants could cause deficiencies in endocrine, developmental, and reproductive health (Storelli et al., 2007a). It is likely that the omnivorous nature of loggerheads makes them more prone to bioaccumulating toxins than other sea turtle species (Godley et al., 1999; McKenzie et al., 1999).

Heavy metals, including arsenic, barium, cadmium, chromium, iron, lead, nickel, selenium, silver, copper, zinc, and manganese, have also been found in a variety of tissues in levels that increase with turtle size (Anan et al., 2001; Fujihara et al., 2003; Garcia-Fernandez et al., 2009; Gardner et al., 2006; Godley et al., 1999; Saeki et al., 2000; Storelli et al., 2008). These metals likely originate from plants and seem to have high transfer coefficients (Anan et al., 2001; Celik et al., 2006; Talavera-Saenz et al., 2007).

Loggerhead sea turtles have higher mercury levels than any other sea turtle studied, but concentrations are an order of magnitude less than many toothed whales (Godley et al., 1999; Pugh and Becker, 2001a). Arsenic occurs at levels several fold more concentrated in loggerhead sea turtles than marine mammals or seabirds.

Also of concern is the spread of antimicrobial agents from human society into the marine environment. Loggerhead sea turtles may harbor antibiotic-resistant bacteria, which may have developed and thrived as a result of high use and discharge of antimicrobial agents into freshwater and marine ecosystems (Foti et al., 2009).

Critical habitat. The NMFS has not designated critical habitat for loggerhead sea turtles.

Environmental baseline

By regulation, environmental baselines for Opinions include the past and present impacts of all state, federal, or private actions and other human activities in the action area, the anticipated impacts of all proposed federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions that are contemporaneous with the consultation in process (50 CFR §402.02). The *Environmental baseline* for this Opinion

includes the effects of several activities affecting the survival and recovery of ESA-listed sea turtle species in the action area.

Climate change

We primarily discuss climate change as a threat common to all species addressed in this Opinion, rather than in each of the species-specific narratives. As we better understand responses to climate change, we will address these effects in the relevant species-specific section.

In general, based on forecasts made by the Intergovernmental Panel on Climate Change, climate change is projected to have substantial direct and indirect effects on individuals, populations, species, and the structure and function of marine, coastal, and terrestrial ecosystems in the near future (IPCC, 2000, 2001a, b, 2002). From 1906 to 2006, global surface temperatures have risen 0.74º C and continue at an accelerating pace; 11 or the 12 warmest years on record since 1850 have occurred since 1995 and the past decade has been the warmest in instrumental history (Arndt et al., 2010; Poloczanska et al., 2009). Furthermore, the Northern Hemisphere (where a greater proportion of ESA-listed species occur) is warming faster than the Southern Hemisphere, although land temperatures are rising more rapidly than over the oceans (Poloczanska et al., 2009). The direct effects of climate change will result in increases in atmospheric temperatures, changes in sea surface temperatures, patterns of precipitation, and sea level. Oceanographic models project a weakening of the thermohaline circulation resulting in a reduction of heat transport into high latitudes of Europe, an increase in the mass of the Antarctic ice sheet, and a decrease in the Greenland ice sheet, although the magnitude of these changes remain unknown. Species that are shorter-lived, larger body size, or generalist in nature are liable to be better able to adapt to climate change over the long term versus those that are longer-lived, smaller-sized, or rely upon specialized habitats (Brashares, 2003; Cardillo, 2003; Cardillo et al., 2005; Issac, 2009; Purvis et al., 2000). Climate change is most likely to have its most pronounced affects on species whose populations are already in tenuous positions (Isaac, 2008). As such, we expect the risk of extinction to listed species to rise with the degree of climate shift associated with global warming.

The indirect effects of climate change would result from changes in the distribution of temperatures suitable for reproduction, the distribution and abundance of prey and abundance of competitors or predators. For species that undergo long migrations, individual movements are usually associated with prey availability or habitat suitability. If either is disrupted by changing ocean temperature regimes, the timing of migration can change or negatively impact population sustainability (Simmonds and Eliott., 2009). For sea turtles, warming ocean temperatures may extend poleward the habitat which they can utilize (Poloczanska et al., 2009). However, seagrass habitats have declined by 29% in the last 130 years and 19% of coral reefs have been lost due to human degradation, reducing lower latitude habitat for some sea turtle species (Poloczanska et al., 2009). Primary production is estimated to have declined by 6% between the early 1980s and 2010, making foraging more difficult for marine species (Hoegh-Guldberg and Bruno, 2010).

Foraging is not the only potential aspect that climate change could influence. Acevedo-Whitehouse and Duffus (2009) proposed that the rapidity of environmental changes, such as those resulting from global warming, can harm immunocompetence and reproductive parameters in wildlife to the detriment of population viability and persistence. An example of this is the altered sex ratios observed in sea turtle populations worldwide (Fuentes et al., 2009a; Mazaris et al., 2008; Reina et al., 2008; Robinson et al., 2008). This does not appear to have yet affected

population viabilities through reduced reproductive success, although average nesting and emergence dates have changed over the past several decades by days to weeks in some locations (Poloczanska et al., 2009). Altered ranges can also result in the spread of novel diseases to new areas via shifts in host ranges (Simmonds and Eliott., 2009). It has also been suggested that increases in harmful algal blooms could be a result from increases in sea surface temperature (Simmonds and Eliott., 2009).

Changes in global climatic patterns will likely have profound effects on the coastlines of every continent by increasing sea levels and the intensity, if not the frequency, of hurricanes and tropical storms {Wilkinson, 2008 #14459}. A half degree Celsius increase in temperatures during hurricane season from 1965 to 2005 correlated with a 40% increase in cyclone activity in the Atlantic. Sea levels have risen an average of 1.7 mm/year over the 20th century and 3.3 mm/year between 1993 and 2006 due to glacial melting and thermal expansion of ocean water; this rate will likely increase, which is supported by the latest data from 2009 (Hoegh-Guldberg and Bruno, 2010){Wilkinson, 2008 #14459}(Arndt et al., 2010). Based on computer models, these phenomena would inundate nesting beaches of sea turtles, change patterns of coastal erosion and sand accretion that are necessary to maintain those beaches, and would increase the number of turtle nests destroyed by tropical storms and hurricanes {Wilkinson, 2008 #14459}, although other areas might experience less frequent tropical activity and a subsequent reduction in tropical cyclone impacts to sea turtle nests (Fuentes and Abbs, 2010). The loss of nesting beaches, by itself, would have catastrophic effects on sea turtle populations globally if they are unable to colonize new beaches that form or if the beaches do not provide the habitat attributes (sand depth, temperatures regimes, and refuge) necessary for egg survival. In some areas, increases in sea level alone may be sufficient to inundate sea turtle nests and reduce hatching success (Caut et al., 2009). Storms may also cause direct harm to sea turtles, causing “mass” strandings and mortality (Poloczanska et al., 2009). Increasing temperatures in sea turtle nests alters sex ratios, reduces incubation times (producing smaller hatchlings), and reduces nesting success due to exceeded thermal tolerances (Fuentes et al., 2009b; Fuentes et al., 2010; Fuentes et al., 2009c). Smaller individuals likely experience increased predation (Fuentes et al., 2009b). Taken together, the body of literature on climate change supports widespread and significant negative consequences to sea turtle species.

Entrapment and entanglement in fishing gear

Fishery interaction remains a major factor in sea turtle recovery and, frequently, the lack there of. NMFS (2002) estimated that 62,000 loggerhead sea turtles have been killed as a result of incidental capture and drowning in shrimp trawl gear. Although turtle excluder devices and other bycatch reduction devices have significantly reduced the level of bycatch to sea turtles and other marine species in U.S. waters, mortality still occurs in Gulf of Mexico waters.

In addition to commercial bycatch, recreational hook-and-line interaction also occurs. Cannon and Flanagan (1996) reported that from 1993 to 1995, at least 170 Kemp’s ridley sea turtles were hooked or tangled by recreational hook-and-line gear in the northern Gulf of Mexico. Of these, 18 were dead stranded turtles, 51 were rehabilitated turtles, five died during rehabilitation, and 96 were reported as released by fishermen.

Commercial and subsistence harvest

Three of the biggest threats to sea turtles result from harvest for commercial and subsistence use. These include egg harvest, the harvest of females on nesting beaches, and directed hunting of sea

turtles in foraging areas. These factors have led to the precipitous declines in worldwide sea turtle populations. In the Atlantic, green sea turtles are captured and killed in turtle fisheries in Colombia, Grenada, the Lesser Antilles, Nicaragua, St. Vincent and the Grenadines; the turtle fishery along the Caribbean coast of Nicaragua, by itself, has captured more than 11,000 green sea turtles annually over the past decade (Bräutigam and Eckert, 2006; Lagueux, 1998). While these threats have been largely eliminated in Florida due to successful conservation measures, the hunting of juvenile and adult turtles continues both legally and illegally in many foraging areas where green sea turtles originating from Florida are known to occur (Chacon, 2002; Fleming, 2001). The killing of nesting hawksbill females continues to threaten the stability of hawksbill subpopulations in many areas. The centuries-old historic trade in tortoise shell greatly impacted hawksbill populations in the Insular Caribbean. Increases in nesting hawksbills in the region coincide with the decline of international trade in hawksbill shell (Milliken and Tokunaga, 1987), and in particular with the 90% reduction in the annual take of large hawksbills from Cuban waters (Carrillo et al., 1999).

Coastal development

A large number of coastal development activities can have adverse impacts on sea turtles. Most of these, such as construction of breakwaters and seawalls, lighting, building construction, and vehicular beach traffic are significant mostly or only for nesting sea turtles and their hatchlings. The action area does generally not host sea turtle nesting (or where it does, the establishment of state and national refuges limit or prevent human development), we focused on impacts to sea turtles in the marine environment, namely dredging activity. Dredging has been documented to capture or kill 168 sea turtles from 1995 to 2009 in the Gulf of Mexico, including 97 loggerheads, 35 Kemp’s ridleys, 32 greens, and three unidentified sea turtles (USACOE, 2010).

Oil and gas development

The northern Gulf of Mexico is the location of massive industrial activity associated with oil and gas extraction and processing. Over 4,000 oil and gas structures are located outside of state waters in the northern Gulf of Mexico; 90% of these occur off Louisiana and Texas (USN, 2009). This is both detrimental and beneficial for sea turtles. These structures appreciably increase the amount of hard substrate in the marine environment, providing shelter and foraging opportunities for species like loggerhead sea turtles (Parker et al., 1983; Stanley and Wilson, 2003). However, the Minerals Management Service requires that structures must be removed within one year of lease termination. Many of these structures are removed by explosively severing the underwater supportive elements, which produces a shock wave that kills, injures, or disrupts marine life in the blast radius (Gitschlag et al., 1997). For sea turtles, this means death or serious injury for individuals within a few hundred meters of the structure and overt behavioral (potentially physiological) impacts for individuals further out (Duronslet et al., 1986; Klima et al., 1988). Although observers and procedures are in place to mitigate impacts to sea turtles (i.e., not blasting when sea turtles are present), not all sea turtles are observed all the time and low-level sea turtle injury and mortality still occurs (Gitschlag and Herczeg, 1994; Gitschlag et al., 1997); two loggerheads were killed in August 2010 (G. Gitschlag, NOAA, pers. comm.). Current annual authorized takes due to MMS’ OCS oil and gas exploration, development, production, and abandonment activities are 30 sea turtles, including no more than one each of Kemp's ridley, green, hawksbill, or leatherback turtles and no more than ten loggerhead turtles (NMFS, 1988). These levels were far surpassed by the *Deepwater Horizon* incident (see oil

spills and releases below).

Pollution

The Gulf of Mexico is a sink for massive levels of pollution from a variety of marine and terrestrial sources, which ultimately can interfere with ecosystem health and particularly that of sea turtles (see *Status of listed resources* section). Sources include the petrochemical industry in and along the Gulf of Mexico, wastewater treatment plants, septic systems, industrial facilities, agriculture, animal feeding operations, and improper refuse disposal. The Mississippi River drains 80% of United States cropland (including the fertilizers, pesticides, herbicides, and other contaminants that are applied to it) and discharges into the Gulf of Mexico near the action area (MMS, 1998). Agricultural discharges, as well as discharges from large urban centers (ex.: Houston and New Orleans) contribute contaminants as well as coliform bacteria to Gulf of Mexico habitats (Garbarino et al., 1995). These contaminants can be carried long distances from terrestrial or nearshore sources and ultimately accumulate in offshore pelagic environments (USCOP, 2004). The ultimate impacts of this pollution are poorly understood.

Significant attention has been paid to nutrient enrichment of Gulf of Mexico waters, which leads to algal blooms (including harmful algal blooms), oxygen depletion, loss of seagrass and coral reef habitat, and the formation of a hypoxic "dead zone" (USCOP, 2004). This hypoxic event occurs annually from as early as February to as late as October, spanning roughly 12,700 km^2 (although in 2005 the "dead zone" grew to a record size of 22,000 km^2) from the Mississippi River Delta to Galveston, Texas (LUMCON, 2005; MMS, 1998; Rabalais et al., 2002; USGS, 2010). Although sea turtles do not extract oxygen from sea water, numerous staple prey items of sea turtles, such as fish, shrimp, and crabs, do and are killed by the hypoxic conditions (Craig et al., 2001). More generally, the "dead zone" decreases biodiversity, alters marine food webs, and destroys habitat (Craig et al., 2001; Rabalais et al., 2002). High nitrogen loads entering the Gulf of Mexico from the Mississippi River is the likely culprit; nitrogen concentrations entering the Gulf of Mexico have increased three fold over the past 60 years (Rabalais et al., 2002).

Marine debris is also a significant problem for the health of Gulf of Mexico ecosystems. For sea turtles, marine debris is a problem due primarily to individuals ingesting debris and blocking the digestive tract, causing death or serious injury (Laist et al., 1999; Lutcavage et al., 1997a). Gulko and Eckert (2003) estimated that between one-third and one-half of all sea turtles ingest plastic at some point in their lives; this figure is supported by data from Lazar and Gracan (Lazar and Gračan, 2010), who found 35% of loggerheads had plastic in their gut. A Brazilian study found that 60% of stranded green sea turtles had ingested marine debris (primarily plastic and oil; (Bugoni et al., 2001)). Loggerhead sea turtles had a lesser frequency of marine debris ingestion. Plastic is possibly ingested out of curiosity or due to confusion with prey items; for example, plastic bags can resemble jellyfish (Milton and Lutz, 2003). Marine debris consumption has been shown to depress growth rates in post-hatchling loggerhead sea turtles, elongating the time required to reach sexual maturity and increasing predation risk (McCauley and Bjorndal, 1999). Studies of shore cleanups have found that marine debris washing up along the northern Gulf of Mexico shoreline amounts to about 100 kg/km (ACC, 2010; LADEQ, 2010; MASGC, 2010; TGLO, 2010). Sea turtles can also become entangled and die in marine debris, such as discarded nets and monofilament line (Laist et al., 1999; Lutcavage et al., 1997a; NRC, 1990a; O'Hara et al., 1988).

Oil spills and releases

Oil pollution has been a significant concern in the Gulf of Mexico for several decades due to the large amount of extraction and refining activity in the region. Routine discharges into the northern Gulf of Mexico (not including oil spills) include roughly 88,200 barrels of petroleum per year from municipal and industrial wastewater treatment plants and roughly 19,250 barrels from produced water discharged overboard during oil and gas operations (MMS, 2007b; USN, 2008). These sources amount to over 100,000 barrels of petroleum discharged into the northern Gulf of Mexico annually. Although this is only 10% of the amount discharged in a major oil spill, such as the Exxon *Valdez* spill (roughly 1 million barrels), this represents a significant and "unseen" threat to Gulf of Mexico wildlife and habitats. Generally, accidental oil spills may amount to less than 24,000 barrels of oil discharged annually in the northern Gulf of Mexico, making non-spilled oil normally one of the leading sources of oil discharge into the Gulf of Mexico, although incidents such as the 2010 Deepwater Horizon incident are exceptional (MMS, 2007a). The other major source from year to year is oil naturally seeping into the northern Gulf of Mexico. Although exact figures are unknown, natural seapage is estimated at between 120,000 and 980,000 barrels of oil annually (MacDonald et al., 1993; MMS, 2007b).

Although non-spilled oil is the primary contributor to oil introduced into the Gulf of Mexico, concern over accidental oil spills is well-founded. Over five million barrels of oil and one million barrels of refined petroleum products are transported in the northern Gulf of Mexico daily (MMS, 2007b); worldwide, it is estimated that 900,000 barrels of oil are released into the environment as a result of oil and gas activities (Epstein and (Eds.). 2002). Even if a small fraction of the annual oil and gas extraction is released into the marine environment, major, concentrated releases can result in significant environmental impacts. Due to the density of oil extraction, transport, and refining facilities in the Houston/Galveston and Mississippi Delta areas (and the extensive activities taking place at these facilities), these locations have the greatest probability of experiencing oil spills. Oil released into the marine environment contains aromatic organic chemicals known to be toxic to a variety of marine life; these chemicals tend to dissolve into the air to a greater or lesser extent, depending upon oil type and composition (Yender et al., 2002). Solubility of toxic components is generally low, but does vary and can be relatively high (0.5-167 parts per billion; (Yender et al., 2002)). Use of dispersants can increase oil dispersion, raising the levels of toxic constituents in the water column, but speeding chemical degradation overall (Yender et al., 2002). The remaining oil becomes tar, which forms floating balls that can be transported thousands of kilometers into the North Atlantic. The most toxic chemicals associated with oil can enter marine food chains and bioaccumulate in invertebrates such as crabs and shrimp to a small degree (prey of some sea turtles (Law and Hellou, 1999; Marsh et al., 1992)), but generally do not bioaccumulate or biomagnify in finfish (Baussant et al., 2001; Meador et al., 1995; Varanasi et al., 1989; Yender et al., 2002). Sea turtles are known to ingest and attempt to ingest tar balls, which can block their digestive systems, impairing foraging or digestion and potentially causing death (NOAA, 2003). Dispersants reduce the formation of tar balls. Although the effects of dispersant chemicals on sea turtles is unknown, testing on other organisms have found currently used dispersants to be less toxic than those used in the past (NOAA, 2003). It is possible that dispersants can interfere with surfactants in the lungs (surfactants prevent the small spaces in the lungs from adhering together due to surface tension, facilitating large surface areas for gas exchange), as well as interfere with digestion, excretion, and salt gland function (NOAA, 2003). Oil exposure can also cause acute damage upon direct exposure to oil, including skin, eye, and respiratory irritation, reduced respiration, burns to mucous membranes such as the mouth and eyes, diarrhea, gastrointestinal ulcers and bleeding,

poor digestion, anemia, reduced immune response, damage to kidneys or liver, cessation of salt gland function, reproductive failure, and death (NOAA, 2003, 2010b; Vargo et al., 1986a, b, c). Nearshore spills or large offshore spills can oil beaches on which sea turtles lay their eggs, causing birth defects or mortality in the nests (NOAA, 2003, 2010b).

Several oil spills have impacted the northern Gulf of Mexico over the past few years, largely due to hurricanes. The impacts of Hurricane Ivan in 2004 on the Gulf Coast included pipeline damage causing 16,000 barrels of oil to be released and roughly 4,500 barrels of petroleum products from other sources (BOEMRE, 2010; USN, 2008). The next year, Hurricane Katrina caused widespread damage to onshore oil storage facilities, releasing 191,000 barrels of oil (LHR, 2010). Another 4,530 barrels of oil were released from 70 other smaller spills associated with hurricane damage. Shortly thereafter, Hurricane Rita damaged offshore facilities resulting in 8,429 barrels of oil to be released (USN, 2008).

Major oil spills have impacted the Gulf of Mexico for decades (NMFS, 2010). Until 2010, the largest oil spill in North America occurred in the Bay of Campeche (1979), when a well "blew out", allowing oil to flow into the marine environment for nine months, releasing 2.8-7.5 million barrels of oil. Oil from this release eventually reached the Texas coast, including the Kemp's ridley sea turtle nesting beach at Rancho Nuevo, where 9,000 hatchlings were airlifted and released offshore (NOAA, 2003). Over 7,600 m^3 of oiled sand was eventually removed from Texas beaches and 200 gallons of oil were removed from the area around Rancho Nuevo (NOAA, 2003). Eight dead and five live sea turtles were recovered during the oil spill event; although cause of deaths were not determined, oiling was suspected to play a part (NOAA, 2003). Also in 1979, the oil tanker *Burmah Agate* collided with another vessel near Galveston, Texas, causing an oil spill and fire that ultimately released 65,000 barrels of oil into estuaries, beachfronts, and marshland along the northern and central Texas coastline (NMFS, 2010). Clean-up of these areas was not attempted due to the environmental damage such efforts would have caused. Another 195,000 barrels of oil are estimated to have been burned in a multi-month-long fire aboard the *Burmah Agate* (NMFS, 2010). The tanker *Alvenus* grounded in 1984 near Cameron, Louisiana, spilling 65,500 barrels of oil which spread west along the shoreline to Galveston (NMFS, 2010). One oiled sea turtle was recovered and released (NOAA, 2003). In 1990, the oil tanker *Megaborg* experienced an accident near Galveston during the lightering process and released 127,500 barrels of oil, most of which burned off in the ensuing fire (NMFS, 2010).

On April 20, 2010, a fire and explosion occurred aboard the semisubmersible drilling platform *Deepwater Horizon* roughly 80 km southeast of the Mississippi Delta (NOAA, 2010a). The platform had 17,500 barrels of fuel aboard, which likely burned, escaped, or sank with the platform (NOAA, 2010a). However, once the platform sank, the riser pipe connecting the platform to the wellhead on the seafloor broke in multiple locations, initiating an uncontrolled release of oil from the exploratory well. Over the next three months, oil was released into the Gulf of Mexico, resulting in oiled regions of Texas, Louisiana, Mississippi, Alabama, and Florida and widespread oil slicks throughout the northern Gulf of Mexico that closed more than one-third of the Gulf of Mexico Exclusive Economic Zone to fishing due to contamination concerns. Apart from the widespread surface slick, massive undersea oil plumes formed, possibly through the widespread use of dispersants and reports of tarballs washing ashore throughout the region were common. Although estimates vary, NOAA has estimated that 4.9 million barrels of oil were released (Lubchenco et al., 2010). A total of 720 sea turtles have been

verified in the spill zone of which 172 were verified as having been exposed to oil (NOAA, 2010c). However, specific causes of injury or death have not yet been established for many of these individuals as investigations into the role of oil in these animals' health status continue.

Oil can also cause indirect effects to sea turtles through impacts to habitat and prey organisms. Seagrass beds may be particularly susceptible to oiling as oil contacts grass blades and sticks to them, hampering photosynthesis and gas exchange (Wolfe et al., 1988). If spill cleanup is attempted, mechanical damage to seagrass can result in further injury and long-term scarring. Loss of seagrass due to oiling would be important to green sea turtles, as this is a significant component of their diets (NOAA, 2003). The loss of invertebrate communities due to oiling or oil toxicity would also decrease prey availability for hawksbill, Kemp's ridley, and loggerhead sea turtles (NOAA, 2003). Furthermore, Kemp's ridley and loggerhead sea turtles, which commonly forage on crustaceans and mollusks, may ingest large amounts of oil due oil adhering to the shells of these prey and the tendency for these organisms to bioaccumulate toxins found in oil (NOAA, 2003). It is suspected that oil adversely impacted the symbiotic bacteria in the gut of herbivorous marine iguanas when the Galapagos Islands experienced an oil spill, contributing to a >60% decline in local populations the following year. The potential exists for green sea turtles to experience similar impacts, as they also harbor symbiotic bacteria to aid in their digestion of plant material (NOAA, 2003). Dispersants are believed to be as toxic to marine organisms as oil itself.

Hurricanes

The Gulf of Mexico is prone to major tropical weather systems, including tropical storms and hurricanes. The impacts of these storms on sea turtles in the marine environment is not known, but storms can cause major impacts to sea turtle eggs on land, as nesting frequently overlaps with hurricane season, particularly Kemp's ridley sea turtles (NRC, 1990a). Mortality can result both from drowning of individuals while still in the egg or emerging from the nest as well as causing major topographic alteration to beaches, preventing hatchling entry to marine waters. Kemp's ridley sea turtles are likely highly sensitive to hurricane impacts, as their only nesting locations are in a limited geographic area along southern Texas and northern Mexico (Milton et al., 1994). In 2010, Hurricane Alex made landfall in this area; surprisingly, few nests were lost (Jaime Pena, Gladys Porter Zoo, pers. comm.). Tropical storm Hermine arrived too late in 2010 to impact eggs or hatchlings at Rancho Nuevo (Donna Shaver, NPS, pers. comm.).

Shipstrike

Sea turtle shipstrikes are a poorly-studied threat to sea turtles, but has the potential to be highly-significant (Work et al., 2010). All sea turtles must surface to breath and several species are known to bask at the surface for long periods, including loggerhead sea turtles. Although sea turtles can move rapidly, sea turtles apparently are not well able to move out of the way of vessels moving at more than 4 km/hr; most vessels move far faster than this in open water (Hazel et al., 2007; Work et al., 2010). This, combined with the massive level of vessel traffic in the Gulf of Mexico, has the potential to result in frequent injury and mortality to sea turtles in the region (MMS, 2007b). Hazel et al. (2007) suggested that green sea turtles may use auditory cues to react to approaching vessels rather than visual cues, making them more susceptible to strike as vessel speed increases. Each state along the Gulf of Mexico has several hundred thousand recreational vessels registered, including Florida with nearly one million-the highest number of registered boats in the United States-and Texas with over 600,000- ranked sixth

nationally)(NMMA, 2007; USCG, 2003, 2005). Commercial vessel operations are also extensive. Vessels servicing the offshore oil and gas industry are estimated to make 115,675-147,175 trips annually, apart from commercial vessels travelling to and from some of the largest ports in the United States (such as New Orleans and Houston)(MMS, 2007a; USN, 2008).

Sea turtles may also be harassed by the high level of helicopter activity over Gulf of Mexico waters. It is estimated that between roughly 900,000 and 1.5 million helicopter take-offs and landings are undertaken in association with oil and gas activities in the Gulf of Mexico annually (NRC, 1990a; USN, 2008). This likely includes numerous overflights of sea turtles, an activity which has been observed to startle and at least temporarily displace sea turtles (USN, 2009).

Scientific and research activities

Scientific research permits issued by the NMFS currently authorize studies listed species in the Atlantic Ocean, which may extend into portions of the action area for the proposed actions. Authorized research on ESA-listed sea turtles includes capture, handling, and restraint, satellite, sonic, and PIT tagging, blood and tissue collection, lavage, ultrasound, captive experiments, laparoscopy, and imaging. Research activities involve “takes” by harassment, with some resulting mortality. Additional “take” is likely to be authorized in the future as additional permits are issued. It is noteworthy that although the numbers tabulated below represent the maximum number of “takes” authorized in a given year, monitoring and reporting indicate that the actual number of “takes” rarely approach the number authorized. Therefore, it is unlikely that the level of exposure indicated below has or will occur in the near term. However, our analysis assumes that these “takes” will occur since they have been authorized. It is also noteworthy that these “takes” are distributed across the Atlantic Ocean, mostly from Florida to Maine, and in the eastern Gulf of Mexico. Although sea turtles are generally wide-ranging, we do not expect many of the authorized “takes” to involve individuals who would also be “taken” under the proposed research.

Tables 4-7 describe the cumulative number of takes for each listed species in the action area authorized in scientific research permits.

Table 4. Green sea turtle takes in the Atlantic Ocean.

Year	Capture/handling /restraint	Satellite,sonic, or pit tagging	Blood/tissue collection	Lavage	Ultrasound	Captive experiment	Laparoscopy	Imaging	Mortality
2009	3,093	3,093	3,009	1,860	555	66	74	72	6
2010	3,753	3,753	3,669	2,480	555	66	74	72	6
2011	3,453	3,453	3,369	2,440	555	66	74	72	4
2012	1,616	1,616	1,550	1,340	495	66	74	72	0
2013	1,471	1,471	1,405	1,370	495	66	74	72	0
Total	13,386	13,386	13,002	9,490	2,655	330	370	360	16

Permit numbers: 10014, 10022, 13306, 13543, 13544, 1462, 1501, 1506, 1507, 1526, 1527, 1540, 1544, 1551, 1552, 1570, 1571, 1576, 13307, 14508, 14655, 14726, 14506, 13573, 1450, 1518, and 1522.

Table 5. Hawksbill sea turtle takes in the Atlantic Ocean.

Year	Capture/handling /restraint	Satellite,sonic, or pit tagging	Blood/tissue collection	Lavage	Ultrasound	Captive experiment	Laparoscopy	Imaging	Mortality
2009	1,073	1,073	1,066	464	254	0	0	0	3
2010	1,079	1,079	1,072	464	254	0	0	0	3
2011	1,044	1,044	1,037	464	254	0	0	0	1
2012	459	459	452	344	254	0	0	0	0
2013	434	434	427	344	254	0	0	0	0
Total	3,655	3,655	4,054	2,080	1,270	0	0	0	7

Permit numbers: 10014, 13306, 13543, 13544, 1462, 1501, 1506, 1507, 1526, 1527, 1540, 1544, 1551, 1552, 1570, 1571, 1576, 13307, 14272, 1518, 14508, 14726, 14506, and 14655.

Table 6. Kemp's ridley sea turtle takes in the Atlantic Ocean.

Year	Capture/handling /restraint	Satellite,sonic, or pit tagging	Blood/tissue collection	Lavage	Ultrasound	Captive experiment	Laparoscopy	Imaging	Mortality
2009	1,394	1,394	1,195	425	371	56	53	53	5
2010	1,402	1,402	1,203	426	371	56	53	53	5
2011	1,227	1,227	1,028	426	371	56	53	53	3
2012	621	621	476	422	371	56	53	53	0
2013	574	574	429	422	371	56	53	53	0
Total	5,218	5,218	4,331	2,121	1,855	280	265	265	13

Permit numbers: 10014, 10022, 13306, 13543, 13544, 1462, 1501, 1506, 1507, 1526, 1527, 1540, 1544, 1551, 1552, 1570, 1571, 1576, 14508, 14726, 14506, and 14655.

Table 7. Loggerhead sea turtle takes in the Atlantic Ocean.

Year	Capture/handling /restraint	Satellite,sonic, or pit tagging	Blood/tissue collection	Lavage	Ultrasound	Captive experiment	Laparoscopy	Imaging	Mortality
2009	5,327	5,327	4,909	1,165	1,322	200	109	123	111
2010	5,199	5,199	4,781	1,205	1,322	200	109	116	111
2011	4,479	4,479	4,331	1,205	1,322	200	109	114	111
2012	1,590	1,590	1,340	1,155	1,084	200	109	114	17
2013	1,557	1,557	1,307	1,155	1,084	200	109	114	17
Total	18,152	18,152	16,668	5,885	6,134	1,000	545	581	367

Permit numbers: 10014, 10022, 13306, 13307, 13543, 13544, 1462, 1501, 1506, 1507, 1526, 1527, 1540, 1544, 1551, 1552, 1570, 1571, 1576, 13307, 14249, 1450, 1522, 14506, 14726, 14508, and 14655.

Effects of the proposed action

Pursuant to section 7(a)(2) of the ESA, federal agencies must ensure, through consultation with the NMFS, that their activities are not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat. The proposed issuance of permit 15606 would authorize "takes" by harassment of sea turtles during the proposed research by André Landry and associated researchers by directed capture, restraint, and handling, flipper, PIT, and satellite tagging, blood draw, and biopsy. In this section, we describe the potential physical, chemical, or biotic stressors associated with the proposed actions, the probability of individuals of listed species being exposed to these stressors based on the best scientific and commercial evidence available, and the probable responses of those individuals (given probable exposures) based on the available evidence. As described in the *Approach to the Assessment* section, for any responses that would be expected to reduce an individual's fitness (i.e., growth, survival, annual reproductive success, or lifetime reproductive success), the assessment would consider the risk posed to the viability of the population(s) those individuals comprise and to the listed species those populations represent. The purpose of this assessment and, ultimately, of this Opinion is to determine if it is reasonable to expect the proposed action to have effects on listed species that could appreciably reduce their likelihood of surviving and recovering in the wild.

For this consultation, we are particularly concerned about behavioral and stress-based physiological disruptions that may result in animals that fail to feed or breed successfully or fail to complete their life history because these responses are likely to have population-level consequences as well as the potential for mortality. The ESA does not define harassment nor has the NMFS defined the term pursuant to the ESA through regulation. For this Opinion, we define harassment similar to the U.S. Fish and Wildlife Service's regulatory definition of "harass": an intentional or unintentional human act or omission that creates the probability of injury to an individual animal by disrupting one or more behavioral patterns that are essential to the animal's life history or its contribution to the population the animal represents.

Our analysis considers that behavioral harassment or disturbance is not limited to the "harassment" definition and may in fact occur in many ways. Fundamentally, if our analysis leads us to conclude that an individual changes its behavioral state (for example, from resting to traveling away from the approaching vessel or from traveling to evading), we consider the individual to have been harassed or disturbed. In addition, individuals may respond in a variety of ways, some of which have more significant fitness consequences than others. For example, evasion of an approaching vessel would be more significant than slow travel away from the same stressor due to increased metabolic demands, stress responses, and potential for habitat abandonment that this response could or would entail. As described in the *Approach to the assessment*, the universe of likely responses is considered in evaluating the fitness consequences to the individual and (if appropriate), the affected population and species as a whole to determine the likelihood of jeopardy.

Potential stressors

The assessment for this consultation identified several possible stressors associated with the proposed research activities, including

1. vessel transit during proposed activities

2. epiphyte and algal removal
3. fecal sampling
4. capture of sea turtles in entanglement or cast nets
5. handling and restraint of sea turtles following capture
6. application of flipper and/or PIT tags
7. application of satellite tag
8. blood sampling
9. skin biopsy scrapping

Based on a review of available information, this Opinion determined which of these possible stressors would be likely to occur and which would be discountable or insignificant. Vessel transit introduces large amounts of sound energy into the marine environment and poses a risk for shipstrike of listed sea turtles. However, we are unaware of any communications or acoustic cues that sea turtles would miss as a result of sound energy introduced by vessels associated with the proposed research and thus consider this aspect insignificant. Considering the level of vessel transit that researchers propose to undertake and levels of shipstrike known to occur, the risk of shipstrike is discountable. Growth of barnacles, algae, and other marine life on sea turtles is considered a negative factor for sea turtles, as this growth introduces additional mass and drag into the hydrodynamic performance of the individual sea turtle. Removal of these materials is expected to aid sea turtles by reducing their metabolic requirements for locomotion in water. We therefore consider this stressor insignificant. Fecal sampling will not involve any physical contact with the individual and will not involve a significant amount of time. Therefore, we discount the effect of fecal sampling.

Accordingly, this consultation focused on the following stressors likely to occur from the proposed activities and may adversely affect ESA-listed sea turtles: capture of sea turtles in entanglement or cast nets; handling and restraint of sea turtles following capture; application of flipper, PIT, and satellite tags; and tissue sampling (blood and skin).

Exposure analysis

Exposure analyses identify the ESA-listed species that are likely to co-occur with the actions' effects on the environment in space and time, and identify the nature of that co-occurrence. The *Exposure analysis* identifies, as possible, the number, age or life stage, and gender of the individuals likely to be exposed to the actions' effects and the population(s) or subpopulation(s) those individuals represent. The proposed permit identifies these parameters and would allow for capture, handling, and restraint, flipper, PIT, and satellite tagging, as well as sampling of blood and skin (Table 8). Any sex from juvenile, subadult, or adult age classes could be exposed to any activity. In addition, the applicant is requesting to conduct multiple activities on any given animal. For example, an individual would likely be exposed to a minimum of flipper and/or PIT tagging (if these tags are not already present), morphometrics (lengths and weight), and biopsy, blood sampled, and satellite tagged under the proposed permit. An individual would be exposed to proposed activities only once per year.

Table 8. Number of animals that could be exposed, by species, manner, and action under Permit No. 15606.

Species	Number of individuals taken annually	Action
Green sea turtle (*Chelonia mydas*)	25	Harassment via restraint and handling, tagging (flipper, PIT, and/or satellite tag), biopsy, blood sample, transport, and morphometrics (lengths, weight); NO CAPTURE AUTHORITY…CAPTURE VIA DREDGE OR NRDA TRAWLER
	235	Harassment via ENTANGLEMENT NET capture, restraint and handling, tagging (flipper, PIT, and/or satellite tag), biopsy, blood sample, transport, and morphometrics (lengths, weight)
	10	Harassment via CAST NET capture, restraint and handling, tagging (flipper, PIT, and/or satellite tag), biopsy, blood sample, transport, and morphometrics (lengths, weight)
	10	Harassment via HAND/DIP NET capture, restraint and handling, tagging (flipper, PIT, and/or satellite tag), biopsy, blood sample, transport, and morphometrics (lengths, weight)
	25	Harassment via OPPORTUNISTIC HOOK AND LINE, OIL BOOM DEPLOYMENT, OR SKIMMING OPERATION capture, restraint and handling, tagging (flipper, PIT, and/or satellite tag), biopsy, blood sample, transport, and morphometrics (lengths, weight)
	25	Harassment via restraint and handling, tagging (flipper, PIT, and/or satellite tag), biopsy, blood sample, transport, and morphometrics (lengths, weight); NO CAPTURE AUTHORITY…ANIMALS FROM REHAB FACILITIES
	5	Harassment via restraint and handling, tagging (flipper, PIT, and/or satellite tag), biopsy, blood sample, transport, and morphometrics (lengths, weight); NO CAPTURE AUTHORITY…CAPTURE VIA DREDGE OR NRDA TRAWLER
	20	Harassment via ENTANGLEMENT NET capture, restraint and handling, tagging (flipper, PIT, and/or satellite tag), biopsy, blood sample, transport, and morphometrics (lengths, weight)
	5	Harassment via HAND/DIP NET capture, restraint and handling, tagging (flipper, PIT, and/or satellite tag), biopsy, blood sample, transport, and morphometrics (lengths, weight)
	10	Harassment via OPPORTUNISTIC HOOK AND LINE, OIL BOOM DEPLOYMENT, OR SKIMMING OPERATION capture, restraint and handling, tagging (flipper, PIT, and/or satellite tag), biopsy, blood sample, transport, and morphometrics (lengths, weight)

Hawksbill sea turtle (*Eretmochelys imbricate*)	10	Harassment via restraint and handling, tagging (flipper, PIT, and/or satellite tag), biopsy, blood sample, transport, and morphometrics (lengths, weight); NO CAPTURE AUTHORITY…ANIMALS FROM REHAB FACILITIES
	60	Harassment via restraint and handling, tagging (flipper, PIT, and/or satellite tag), biopsy, blood sample, transport, and morphometrics (lengths, weight); NO CAPTURE AUTHORITY…CAPTURE VIA DREDGE OR NRDA TRAWLER
Kemp's ridley sea turtle (*Lepidochelys kempii*)	265	Harassment via ENTANGLEMENT NET capture, restraint and handling, tagging (flipper, PIT, and/or satellite tag), biopsy, blood sample, transport, and morphometrics (lengths, weight)
	10	Harassment via CAST NET capture, restraint and handling, tagging (flipper, PIT, and/or satellite tag), biopsy, blood sample, transport, and morphometrics (lengths, weight)
	10	Harassment via HAND/DIP NET capture, restraint and handling, tagging (flipper, PIT, and/or satellite tag), biopsy, blood sample, transport, and morphometrics (lengths, weight)
	25	Harassment via OPPORTUNISTIC HOOK AND LINE, OIL BOOM DEPLOYMENT, OR SKIMMING OPERATION capture, restraint and handling, tagging (flipper, PIT, and/or satellite tag), biopsy, blood sample, transport, and morphometrics (lengths, weight)
	50	Harassment via restraint and handling, tagging (flipper, PIT, and/or satellite tag), biopsy, blood sample, transport, and morphometrics (lengths, weight); NO CAPTURE AUTHORITY…ANIMALS FROM REHAB FACILITIES
	60	Harassment via restraint and handling, tagging (flipper, PIT, and/or satellite tag), biopsy, blood sample, transport, and morphometrics (lengths, weight); NO CAPTURE AUTHORITY…CAPTURE VIA DREDGE OR NRDA TRAWLER
Loggerhead sea turtle (*Caretta caretta*)	130	Harassment via ENTANGLEMENT NET capture, restraint and handling, tagging (flipper, PIT, and/or satellite tag), biopsy, blood sample, transport, and morphometrics (lengths, weight)
	25	Harassment via OPPORTUNISTIC HOOK AND LINE, OIL BOOM DEPLOYMENT, OR SKIMMING OPERATION capture, restraint and handling, tagging (flipper, PIT, and/or satellite tag), biopsy, blood sample, transport, and morphometrics (lengths, weight)
	25	Harassment via restraint and handling, tagging (flipper, PIT, and/or satellite tag), biopsy, blood sample, transport, and morphometrics (lengths, weight); NO CAPTURE AUTHORITY…ANIMALS FROM REHAB FACILITIES

Response analysis

As discussed in the *Approach to the assessment* section of this Opinion, response analyses determine how listed resources are likely to respond after exposure to an action's effects on the environment or directly on listed species themselves. For the purposes of consultation, our assessments try to detect potential lethal, sub-lethal (physiological), or behavioral responses that might result in reducing the fitness of listed individuals. Ideally, response analyses would consider and weigh evidence of adverse consequences as well as evidence suggesting the absence of such consequences and beneficial outcomes for the listed individuals.

There is mounting evidence that wild animals respond to human disturbance in the same way that they respond to predators (Beale and Monaghan, 2004; Frid, 2003; Frid and Dill, 2002; Gill et al., 2001; Harrington and Veitch, 1992; Lima, 1998; Romero, 2004). These responses manifest themselves as stress responses (in which an animal perceives human activity as a potential threat and undergoes physiological changes to prepare for a flight or fight response or more serious physiological changes with chronic exposure to stressors), interruptions of essential behavioral or physiological events, alteration of an animal's time budget, or some combinations of these responses (Frid, 2003; Frid and Dill, 2002; Romero, 2004; Sapolsky et al., 2000; Walker et al., 2005). These responses have been associated with abandonment of sites (Sutherland and Crockford, 1993), reduced reproductive success (Beale and Monaghan, 2004; Giese, 1996; Lordi et al., 2000; Mullner et al., 2004), reduced energy budget (Frid, 2003), and the death of individual animals (Bearzi, 2000; Daan, 1996; Feare, 1976). Stress is an adaptive response and does not normally place an animal at risk. However, distress involves a stress response resulting in a biological consequence to the individual. The mammalian and reptilian stress response involves the hypothalamic-pituitary-adrenal (HPA) axis being stimulated by a stressor, causing a cascade of physiological responses, such as the release of the stress hormones cortisol, adrenaline (epinephrine), glucocorticosteroids, and others (Busch and Hayward, 2009)(Gulland et al. 1999; Morton et al. 1995; St. Aubin and Geraci 1988; St. Aubin et al. 1996; Thomson and Geraci 1986)(Gregory and Schmid, 2001b). These hormones subsequently can cause short-term weight loss, the liberation of glucose into the blood stream, impairment of the immune and nervous systems, elevated heart rate, body temperature, blood pressure, and alertness, and other responses (Busch and Hayward, 2009; NMFS, 2006g)(Cattet et al. 2003; Delehanty and Boonstra 2009; Elftman et al. 2007; Fonfara et al. 2007; Kaufman and Kaufman 1994; Mancia et al. 2008; Moe and Bakken 1997; Noda et al. 2007; Thomson and Geraci 1986)(Dierauf and Gulland, 2001; Omsjoe et al., 2009). In some species, stress can also increase an individual's susceptibility to gastrointestinal parasitism (Greer et al. 2008). In highly-stressful circumstances, or in species prone to strong "fight-or-flight" responses, more extreme consequences can result, including muscle damage and death (Cowan and Curry, 1998, 2002, 2008; Herraez et al., 2007). The most widely-recognized indicator of vertebrate stress, cortisol, normally takes hours to days to return to baseline levels following a significantly stressful event, but other hormones of the HPA axis may persist for weeks (Dierauf and Gulland, 2001). Repeated exposure to stressors can negatively impact the health and viability of populations (Gregory and Schmid, 2001b).

Entanglement and cast net capture

Sea turtles captured during the course of proposed research would be captured in one of two ways: entanglement netting and cast netting. Cast netting is perhaps the less risky option, as this allows researchers to immediately remove captured individuals from the water, eliminating the

possibility of drowning or injury resulting from forced submergence. Although corticosterone does not appear to increase with entanglement time for green and Kemp's ridley sea turtles (Snoddy et al., 2009), we expect capture to be a stressful experience as indicated by severe metabolic and respiratory imbalances resulting from forced submergence (Gregory and Schmid, 2001a; Harms et al., 2003; Stabenau and Vietti, 2003). We also expect behavioral responses (attempts to break loose of the netting via rapid swimming and biting) as well as physiological responses (release of stress hormones; (Gregory et al., 1996; Gregory and Schmid, 2001a; Harms et al., 2003; Hoopes et al., 2000; Stabenau and Vietti, 2003). We expect individuals captured via cast net to be rapidly removed from the cast net, although responses associated with subsequent stressors will continue. For example, handling has been shown to result in progressive changes in blood chemistry indicative of a continued stress response (Gregory and Schmid, 2001a; Hoopes et al., 2000).

Additional risk to sea turtles is involved with capturing sea turtles in entanglement nets due to forced submersion. Sea turtles forcibly submerged in any type of restrictive gear eventually suffer fatal consequences from prolonged anoxia and/or seawater infiltration of the lungs (Lutcavage et al., 1997a). Trawl studies have found that no mortality or serious injury occurred in tows of 50 minutes or less, but these increased rapidly to 70% after 90 minutes (Epperly et al., 2002; Henwood and Stuntz, 1987). However, metabolic changes that can impair a sea turtles' ability to function can occur within minutes of a forced submergence. Serious injury and mortality is likely due to acid-base imbalances resulting from accumulation of carbon dioxide and lactate in the bloodstream (Lutcavage et al., 1997a); this imbalance can become apparent in captured, submerged sea turtles after a few minutes (Stabenau et al., 1991). Recovery times can take 20 hours or more (Henwood and Stuntz, 1987). To minimize the effects of this type of capture, nets will be tended continuously and must be checked at intervals of less than 30 minutes, and more frequently whenever turtles or other organisms begin to be observed in the net or environmental temperatures become potentially stressful. This methodology should mitigate the potential for mortality as much as possible (Landry, 2010). However, we expect that sea turtles captured by entanglement will experience a greater degree of stress due to the greater or lesser degree of forced submergence which they will undergo as compared to cast netting. We do not expect any sea turtle to require extensive recovery, but methodology proposed by the researcher (holding comatose or behaviorally abnormal sea turtles) should mitigate sea turtles being released that have not recovered from forced submergence. In addition, veterinary assistance would be sought for these individuals.

Over the past two decades, the applicant has captured 993 sea turtles, of which four have died as a result of or subsequent to capture. Probability analyses based upon this incidence of mortality and an estimate of 674 annual captures suggests that it is likely two sea turtles may die annually, or eight over the five-year life of the permit. We expect capture methodology, environmental conditions, and sea turtle biology to generally be the same during the life of the proposed permit as they have previously been. However, as a higher rate of fibropapillomatosis in green sea turtles has recently been documented by the applicant, more unhealthy sea turtles may be captured under the proposed permit than in years past. Until we can better evaluate the significance and extent of this trend (if it is a trend), we expect mortality level to be the same as previous levels. Therefore, we anticipate up to two mortalities per year and eight over the life of the proposed permit.

Morphometrics, biopsy, flipper tagging, and PIT tagging

Once sea turtles have been captured, individuals will be handled and exposed to various activities of greater or lesser degrees of invasiveness. Each sea turtle will be exposed to morphometric measurement, including at least four measures of carapace size, as well as weight measurement. Although these activities are not considered invasive, we expect individual sea turtles to experience a continued stress response due to the handling and restraint necessary to conduct these activities. All sea turtles will also be scanned or visually inspected for PIT and flipper tags, respectively. If either of these are absent, then individuals will be tagged with them. Both procedures involve the implantation of tags in or through skin and/or muscle of the flippers. In addition to the stress sea turtles are expected to experience by handling and restraint associated with inspection, tagging, and biopsy, we expect an additional stress response associated with the short-term pain experienced during tag implantation and biopsy (Balazs, 1999). Based upon several hundred tagging events, behavioral responses may or may not be evident during tag implantation; when evident, behavioral responses are fleeting. We expect disinfection methods proposed by the applicant should mitigate risks from infection from both tagging and biopsy. Wounds are expected to heal without infection. Tags are designed to be small, physiologically inert, and not hinder movement or cause chafing; we do not expect the tags themselves to negatively impact sea turtles (Balazs, 1999).

Blood sampling

Sea turtles are also expected to experience a short-term stress response in association with the handling, restraint, and pain associated with blood sampling. Taking a blood sample from the sinuses in the dorsal side of the neck is a routine procedure (Owens, 1999), although it requires knowledgeable and experienced staff to do correctly and requires the animal to be restrained (DiBello et al., 2010; Wallace and George, 2007). According to Owens (1999), with practice, it is possible to obtain a blood sample 95% of the time and the sample collection time should be about 30 seconds in duration. The applicant has sampled several hundred sea turtles for blood since 1991. No sea turtle mortalities have occurred during the applicant's blood sampling activities. Sample collection sites are always sterilized prior to needle insertions, which would be limited to two on either side of the neck. Bjorndal et al. (2010) found that repeated scute, blood, and skin sampling of the same individual loggerhead sea turtles did not alter growth, result in scarring, or apparently impact other physiological or health parameters.

Satellite tagging

Sea turtles exposed to satellite tagging will experience invasive activities, such as sanding sanding of the carapace, will be held and restrained for significant periods of time in an unfamiliar environment. This is expected to cause a stress response. The applicant proposes to use methods that will minimize adverse impacts to sea turtles, including use of low-heat producing epoxy, covering skin and eyes to prevent epoxy contact with these surfaces, and ensuring adequate ventilation to prevent epoxy vapor accumulation. Sea turtles are not capable of hearing the frequencies produced by tags nor are their predators (Bartol et al., 1999; Casper et al., 2003; Casper and Mann, 2004; Lenhardt, 2003; Ridgeway et al., 1969). However, satellite tags have the potential to significantly increase hydrodynamic drag, reduce lift, and increase pitch (Watson and Granger, 1998). Thus, determination of altered movement will be monitored following tagging. To date, the applicant has not found tagged sea turtles to move in ways suggesting locomotory hindrance.

Cumulative effects

Cumulative effects include the effects of future state, tribal, local, or private actions that are reasonably certain to occur in the action area considered by this Opinion. Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA. Sources queried for the information herein include the United States Census Bureau, Department of Labor, and Lexis-Nexis information system. With the latter (which was our source for state legislation), we reviewed bills passed in 2010 and pending bills under consideration were included as further evidence that actions "are reasonably certain to occur". Bills that died in process or were vetoed are not included in our review.

We expect that those aspects described in the *Environmental baseline* will continue to impact listed resources into the foreseeable future. We expect climate change, ship-strikes, bycatch, hurricane impacts, oil and gas extraction and development to continue into the future. Movement towards bycatch reduction and greater foreign protections of sea turtles are generally occurring through the Atlantic Ocean, which may aid in recovery of sea turtle populations. Risk of shipstrike will likely increase in the future as more vessels are used in commercial and recreational marine activities. In addition, impacts from oil development and pollution will likely increase, as this industry is anticipated to grow in the northern Gulf of Mexico over the next few decades (MMS, 2007a, b). Additional seismic survey operations will commence, likely rising from roughly 100 to about 130 annually. A windfarm is proposed for construction three to eight miles offshore of Padre Island near Baffin Bay (TGLO, 2006). This 100-turbine farm would involve extensive construction, including vessel traffic and noise-generating pile driving that could adversely impact sea turtles (TGLO, 2006; Washington Post, 2006).

Louisiana's legislature is proposing to further restrict gear use in fisheries.

Based upon 2000 United States census data, numerous micropolitan and metropolitan areas along the northern Gulf of Mexico and within the drainage basin of the Mississippi River have shown significant increases in population (USCB, 2008a, b). Growth of metropolitan centers will increase discharge of wastewater from water treatment systems into rivers and streams, which will increase the loads of contaminants carried by these waterways to the marine environment, and would have concomitant effects on such parameters as biological oxygen demand, chemical oxygen demand, dissolved oxygen, and water temperature. It is likely that development will continue along the coast and waterways, which will add sediment to river systems. Oil and other roadway pollutants may increase as a result of additional vehicular traffic. Additional recreational use of lakes, waterways, and coastal areas will increase fish takes and add additional discharges from vessels.

Many of the major industrial activities along the northern Gulf of Mexico, such as oil and gas extraction and fishing, are forecasted to experience significant decreases in output between 2008 and 2018 (USBLS, 2010b). Stressors associated with these activities include net entanglements, ship-strike potential, and underwater noise (USBLS, 2010a, b). Agriculture as a whole has been declining in output between 1998 and 2008, but this rate of decline is predicted to slow between 2008 and 2018, likely meaning more herbicides, fungicides, pesticides, and fertilizer will be applied and ultimately run-off into streams which can drain into the Gulf of Mexico.

Integration and synthesis of effects

As explained in the *Approach to the assessment* section, risks to listed individuals are measured using changes to an individual's "fitness" – i.e., the individual's growth, survival, annual reproductive success, and lifetime reproductive success. When listed plants or animals exposed to an action's effects are not expected to experience reductions in fitness, we would not expect the action to have adverse consequences on the viability of the population(s) those individuals represent or the species those populations comprise (Anderson, 2000; Brandon, 1978; Mills and Beatty, 1979; Stearns, 1992). As a result, if the assessment indicates that listed plants or animals are not likely to experience reductions in their fitness, we conclude our assessment. If possible, reductions in individuals' fitness are likely to occur, the assessment considers the risk posed to population(s) to which those individuals belong, and then to the species those population(s) represent.

The *Status of listed resources* discussion describes how listed sea turtles affected by the actions outside the action area have been adversely affected by human-induced factors such as commercial fisheries, direct harvest of sea turtles, and modification or degradation of the sea turtle's terrestrial and aquatic habitat. Effects occurring in terrestrial habitats have generally resulted in the loss of eggs or hatchling sea turtles, or nesting females, while those occurring in aquatic habitat have caused the mortality of juvenile, subadult and adult sea turtles through entanglement or capture in fishing gear, ingestion of debris or pollution. Similarly, the actions discussed in the baseline, as well as those considered under *Cumulative effects* all pose the potential to result in take of sea turtle species resulting in stress or possible mortality.

Species with delayed maturity such as sea turtles are demographically vulnerable to increases in mortality, particularly of juveniles and subadults, those stages with higher reproductive value. As discussed in the *Status of listed resources*, the age of sexual maturity of most species of sea turtles is currently unknown, although the sexual maturity of loggerhead turtles may be as high as 35 years, and green turtles may not reach maturity until as late as 50 years. The potential for an egg to develop into a hatchling, into a juvenile, and finally into a sexually mature adult sea turtle varies among species, populations, and the degree of threats faced during each life stage. Each juvenile that does not survive to produce will be unable to contribute to the maintenance or improvement of the species' status. Reproducing females that are prematurely killed due the threats mentioned in the above sections or as a result of the proposed actions, while possibly having contributing something before being removed from the population, will not be allowed to realize their reproductive potential. Similarly, reproductive males prematurely removed from the population will be unable to make their reproductive contribution to the species' population.

The research activities that would take place under the permit are expected to result in sea turtle mortality. We expect up to two sea turtles (most likely green or Kemp's ridley, based upon species-specific capture data from previous years) to die annually, or up to eight over the life of the permit. We do not know from which nesting group green sea turtles captured along the northern Gulf of Mexico come and therefore cannot specifically address the population trend of the population(s) which would be exposed to proposed researcher activities. However, most studied green sea turtle populations worldwide are stable or increasing, with few decreasing. In addition, most green sea turtle rookeries in the Atlantic basin are composed of several thousand nests or females annually. Based upon this, the loss of one or two green sea turtles annually is not likely to sizably decrease the survival rate or recovery potential of a given population. Kemp's ridley sea turtle population recovery over the past two decades has been robust, with

greater than 10% annual increases in nesting from year-to-year in many cases, with several thousand females nesting annually and range expansions onto Texas beaches becoming more common. Although the 2010 nesting season was very poor compared to recent years (warranting caution in recovery, but not as yet indicating a downward trend in recovery), the general trend overall has been very encouraging for the recovery of the species. The loss of one or two Kemp's ridley sea turtles annually as a result of the proposed research is not expected to alter the survival or recovery trajectory of the Kemp's ridley population.

The research activities will also result in temporary stress to the animal, which is not expected to have more than short-term effects on individual threatened or endangered sea turtles. These non-lethal interactions will not affect the individual's ability to reproduce and contribute to the maintenance or recovery of the species. These effects are expected to be short-term because previous experience with the proposed research activities has demonstrated that it is reasonable to expect that effects will be minimal. This research will affect the individuals by harassing sea turtles during the research thus raising levels of stressor hormones, and individuals may experience some discomfort during capture, weighing, measuring, tagging, and other procedures. Based on past observations of similar research, these effects are expected to dissipate within approximately a day. NMFS does not expect any delayed mortality of any sea turtles following their release as a direct result of the research based on past research efforts by other researchers and adherence to certain protocols identified in the proposed action.

NMFS does expect some individual sea turtles will die, appreciably reducing the survival, growth, and reproductive potential of these individuals, as a result of the proposed actions. However, at the population level, NMFS does not expect the proposed research activities to appreciably reduce the green, loggerhead, hawksbill, or Kemp's ridley sea turtles' likelihood of survival and recovery in the wild by adversely affecting their birth rates, death rates, growth rates, or recruitment rates. For the vast majority of sea turtles, the proposed action is not expected to have more than short-term effects. The data generated by the applicant regarding these populations over the duration of this study will provide beneficial information that will be important to the management and recovery of threatened and endangered species. The information collected as a direct result of permit issuance will be used to implement the goals identified in the recovery plans for the U.S. Atlantic populations of sea turtles. As discussed above, NMFS believes it is reasonable to assume that issuance of the proposed permit will have beneficial effects for the Gulf of Mexico/Atlantic Ocean populations of green, loggerhead, hawksbill, and Kemp's ridley sea turtles.

Conclusion

After reviewing the current status of green, hawksbill, Kemp's ridley, and loggerhead; the *Environmental baseline* for the action area; the anticipated effects of the proposed activities; and the *Cumulative effects*, it is the NMFS' Opinion that the actions (the Permits Division's issuance of a permit for research activities on sea turtles in the northern Gulf of Mexico) are not likely to jeopardize the continued existence of these species. No critical habitat co-occurs within the action area and thus the proposed action would have no effect on critical habitat.

Incidental take statement

Section 9 of the ESA and Federal regulation pursuant to section 4(d) of the ESA prohibits the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt

to engage in any such conduct. Harm is further defined by NMFS to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

As discussed in the accompanying Opinion, only the target species will be harassed as part of the proposed actions. Therefore, we do not expect incidental take of threatened or endangered species as a result of the proposed actions.

Conservation recommendations

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

The Endangered Species Division recommends that annual reports submitted to the Permits Division require detail on the response of listed individuals of any taxa (not only listed marine mammals) to directed activities. Although expansive, individual-by-individual detail is not recommended, a minimum of general comments on response can be informative regarding methodological, population, researcher-based responses in future consultations.

In order for NMFS Endangered Species Division to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, the Permits Division should notify the Endangered Species Division of any conservation recommendations they implement in their final action.

Reinitiation notice

This concludes formal consultation on NMFS' proposal to issue Permit 15606 to André Landry of Texas A&M University at Galveston, pursuant to the provisions of section 10 of the ESA and MMPA. As provided in 50 CFR '402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this Opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this Opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of authorized take is exceeded, NMFS Permits, Conservation and Education Division must immediately request reinitiation of section 7 consultation.

Literature cited

ACC 2010. Alabama's debris history (Alabama Coastal Cleanup).

Acevedo-Whitehouse, K., Duffus., A.L.J., 2009, Effects of environmental change on wildlife health. Philosophical Transactions of the Royal Society of London B Biological Sciences 364, 3429-3438.

Ackerman, R.A., 1997, The nest environment, and the embryonic development of sea turtles, In: Lutz, P.L., Musick, J.A. (Eds.) The Biology of Sea Turtles. CRC Press, Boca Raton, Florida, pp. 83-106.

Addison, D.S., 1997, Sea turtle nesting on Cay Sal, Bahamas, recorded June 2-4, 1996. Bahamas Journal of Science 5, 34-35.

Addison, D.S., Morford, B., 1996, Sea turtle nesting activity on the Cay Sal Bank, Bahamas. Bahamas Journal of Science 3, 31-36.

Aguilar, R., Mas, J., Pastor, X. 1995. Impact of Spanish swordfish longline fisheries on the loggerhead sea turtle *Caretta caretta* population in the western Mediterranean. In Proceedings of the Twelfth Annual Workshop on Sea Turtle Biology and Conservation, Richardson, J.I., Richardson, T.H., eds. (Jekyll Island, Georgia, U.S. Department of Commerce).

Aguirre, A.A., Balazs, G.H., Zimmerman, B., Galey, F.D., 1994, Organic contaminants and trace metals in the tissues of green turtles (*Chelonia mydas*) afflicted with fibropapillomas in the Hawaiian Islands. Marine Pollution Bulletin 28, 109-114.

Aguirre, A.A., Spraker, T.R., Balazs, G.H., Zimmerman, B., 1998, Spirochidiasis and fibropapillomatosis in green turtles of the Hawaiian Islands. Journal of Wildlife Diseases 34, 91-98.

Al-Bahry, S., Mahmoud, I., Elshafie, A., Al-Harthy, A., Al-Ghafri, S., Al-Amri, I., Alkindi, A., 2009, Bacterial flora and antibiotic resistance from eggs of green turtles Chelonia mydas: An indication of polluted effluents. Marine Pollution Bulletin 58, 720-725.

Alava, J.J., Keller, J.M., Kucklick, J.R., Wyneken, J., Crowder, L., Scott, G.I., 2006, Loggerhead sea turtle (*Caretta caretta*) egg yolk concentrations of persistent organic pollutants and lipid increase during the last stage of embryonic development. Science of the Total Environment 367, 170-181.

Amos, A.F. 1989. Recent strandings of sea turtles, cetaceans and birds in the vicinity of Mustang Island, Texas. In Proceedings of the First International Symposium on Kemp's Ridley Sea Turtle Biology, Conservation and Management, Jr., C.W.C., Landry, A.M., eds., p. 51.

Anan, Y., Kunito, T., Watanabe, I., Sakai, H., Tanabe, S., 2001, Trace element accumulation in hawksbill turtles (Eretmochelys imbricata) and green turtles (Chelonia mydas) from Yaeyama Islands, Japan. Environmental Toxicology and Chemistry 20, 2802-2814.

Anderson, J.J., 2000, A vitality-based model relating stressors and environmental properties to organism survival. Ecological Monographs 70, 445-470.

Arndt, D.S., Baringer, M.O., Johnson, M.R., Alexander, L.V., Diamond, H.J., Fogt, R.L., Levy, J.M., Richter-Menge, J., Thorne, P.W., Vincent, L.A., Watkins, A.B., Willett, K.M.,

2010, State of the climate in 2009. Bulletin of the American Meteorological Society 91, S1-S224.

Arthur, K., Limpus, C., Balazs, G., Capper, A., Udy, J., Shaw, G., Keuper-Bennett, U., Bennett, P., 2008, The exposure of green turtles (Chelonia mydas) to tumour promoting compounds produced by the cyanobacterium Lyngbya majuscula and their potential role in the aetiology of fibropapillomatosis. Harmful Algae 7, 114-125.

Asrar, F.F., 1999, Decline of marine turtle nesting populations in Pakistan. Marine Turtle Newsletter 83, 13-14.

Baker, J.D., Littnan, C.L., Johnston, D.W., 2006, Potential effects of sea level rise on the terrestrial habitats of endangered and endemic megafauna in the Northwestern Hawaiian Islands. Endangered Species Research 4, 1-10.

Balazs, G.H., 1999, Factors to consider in the tagging of sea turtles in research and management techniques for the conservation of sea turtles, In: Eckert, K.L., Bjorndal, K.A., Abreu-Grobois, F.A., Donnelly, M. (Eds.) IUCN/SSC Marine Turtle Specialist Group Publication No 4.

Balazs, G.H., Chaloupka, M., 2004, Thirty-year recovery trend in the once depleted Hawaiian green sea turtle stock. Biological Conservation 117, 491-498.

Balazs, G.H., Chaloupka, M., 2006, Recovery trend over 32 years at the Hawaiian green turtle rookery of French Frigate Shoals. Atoll Research Bulletin 543, 147-158.

Baldwin, R., Hughes, G.R., Prince, R.I.T., 2003, Loggerhead turtles in the Indian Ocean, In: Bolten, A.B., Witherington, B.E. (Eds.) Loggerhead Sea Turtles. Smithsonian Institution Press, Washington, D.C., pp. 218-232.

Baldwin, R.M. 1992. Nesting turtles on Masirah Island: Management issues, options, and research requirements (Oman, Ministry of Regional Municipalities and Environment).

Barbieri, E., 2009, CONCENTRATION OF HEAVY METALS IN TISSUES OF GREEN TURTLES (CHELONIA MYDAS) SAMPLED IN THE CANANEIA ESTUARY, BRAZIL. Brazilian Journal of Oceanography 57, 243-248.

Bartol, S.M., Musick, J.A., Lenhardt, M., 1999, Evoked Potentials of the Loggerhead Sea Turtle (Caretta caretta). Copeia 1999, 836-840.

Barton, B.T., Roth, J.D., 2008, Implications of intraguild predation for sea turtle nest protection. Biological Conservation 181, 2139-2145.

Bass, A.L., 1999, Genetic analysis to elucidate the natural history and behavior of hawksbill turtles (Eretmochelys imbricata) in the wider Caribbean: a review and re-analysis. Chelonian Conservation and Biology 3, 195-199.

Bass, A.L., Epperly, S.P., Braun, J., Owens, D.W., Patterson, R.M. 1998. Natal origin and sex ratios of foraging sea turtles in the Pamlico-Albemarle Estuarine Complex. In NOAA Technical Memorandum (Miami, Florida, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center).

Baussant, T., Sanni, S., Jonsson, G., Skadsheim, A., Borseth, J.F., 2001, Bioaccumulation of

polycyclic aromatic compounds: 1. bioconcentration in two marine species and in semipermeable membrane devices during chronic exposure to dispersed crude oil. Environ. Toxicol. Chem. 20, 1175-1184.

Beale, C.M., Monaghan, P., 2004, Human disturbance: people as predation-free predators? Journal of Applied Ecology 41, 335-343.

Bearzi, G., 2000, First report of a common dolphin (Delphinus delphis) death following penetration of a biopsy dart. Journal of Cetacean Research and Management 2, 217-221.

Bell, L.A.J., Fa'Anunu, U., Koloa, T. 1994. Fisheries resources profiles: Kingdom of Tonga (Honiara, Solomon Islands).

Berkson, H., 1967, Physiological adjustments to deep diving in the Pacific green turtle (Chelonia mydas agassizi). Comparative Biochemistry and Physiology 21, 507-524.

Bernardo, J., Plotkin, P.T., 2007, An evolutionary perspective on the arribada phenomenon, and reproductive behavioral polymorphism of olive ridley sea turtles (*Lepidochelys olivacea*), In: Plotkin, P.T. (Ed.) Biology and conservation of Ridley sea turtles. Johns Hopkins University Press, Baltimore, Maryland, pp. 59-87.

Bjorndal, K.A., 1982, The consequences of herbivory for the life history pattern of the Caribbean green turtle, Chelonia mydas, In: Bjorndal, K.A. (Ed.) Biology and conservation of sea turtles. Smithsonian Institution Press, Washington, D.C., pp. 111-116.

Bjorndal, K.A., 1997, Foraging ecology, and nutrition of sea turtles, In: Lutz, P.L., Musick, J.A. (Eds.) The biology of sea turtles. CRC Press, Boca Raton, Florida, pp. 199-232.

Bjorndal, K.A., Bolten, A.B. 2000. Proceedings on a workshop on accessing abundance and trends for in-water sea turtle populations (NOAA).

Bjorndal, K.A., Bolten, A.B., 2010, Hawksbill sea turtles in seagrass pastures: success in a peripheral habitat. Mar. Biol. 157, 135-145.

Bjorndal, K.A., Bolten, A.B., Chaloupka, M.Y., 2000, Green turtle somatic growth model: evidence for density dependence. Ecological Applications 10, 269-282.

Bjorndal, K.A., Bolten, A.B., Chaloupka, M.Y., 2003, Survival probability estimates for immature green turtles Chelonia mydas in the Bahamas. Marine Ecology Progress Series 252, 273-281.

Bjorndal, K.A., Bolten, A.B., Chaloupka, M.Y., 2005, Evaluating trends in abundance of immature green turtles, *Chelonia mydas*, in the greater Caribbean. Ecological Applications 15, 304-314.

Bjorndal, K.A., Reich, K.J., Bolten, A.B., 2010, Effect of repeated tissue sampling on growth rates of juvenile loggerhead turtles Caretta caretta. Dis. Aquat. Org. 88, 271-273.

Blumenthal, J.M., Austin, T.J., Bell, C.D.L., Bothwell, J.B., Broderick, A.C., Ebanks-Petrie, G., Gibb, J.A., Luke, K.E., Olynik, J.R., Orr, M.F., Solomon, J.L., Godley, B.J., 2009a, Ecology of Hawksbill Turtles, Eretmochelys imbricata, on a Western Caribbean Foraging Ground. Chelonian Conservation and Biology 8, 1-10.

Blumenthal, J.M., Austin, T.J., Bothwell, J.B., Broderick, A.C., Ebanks-Petrie, G., Olynik, J.R., Orr, M.F., Solomon, J.L., Witt, M.J., Godley, B.J., 2009b, Diving behavior and

movements of juvenile hawksbill turtles Eretmochelys imbricata on a Caribbean coral reef. Coral Reefs 28, 55-65.

BOEMRE 2010. Gulf of Mexico region-spills = 50 barrels (2,100 gallons) - 2004 - Hurricane Ivan (Bureau of Ocean Energy Management, Regulation and Enforcement Offshore Energy and Minerals Management).

Bolten, A.B., K.A. Bjorndal, Martins, H.R., 1994, Life history model for the loggerhead sea turtle (*Caretta caretta*) populations in the Atlantic: Potential impacts of a longline fishery. . Pp.48-55 *In:* Balazs, G.J. and S.G. Pooley (eds), Research Plan to Assess Marine Turtle Hooking Mortality: Results of an Expert Workshop Held in Honolulu, Hawaii, November 16-18, 1993. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SEFSC-201, pp.48-55.

Bolten, A.B., Wetherall, J.A., Balazs, G.H., Pooley, S.J. 1996. Status of marine turtles in the Pacific Ocean relevant to incidental take in the Hawaii-based pelagic longline fishery. In NOAA Technical Memorandum

Bouchard, S., Moran, K., Tiwari, M., Wood, D., Bolten, A., Eliazar, P., Bjorndal, K., 1998, Effects of exposed pilings on sea turtle nesting activity at Melbourne Beach, Florida. Journal of Coastal Research 14, 1343-1347.

Boulon, R.H., Jr., 1994, Growth rates of wild juvenile hawksbill turtles, *Eretmochelys imbricata*, in St. Thomas, United States Virgin Islands. Copeia 1994, 811-814.

Bowen, B.W., Abreu-Grobois, F.A., Balazs, G.H., Kamezaki, N., Limpus, C.J., Ferl., R.J., 1995, TransPacific migrations of the loggerhead turtle (Caretta caretta) demonstrated with mitochondrial DNA markers. Proceedings of the National Academy of Sciences USA 92, 3731-3734.

Bowen, B.W., Bass, A.L., Chow, S.-M., Bostrom, M., Bjorndal, K.A., Bolten, A.B., Okuyama, T., Bolker, B.M., Epperly, S., LaCasella, E., Shaver, D., Dodd, M., Hopkins-Murphy, S.R., Musick, J.A., Swingle, M., Rankin-Baransky, K., Teas, W., Witzell, W.N., Dutton, P.H., 2004, Natal homing in juvenile loggerhead turtles (*Caretta caretta*). Molecular Ecology 13, 3797–3808.

Bowen, B.W., Bass, A.L., Garcia Rodriguez, A., Diez, C.E., Van Dam, R., Bolten, A.B., Bjorndal, K.A., Miyamoto, M.M., Feri, R.J., 1996, Origin of hawksbill turtles in a Caribbean feeding area as indicated by genetic markers. Ecological Applications 6, 566-572.

Bowen, B.W., Bass, A.L., Soares, L., Toonen, R.J., 2005, Conservation implications of complex population structure lessons from the loggerhead turtle (*Caretta caretta*). Molecular Ecology 14, 2389-2402.

Bowen, B.W., Grant, W.S., Hillis-Starr, Z., Shaver, D.J., Bjorndal, K.A., Bolten, A.B., Bass, A.L., 2007, Mixed stock analysis reveals the migrations of juvenile hawksbill turtles (Eretmochelys imbricata) in the Caribbean Sea. Molecular Ecology 16, 49-60.

Boyle, M.C., FitzSimmons, N.N., Limpus, C.J., Kelez, S., Velez-Zuazo, X., Waycott, M., 2009, Evidence for transoceanic migrations by loggerhead sea turtles in the southern Pacific Ocean. Proceedings of the Royal Society B-Biological Sciences 276, 1993-1999.

Brandon, R., 1978, Adaptation and evolutionary theory. Studies in the History and Philosophy of Science 9, 181-206.

Brashares, J.S., 2003, Ecological, behavioral, and life-history correlates of mammal extinctions in West Africa. Conservation Biology 17, 733-743.

Bräutigam, A., Eckert, K.L. 2006. Turning the tide: Exploitation, trade, and management of marine turtles in the Lesser Antilles, Central America, Colombia, and Venezuela (Cambridge, United Kingdom, TRAFFIC International).

Brill, R.W., Balazs, G.H., Holland, K.N., Chang, R.K.C., Sullivan, S., George, J.C., 1995, Daily movements, habitat use, and submergence intervals of normal and tumor-bearing juvenile green turtles (Chelonia mydas L.) within a foraging area in the Hawaiian Islands. J. Exp. Mar. Biol. Ecol. 185, 203-218.

Brock, K.A., Reece, J.S., Ehrhart, L.M., 2009, The Effects of Artificial Beach Nourishment on Marine Turtles: Differences between Loggerhead and Green Turtles. Restoration Ecology 17, 297-307.

Broderick, A., Frauenstein, C.R., Glen, F., Hays, G.C., Jackson, A.L., Pelembe, T., Ruxton, G.D., Godley, B.J., 2006, Are green turtles globally endangered? Global Ecology and Biogeography 15, 21-26.

Broderick, A., Glen, C.F., Godley, B.J., Hays, G.C., 2002, Estimating the number of green and loggerhead turtles nesting annually in the Mediterranean. Oryx 36, 227-235.

Bugoni, L., Krause, L., Petry, M.V., 2001, Marine debris and human impacts on sea turtles in southern Brazil. Marine Pollution Bulletin 42, 1330-1334.

Busch, D.S., Hayward, L.S., 2009, Stress in a conservation context: A discussion of glucocorticoid actions and how levels change with conservation-relevant variables. Biological Conservation 142, 2844-2853.

Byles, R.A., 1988. The behavior and ecology of sea turtles, Caretta caretta and Lepidochelys kempi, in the Chesapeake Bay. College of William and MAry, Williamsburg, Virginia.

Byles, R.A., 1989a. Distribution, and abundance of Kemp's ridley sea turtle, Lepidochelys kempii, in Chesapeake Bay and nearby coastal waters. In: First International Symposium on Kemp's Ridley Sea Turtle Biology, Conservation and Management, p. 145.

Byles, R.A. 1989b. Satellite telemetry of Kemp's ridley sea turtle Lepidochelys kempii in the Gulf of Mexico. In Proceedings of the Ninth Annual Workshop on Sea Turtle Conservation and Biology. NOAA Technical Memorandum NMFS-SEFC-232, Eckert, S.A., Eckert, K.L., Richardson, T.H., eds., pp. 25-26.

Byles, R.A., Plotkin, P.T., 1994. Comparison of the migratory behavior of the congeneric sea turtles Lepidochelys olivacea and L. kempii. In: Thirteenth Annual Symposium on Sea Turtle Biology and Conservation, p. 39.

Byles, R.A., Swimmer, Y.B., 1994. Post-nesting migration of *Eretmochelys imbricata* in the Yucatan Peninsula. In: Fourteenth Annual Symposium on Sea Turtle Biology and Conservation, p. 202.

Caillouet, C.C., Fontaine, T., Manzella-Tirpak, S.A., Williams, T.D., 1995, Growth of head-

started Kemp's ridley sea turtles (Lepidochelys kempii) following release. Chelonian Conservation and Biology 1, 231-234.

Campbell, C.L., Lagueux, C.J., 2005, Survival probability estimates for large juvenile and adult green turtles (Chelonia mydas) exposed to an artisanal marine turtle fishery in the western Caribbean. Herpetologica 61, 91-103.

Cannon, A.C., Flanagan, J.P. 1996. Trauma and treatment of Kemp's ridley sea turtles caught on hook-and-line by recreational fisherman. In Sea turtles biology and conservation workshop.

Cardillo, M., 2003, Biological determinants of extinction risk: Why are smaller species less vulnerable? Animal Conservation 6, 63-69.

Cardillo, M., Mace, G.M., Jones, K.E., Bielby, J., 2005, Multiple causes of high extinction risk in large mammal species. Science 309, 1239-1241.

Cardona, L., Aguilar, A., Pazos, L., 2009, Delayed ontogenic dietary shift and high levels of omnivory in green turtles (Chelonia mydas) from the NW coast of Africa. Marine Biology 156, 1487-1495.

Carr, A., Caldwell, D.K., 1956, The ecology, and migrations of sea turtles: 1. Results of field work in Florida, 1955. American Museum Novitates 1793, 1-23.

Carr, A., Carr, M.H., Meylan, A.B., 1978, The ecology and migration of sea turtles, 7. the west Caribbean turtle colony. Bulletin of the American Museum of Natural History, New York 162, 1-46.

Carr, A.F., 1986, RIPS, FADS, and little loggerheads. Bioscience 36, 92-100.

Carrillo, E., Webb, G.J.W., Manolis, S.C., 1999, Hawksbill Turtles (*Eretmochelys imbricata*) in Cuba: An Assessment of the Historical Harvest and its Impacts. Chelonian Conservation and Biology 3, 264-280.

Carruthers, E.H., Schneider, D.C., Neilson, J.D., 2009, Estimating the odds of survival and identifying mitigation opportunities for common bycatch in pelagic longline fisheries. Biological Conservation 142, 2620-2630.

Casale, P., d'Astore, P.P., Argano, R., 2009a, Age at size and growth rates of early juvenile loggerhead sea turtles (Caretta caretta) in the Mediterranean based on length frequency analysis. Herpetological Journal 19, 29-33.

Casale, P., Mazaris, A.D., Freggi, D., Vallini, C., Argano, R., 2009b, Growth rates and age at adult size of loggerhead sea turtles (Caretta caretta) in the Mediterranean Sea, estimated through capture-mark-recapture records. Scientia Marina 73, 589-595.

Casper, B.M., Lobel, P.S., Yan., H.Y., 2003, The hearing sensitivity of the little skate, Raja erinacea: A comparison of two methods. Environmental Biology of Fishes 68, 371-379.

Casper, B.M., Mann, D. 2004. The hearing abilities of the nurse shark, *Ginglymostoma cirratum*, and the yellow stingray, Urobatis jamaicensis. In American Elasmobranch Society Meeting (University of South Florida, College of Marine Science, St. Petersburg, Florida).

Catry, P., Barbosa, C., Paris, B., Indjai, B., Almeida, A., Limoges, B., Silva, C., Pereira, H.,

2009, Status, Ecology, and Conservation of Sea Turtles in Guinea-Bissau. Chelonian Conservation and Biology 8, 150-160.

Caut, S., Guirlet, E., Girondot, M., 2009, Effect of tidal overwash on the embryonic development of leatherback turtles in French Guiana. Marine Environmental Research 69, 254-261.

Celik, A., Kaska, Y., Bag, H., Aureggi, M., Semiz, G., Kartal, A.A., Elci, L., 2006, Heavy metal monitoring around the nesting environment of green sea turtles in Turkey. Water Air and Soil Pollution 169, 67-79.

Chacon, D. 2002. Assessment about the trade of sea turtles and their products in the Central American isthmus (San José, Costa Rica, Red Regional para la Conservación de last Tortugas Marinas en Centroamérica), p. 247 pages.

Chaloupka, M., 2001, Historical trends, seasonality, and spatial synchrony in green sea turtle egg production. Biological Conservation 101, 263-279.

Chaloupka, M., Bjorndal, K.A., Balazs, G.H., Bolten, A.B., Ehrhart, L.M., Limpus, C.J., Suganuma, H., Troeng, S., Yamaguchi, M., 2007, Encouraging outlook for recovery of a once severely exploited marine megaherbivore. Global Ecology and Biogeography Dec 2007. Available online at http://www.cccturtle.org/pdf/Chaloupka_et_alGEB2007.pdf. Accessed 12/31/2007.

Chaloupka, M., Limpus, C., 2005, Estimates of sex- and age-class-specific survival probabilities for a southern Great Barrier Reef green sea turtle population. Mar. Biol. 146, 1251-1261.

Chaloupka, M., Limpus, C., Miller, J., 2004, Green turtle somatic growth dynamics in a spatially disjunct Great Barrier Reef metapopulation. Coral Reefs 23, 325-335.

Chaloupka, M.Y., Kamezaki, N., Limpus, C., 2008, Is climate change affecting the population dynamics of the endangered Pacific loggerhead sea turtle? J. Exp. Mar. Biol. Ecol. 356, 136-143.

Chaloupka, M.Y., Musick, J.A., 1997, Age, growth, and population dynamics, In: Lutz, P.L., Musick, J.A. (Eds.) The biology of sea turtles. CRC Press, Boca Raton, Florida, pp. 233-273

Chan, E.H., 2006, Marine turtles in Malaysia: on the verge of extinction? Aquatic Ecosystems Health and Management 9, 175-184.

Cheng, I.J., Huang, C.T., Hung, P.Y., Ke, B.Z., Kuo, C.W., Fong, C.L., 2009, Ten Years of Monitoring the Nesting Ecology of the Green Turtle, Chelonia mydas, on Lanyu (Orchid Island), Taiwan. Zoological Studies 48, 83-94.

Collard, S.B., Ogren, L.H., 1990, Dispersal scenarios for pelagic post-hatchling sea turtles. . Bulletin of Marine Science 47, 233-243.

Corsolini, S., Aurigi, A., Focardi, S., 2000, Presence of polychlorobiphenyls (PCBs), and coplanar congeners in the tissues of the Mediterranean loggerhead turtle Caretta caretta. Mar. Pollut. Bull. 40, 952-960.

Cowan, D.E., Curry, B.E. 1998. Investigation of the potential influence of fishery-induced stress on dolphins in the eastern tropical pacific ocean: Research planning (National Marine Fisheries Service, Southwest Fisheries Science Center).

Cowan, D.E., Curry, B.E. 2002. Histopathological assessment of dolphins necropsied onboard vessels in the eastern tropical pacific tuna fishery (National Marine Fisheries Service, Southwest Fisheries Science Center).

Cowan, D.E., Curry, B.E., 2008, Histopathology of the alarm reaction in small odontocetes. Journal of Comparative Pathology 139, 24-33.

Coyne, M., Landry Jr., A.M., 2007, Population sex ratios, and its impact on population models, In: Plotkin, P.T. (Ed.) Biology and conservation of Ridley sea turtles. Johns Hopkins University Press, Baltimore, MD, pp. 191-211.

Coyne, M., Landry Jr., A.M., Costa, D.T., Williams, B.B., 1995. Habitat preference, and feeding ecology of the green sea turtle (*Chelonia mydas*) in south Texas waters. In: Twelfth Annual Workshop on Sea Turtle Biology and Conservation, pp. 21-24.

Craig, J.K., Crowder, L.B., Gray, C.D., McDaniel, C.J., Henwood, T.A., Hanifen, J.G. 2001. Ecological effects of hypoxia on fish, sea turtles, and marine mammals in the northwestern Gulf of Mexico. In Coastal and estuarine studies series, Rabalais, N.N., Turner, R.E., eds. (Washington, D.C., American Geophysical Union), pp. 262-292.

Crouse, O.T., Crowder, L.B., Caswell, H., 1987, A site based population model for loggerhead sea turtles and implications for conservation. Ecology 68, 1412-1423.

Cruz, R.D., 2002. Marine turtle distribution in the Philippines. In: Western Pacific Sea Turtle Cooperative Research and Management Workshop. , Honolulu, Hawaii, pp. 57-66.

Cummings, V., 2002. Sea turtle conservation in Guam. In: Western Pacific Sea Turtle Cooperative Research and Management Workshop. , Honolulu, Hawaii, pp. 37-38.

Daan, N. 1996. Multispecies assessment issues for the North Sea. In American Fisheries Society Symposium 20, E.K.Pikitch, D.D.Huppert, M.P.Sissenwine, eds. (Seattle, Washignton), pp. 126-133.

Davis, R.W., Evans, W.E., Würsig, B. 2000. Cetaceans, Sea Turtles and Seabirds in the Northern Gulf of Mexico: Distribution, Abundance and Habitat Associations. Volume II: Technical Report (Galveston, Texas A&M), p. 346.

De Weede, R.E., 1996, The impact of seaweed introductions on biodiversity. Global Biodiversity 6, 2-9.

Deem, S.L., Norton, T.M., Mitchell, M., Segars, A., Alleman, A.R., Cray, C., Poppenga, R.H., Dodd, M., Karesh, W.B., 2009, COMPARISON OF BLOOD VALUES IN FORAGING, NESTING, AND STRANDED LOGGERHEAD TURTLES (CARETTA CARETTA) ALONG THE COAST OF GEORGIA, USA. Journal of Wildlife Diseases 45, 41-56.

Diaz-Fernandez, R., Okayama, T., Uchiyama, T., Carrillo, E., Espinosa, G., Marquez, R., Diez, C.E., Koike, H., 1999, Genetic sourcing for the hawksbill turtle, Eretmochelys imbricata, in the Northern Caribbean Region. Chelonian Conservation and Biology 3, 296-300.

DiBello, A., Valastro, C., Freggi, D., Saponaro, V., Grimaldi, D., 2010, Ultrasound-guided vascular catheterization in loggerhead sea turtles (Caretta caretta). Journal of Zoo and Wildlife Medicine 41, 516-518.

Dierauf, L., Gulland, F., 2001, CRC Handbook of Marine Mammal Medicine. CRC Press, Boca

Raton, Florida.

Dodd, C.K., 1988a, Synopsis of the biological data on the loggerhead sea turtle: *Caretta caretta* (Linnaeus 1758). Fish and Wildlife Service Biological Report 88, 110.

Dodd, C.K.J., 1988b, Synopsis of the biological data on the loggerhead sea turtle *Caretta caretta* (Linnaeus 1758). USFWS Biological Report 88, 110 pp.

Dodd Jr., C.K. 1988. Synopsis of the biological data on the loggerhead sea turtle, Caretta caretta (Linnaeus 1758). In U.S. Fish and Wildlife Service Biological Report

Duronslet, M.J., Caillouet, C.W., Manzella, S., Indelicato, K.W., Fontaine, C.T., Revera, D.B., Williams, T., Boss, D. 1986. The effects of an underwater explosion on the sea turtles Lepidochelys kempii and Caretta caretta with observations of effects on other marine organisms (Galveston, Texas, Southeast Fisheries Center, National Marine Fisheries Service).

Dutton, P.H. 2003. Molecular ecology of *Chelonia mydas* in the eastern Pacific Ocean. In Proceedings of the 22nd annual symposium on sea turtle biology and conservation

Seminoff, J.A., ed.

Dutton, P.H., Balazs, G.H., In review, Molecular ecology of the green turtle (Chelonia mydas) in the Hawaiian Archipelago: evidence for a distinct population. Endangered Species Research.

Dutton, P.H., Davis, S.K., Guerra, T., Owens, D., 1996, Molecular phylogeny for marine turtles based on sequences of the ND4-leucine tRNA and control regions of mitochondrial DNA. Molecular Phylogenetics and Evolution 5, 511-521.

Eckert, K.L. 1993. The biology and population status of marine turtles in the North Pacific Ocean (Honolulu, Hawaii, NOAA, NMFS, SWFSC).

Ehrhart, L.M., Bagley, D.A., Redfoot, W.E., 2003, Loggerhead turtles in the Atlantic Ocean: Geographic distribution, abundance, and population status, In: Bolten, A.B., Witherington, B.E. (Eds.) Loggerhead Sea Turtles. Smithsonian Books, Washington D.C., pp. 157-174.

Epperly, S., Avens, L., Garrison, L., Henwood, T., Hoggard, W., Mitchell, J., Nance, J., Poffenberger, J., Sasso, C., Scott-Denton, E., Yeung, C. 2002. Analysis of sea turtle bycatch in the commercial shrimp fisheries of southeast U.S. waters and the Gulf of Mexico. In NOAA Technical Memorandum (U.S. Department of Commerce), p. 88.

Epstein, P.R., (Eds.)., J.S. 2002. Oil, a life cycle analysis of its health and environmental impacts. (Boston, MA, Report published by the Center for Health and the Global Environment, Harvard Medical School), p. 73.

Erhart, L.M., D.A. Bagley, Redfoot, W.E., 2003, Loggerhead Turtles in the Atlantic Ocean : Geographic Distribution, Abundance, and Population Status. Pp.157-174 *In:* Bolten, A.B. and B.E. Witherington (eds), Loggerhead Sea Turtles. Smithsonian Books, Washington D.C.

Feare, C.J., 1976, Desertion and abnormal development in a colony of Sooty terns infested by virus-infected ticks. Ibis 118, 112-115.

FFWCC 2007a. Florida Statewide Nesting Beach Survey Data–2005 Season (Florida Fish and Wildlife Conservation Commission).

FFWCC 2007b. Long-term monitoring program reveals a continuing loggerhead decline, increases in green turtle and leatherback nesting (Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute).

Ficetola, G.F., 2008, Impacts of Human Activities and Predators on the Nest Success of the Hawksbill Turtle, Eretmochelys imbricata, in the Arabian Gulf. Chelonian Conservation and Biology 7, 255-257.

Fitzsimmons, N.N., Tucker, A.D., Limpus, C.J., 1995, Long-term breeding histories of male green turtles and fidelity to a breeding ground. Marine Turtle Newsletter 68, 2-4.

Fleming, E.H. 2001. Swimming against the tide; recent surveys of exploitation, trade, and management of marine turtles in the Northern Caribbean. In TRAFFIC North America, p. 161.

Flint, M., Morton, J.M., Limpus, C.J., Patterson-Kane, J.C., Murray, P.J., Mills, P.C., 2009, Development and application of biochemical and haematological reference intervals to identify unhealthy green sea turtles (Chelonia mydas). The Veterinary Journal.

Foley, A.M., Schroeder, B.A., Redlow, A.E., Fick-Child, K.J., Teas, W.G., 2005, Fibropapillomatosis in stranded green turtles (Chelonia mydas) from the eastern United States (1980-98): Trends and associations with environmental factors. Journal of Wildlife Diseases 41, 29-41.

Foti, M., Giacopello, C., Bottari, T., Fisichella, V., Rinaldo, D., Mammina, C., 2009, Antibiotic Resistance of Gram Negatives isolates from loggerhead sea turtles (Caretta caretta) in the central Mediterranean Sea. Marine Pollution Bulletin 58, 1363-1366.

Francour, P., Ganteaume, A., Poulain, M., 1999, Effects of boat anchoring in Posidonia oceanica seagrass beds in the Port-Cros National Park (north-western Mediterranean Sea). Aquatic Conservation: Marine and Freshwater Ecosystems 9, 391-400.

Frazer, N.B., Ehrhart, L.M., 1985, Preliminary growth models for green, *Chelonia mydas*, and loggerhead, *Caretta caretta*, turtles in the wild. Copeia 1985, 73-79.

Fretey, J. 2001. Biogeography and conservation of marine turtles of the Atlantic coast of Africa. In CMS Technical Series Publication (Bonn, Germany, UNEP/CMS Secretariat).

Frid, A., 2003, Dall's sheep responses to overflights by helicopter and fixed-wing aircraft. Biological Conservation 110, 387-399.

Frid, A., Dill, L., 2002, Human-caused disturbance stimuli as a form of predation risk. Conservation Ecology 6.

Fritts, T.H., Hoffman, W., McGehee, M.A., 1983, The distribution and abundance of marine turtles in the Gulf of Mexico and nearby Atlantic waters. Journal of Herpetology 17, 327-344.

Fritts, T.H., McGehee, M.A. 1981. Effects of petroleum on the development and survival of marine turtles embryos. In U.S. Fish and Wildlife Service, Contract No. 14-16-00009-80-946, FWSIOBS-81-3 (Washington, D.C).

Fuentes, M., Hamann, M., Limpus, C.J., 2009a, Past, current and future thermal profiles of green turtle nesting grounds: Implications from climate change. Journal of Experimental Marine Biology and Ecology 383, 56-64.

Fuentes, M.M.P.B., Abbs, D., 2010, Effects of projected changes in tropical cyclone frequency on sea turtles. Marine Ecology Progress Series 412, 283-292.

Fuentes, M.M.P.B., Hamann, M., Limpus, C.J., 2009b, Past, current and future thermal profiles of green turtle nesting grounds: Implications from climate change. J. Exp. Mar. Biol. Ecol. in press, in press.

Fuentes, M.M.P.B., Limpus, C.J., Hamann, M., 2010, Vulnerability of sea turtle nesting grounds to climate change. Global Change Biology in press, in press.

Fuentes, M.M.P.B., Maynard, J.A., Guinea, M., Bell, I.P., Werdell, P.J., Hamann, M., 2009c, Proxy indicators of sand temperature help project impacts of global warming on sea turtles in northern Australia. Endangered Species Research 9, 33-40.

Fujihara, J., Kunito, T., Kubota, R., Tanabe, S., 2003, Arsenic accumulation in livers of pinnipeds, seabirds and sea turtles: Subcellular distribution and interaction between arsenobetaine and glycine betaine. Comparative Biochemistry and Physiology C-Toxicology & Pharmacology 136, 287-296.

Garbarino, J.R., Hayes, H.C., Roth, D.A., Antweiler, R.C., Brinton, T.I., Taylor, H.E. 1995. Heavy metals in the Mississippi River. In Contaminants in the Mississippi River, Meade, R., ed.

Garcia-Fernandez, A.J., Gomez-Ramirez, P., Martinez-Lopez, E., Hernandez-Garcia, A., Maria-Mojica, P., Romero, D., Jimenez, P., Castillo, J.J., Bellido, J.J., 2009, Heavy metals in tissues from loggerhead turtles (Caretta caretta) from the southwestern Mediterranean (Spain). Ecotoxicology and Environmental Safety 72, 557-563.

Gardner, S.C., Fitzgerald, S.L., Vargas, B.A., Rodriguez, L.M., 2006, Heavy metal accumulation in four species of sea turtles from the Baja California Peninsula, Mexico. Biometals 19, 91-99.

Gardner, S.C., Pier, M.D., Wesselman, R., Juarez, J.A., 2003, Organochlorine contaminants in sea turtles from the Eastern Pacific. Mar. Pollut. Bull. 46, 1082-1089.

Garofalo, L., Mingozzi, T., Mico, A., Novelletto, A., 2009, Loggerhead turtle (Caretta caretta) matrilines in the Mediterranean: further evidence of genetic diversity and connectivity. Marine Biology 156, 2085-2095.

Giese, M., 1996, Effects of human activity on Adelie penguin (Pygoscelis adeliae) breeding success. Biological Conservation 75, 157-164.

Gill, J.A., Norris, K., Sutherland, W.J., 2001, Why behavioural responses may not reflect the population consequences of human disturbance. Biological Conservation 97, 265-268.

Gilman, E.L. 2009. Guidelines to reduce sea turtle mortality in fishing operations (Rome, FAO).

Girard, C., Tucker, A.D., Calmettes, B., 2009, Post-nesting migrations of loggerhead sea turtles in the Gulf of Mexico: dispersal in highly dynamic conditions. Marine Biology 156, 1827-1839.

Gitschlag, G.R., 1996, Migration and diving behavior of Kemp's ridley (Garman) sea turtles along the U.S. southeastern Atlantic coast. Journal of Experimental Marine Biology and Ecology 205, 115-135.

Gitschlag, G.R., Herczeg, B.A., 1994, Sea turtle observations at explosive removals of energy structures. Marine Fisheries Review 56, 1-8.

Gitschlag, G.R., Herczeg, B.A., Barcak, T.R., 1997, Observations of sea turtles and other marine life at the explosive removal of offshore oil and gas structures in the Gulf of Mexico. Gulf Research Reports 9, 247-262.

Godley, B., Richardson, J.S., Broderick, A.C., Coyne, M.S., Glen, F., Hays, G.C., 2002, Long-term satellite telemetry of the movements and habitat utilization by green turtles in the Mediterranean. Ecography 25, 352-362.

Godley, B.J., Thompson, D.R., Furness, R.W., 1999, Do heavy metal concentrations pose a threat to marine turtles from the Mediterranean Sea? Mar. Pollut. Bull. 38, 497-502.

Godley, B.J., Thompson, D.R., Waldron, S., Furness, R.W., 1998, The trophic status of marine turtles as determined by stable isotope analysis. Marine Ecology Progress Series 166, 277-284.

Godley, B.J.E., Lima, H.S.M., Akesson, S., Broderick, A.C., Glen, F., Godfrey, M.H., Luschi, P., Hays, G.C., 2003, Movement patterns of green turtles in Brazilian coastal waters described by satellite tracking and flipper tagging. Marine Ecology Progress Series 253, 279-288.

Grant, G.S., Craig, P., Balazs, G.H., 1997, Notes on juvenile hawksbill and green turtles in American Samoa. Pacific Science 51, 48-53.

Gregory, L.F., Gross, T.S., Bolten, A., Bjorndal, K., Guillette, L.J., 1996, Plasma corticosterone concentrations associated with acute captivity stress in wild loggerhead sea turtles (Caretta caretta). General and Comparative Endocrinology 104, 312-320.

Gregory, L.F., Schmid, J.R., 2001a, Stress responses and sexing of wild Kemp's ridley sea turtles (Lepidochelys kempii) in the Northeastern Gulf of Mexico. Gen. Comp. Endocrinol. 124, 66-74.

Gregory, L.F., Schmid, J.R., 2001b, Stress responses and sexing of wild Kemp's ridley sea turtles (*Lepidochelys kempii*) in the northwestern Gulf of Mexico. General and Comparative Endocrinology 124, 66-74.

Gulko, D., Eckert, K.L., 2003, Sea turtles: an ecological guide. Mutual Publishing, Honolulu, Hawaii.

Hamann, M., Limpus, C., Hughes, G., Mortimer, J., Pilcher, N. 2006. Assessment of the conservation status of the leatherback turtle in the Indian Ocean and South East Asia, including consideration of the impacts of the December 2004 tsunami on turtles and turtle habitats (Bangkok, Thailand, IOSEA Marine Turtle MoU Secretariat).

Harms, C.A., Mallo, K.M., Ross, P.M., Segars, A., 2003, Venous blood gases and lactates of wild loggerhead sea turtles (Caretta caretta) following two capture techniques. Journal of Wildlife Diseases 39, 366-374.

Harrington, F.H., Veitch, A.M., 1992, Calving success of woodland caribou exposed to low-level jet fighter overflights. Arctic 45, 213-218.

Hatase, H., Kinoshita, M., Bando, T., Kamezaki, N., Sato, K., Matsuzawa, Y., Goto, K., Omuta, K., Nakashima, Y., Takeshita, H., Sakamoto, W., 2002a, Population structure of loggerhead turtles, *Caretta caretta*, nesting in Japan: bottlenecks on the Pacific population. Marine biology 141, 299-305.

Hatase, H., Matsuzawa, Y., Sakamoto, W., Baba, N., Miyawaki, I., 2002b, Pelagic habitat use of an adult Japanese male loggerhead turtle Caretta caretta examined by the Argos satellite system. Fisheries Science 68, 945-947.

Hatase, H., Sakamoto, W., 2004, Forage-diving behaviour of adult Japanese female loggerhead turtles (Caretta caretta) inferred from Argos location data. Journal of the Marine Biological Association of the United Kingdom 84, 855-856.

Hatase, H., Sato, K., Yamaguchi, M., Takahashi, K., Tsukamoto, K., 2006, Individual variation in feeding habitat use by adult female green sea turtles (Chelonia mydas): Are they obligately neritic herbivores? Oecologia 149, 52-64.

Hatase, H., Takai, N., Matsuzawa, Y., Sakamoto, W., Omuta, K., Goto, K., Arai, N., Fujiwara, T., 2002c, Size-related differences in feeding habitat use of adult female loggerhead turtles Caretta caretta around Japan determined by stable isotope analyses and satellite telemetry. Marine Ecology Progress Series 233, 273-281.

Hawkes, L.A., Broderick, A., Godfrey, M.H., Godley, B.J., 2007, The potential impact of climate change on loggerhead sex ratios in the Carolinas - how important are North Carolina's males? P.153 *in*: Frick, M.; A. Panagopoulou; A.F. Rees; K. Williams (compilers), 27th Annual Symposium on Sea Turtle Biology and Conservation [abstracts]. 22-28 February 2007, Myrtle Beach, South Carolina. 296p.

Hazel, J., 2009, Evaluation of fast-acquisition GPS in stationary tests and fine-scale tracking of green turtles. Journal of Experimental Marine Biology and Ecology 374, 58-68.

Hazel, J., Lawler, I.R., Hamann, M., 2009, Diving at the shallow end: Green turtle behaviour in near-shore foraging habitat. Journal of Experimental Marine Biology and Ecology 371, 84-92.

Hazel, J., Lawler, I.R., Marsh, H., Robson, S., 2007, Vessel speed increases collision risk for the green turtle *Chelonia mydas*. Endangered Species Research 3, 105-113.

Heithaus, M.R., McLash, J.J., Frid, A., Dill, L.M., Marshall, G.J., 2002, Novel insights into green sea turtle behaviour using animal-borne video cameras. Journal of the Marine Biological Association of the United Kingdom 82, 1049-1050.

Henwood, T.A., Stuntz, W.E., 1987, Analysis of sea turtle captures and mortalities during commercial shrimp trawling. Fishery Bulletin 85, 813-817.

Heppell, S.S., Snover, M.L., Crowder, L.B., 2003, Sea turtle population ecology. Chapter 11 *In*: Lutz, P.L., J.A. Musick, and J. Wyneken (eds), The Biology of Sea Turtles: Volume II. CRC Press. Pp.275-306.

Hermanussen, S., Matthews, V., Papke, O., Limpus, C.J., Gaus, C., 2008, Flame retardants (PBDEs) in marine turtles, dugongs and seafood from Queensland, Australia. Mar. Pollut.

Bull. 57, 409-418.

Herraez, P., Sierra, E., Arbelo, M., Jaber, J.R., de los Monteros, A.E., Fernandez, A., 2007, Rhabdomyolysis and myoglobinuric nephrosis (capture myopathy) in a striped dolphin. Journal of Wildlife Diseases 43, 770-774.

Hildebrand, H.H., 1963, Hallazgo del area de anidacion de la tortuga marina "lora", Lepidochelys kempi (Garman), en la costa occidental del Golfo de Mexico (Rept., Chel.). Ciencia, Mexico 22, 105-112.

Hildebrand, H.H., 1983, Random notes on sea turtles in the western Gulf of Mexico. Western Gulf of Mexico Sea Turtle Workshop Proceedings, January 13-14, 1983, 34-41.

Hillis-Starr, Coyne, Z.M., Monaco, M., 2000. Buck Island and back: Hawksbill turtles make their move. In: Nineteenth Annual Symposium on Sea Turtle Biology and Conservation, p. 159.

Hirth, H.F. 1997. Synopsis of the biological data on the green turtle, Chelonia mydas (Linnaeus 1758).

Hoegh-Guldberg, O., Bruno, J.F., 2010, The Impact of Climate Change on the World's Marine Ecosystems. Science 328, 1523-1528.

Hoopes, L.A., Landry, A.M.J., Stabenau, E.K., 2000, Physiological effects of capturing Kemp's ridley sea turtles, *Lepidochelys kempii*, in entanglement nets. Canadian Journal of Zoology 78, 1941-1947.

Hornell, J. 1927. The turtle fisheries of the Seychelles Islands (London, UK, H.M. Stationery Office).

Horrocks, J.A., Scott, N., 1991, Nest site location, and nest success in the hawksbill turtle Eretmochelys imbricata in Barbados, West Indies. Marine Ecology Progress Series 69, 1-8.

Horrocks, J.A., Vermeer, L.A., Krueger, B., Coyne, M., Schroeder, B.A., Balazs, G.H., 2001, Migration routes and destination characteristics of post-nesting hawksbill turtles satellite-tracked from Barbados, West Indies. Chelonian Conservation and Biology 4, 107-114.

Howell, E.A., Kobayashi, D.R., Parker, D.M., Balazs, G.H., Polovina, J.J., 2008, TurtleWatch: a tool to aid in the bycatch reduction of loggerhead turtles Caretta caretta in the Hawaii-based pelagic longline fishery. Endangered Species Research 5, 267-278.

Hulin, V., Delmas, V., Girondot, M., Godfrey, M.H., Guillon, J.M., 2009, Temperature-dependent sex determination and global change: are some species at greater risk? Oecologia 160, 493-506.

Hutchinson, B.J., Dutton, P. 2007. Modern genetics reveals ancient diversity in the loggerhead. In SWOT report, volume II. State of the World’s Sea Turtles.

I-Jiunn, C., 2009, Changes in diving behaviour during the internesting period by green turtles. Journal of Experimental Marine Biology and Ecology.

Innis, C., Nyaoke, A.C., Williams, C.R., Dunnigan, B., Merigo, C., Woodward, D.L., Weber, E.S., Frasca, S., 2009, PATHOLOGIC AND PARASITOLOGIC FINDINGS OF COLD-STUNNED KEMP'S RIDLEY SEA TURTLES (LEPIDOCHELYS KEMPII)

STRANDED ON CAPE COD, MASSACHUSETTS, 2001-2006. Journal of Wildlife Diseases 45, 594-610.

Innis, C., Tlusty, M.F., Perkins, C., Holladay, S., Merigo, C., Scott Webber III, E., 2008, Trace metal and organochlorine pesticide concentrations in cold-stunned kuvenile Kemp's ridley turtles (Lepidochelys kempii) from Cape Cod, Massachusetts. Chelonian Conservation and Biology 7, 230-239.

IPCC 2000. Land use, land-use change, and forestry. In (Intergovernmental Panel on Climate Change), Watson, R.T., Noble, I.R., Bolin, B., Ravindranath, N.H., Verardo, D.J., Dokken, D.J., eds. (Cambridge, England, Cambridge University Press).

IPCC 2001a. Climate change 2001: Impacts, adaptation and vulnerability, contribution of working group II to the third assessment report of the intergovernmental panel on climate change. In (Intergovernmental Panel on Climate Change), McCarthy, J.J., Canziani, O.F., Leary, N.A., Dokken, D.J., White, K.S., eds. (Cambridge, England, Cambridge University Press).

IPCC 2001b. Climate change 2001: The scientific basis, contribution of working group I to the third assessment report of the intergovernmental panel of climate change. In (Intergovernmental Panel on Climate Change), Houghton, J.T., Ding, Y., Griggs, D.J., Noguer, M., Linden, P.J.v., Dai, X., Maskell, K., Johnson, C.A., eds. (Cambridge, England, Cambridge University Press).

IPCC 2002. Climate change and biodiversity. In (Intergovernmental Panel on Climate Change), Gitay, H., Suárez, A., Watson, R.T., Dokken, D.J., eds.

Isaac, J.L., 2008, Effects of climate change on life history: Implications for extinction risk in mammals. Endangered Species Research.

Ischer, T., Ireland, K., Booth, D.T., 2009, Locomotion performance of green turtle hatchlings from the Heron Island Rookery, Great Barrier Reef. Marine Biology 156, 1399-1409.

Issac, J.L., 2009, Effects of climate change on life history: Implications for extinction risk in mammals. Endangered Species Research 7, 115-123.

Iwamoto, T., Ishii, M., Nakashima, Y., Takeshita, H., Itoh, A., 1985, Nesting cycles and migrations of the loggerhead sea turtle in Miyazaki, Japan. Japanese Journal of Ecology 35, 505-511.

Kamezaki, N., 1989, The nesting sites of sea turtles in the Ryukyu Archipelago and Taiwan, In: Matsui, M., Hikida, T., Goris, R.C. (Eds.) Current herpetology in East Asia. Herpetological Society of Japan, Kyoto, pp. 342-348.

Kamezaki, N., Matsuzawa, Y., Abe, O., Asakawa, H., Fujii, T., Goto, K., Hagino, S., Hayami, M., Ishii, M., Iwamoto, T., Kamata, T., Kato, H., Kodama, J., Kondo, Y., Miyawaki, I., Mizobuchi, K., Nakamura, Y., Nakashima, Y., Naruse, H., Omuta, K., Samejima, M., Suganuma, H., Takeshita, H., Tanaka, T., Toji, T., Uematsu, M., Yamamoto, A., Yamato, T., Wakabayashi, I., 2003, Loggerhead turtles nesting in Japan, In: Bolten, A.B., Witherington, B.E. (Eds.) Loggerhead sea turtles. Smithsonian Books, Washington D.C., pp. 210-217.

Kapurisinghe, T., 2006, Status and conservation of marine turtles in Sri Lanka, In: Shanker, K.,

Choudhury, B.C. (Eds.) Marine Turtles of the Indian Subcontinent. Universities Press, India, pp. 173-187.

Kawamura, G., Naohara, T., Tanaka, Y., Nishi, T., Anraku, K., 2009, Near-ultraviolet radiation guides the emerged hatchlings of loggerhead turtles Caretta caretta (Linnaeus) from a nesting beach to the sea at night. Marine and Freshwater Behaviour and Physiology 42, 19-30.

Keinath, J.A., Musick, J.A., Barnard, D.E., 1996, Abundance and distribution of sea turtles off North Carolina. OCS Study, MMS 95-0024, 156.

Keller, J.M., Kannan, K., Taniyasu, S., Day, R.D., Arendt, M.D., Segars, A.L., Kucklick, J.R., 2005, Perfluorinated compounds in the plasma of loggerhead and Kemp's ridley sea turtles from the southeastern coast of the United States. Environmental Science and Technology 39, 9101-9108.

Keller, J.M., Kucklick, J.R., Harms, C.A., McClellan-Green, P.D., 2004a, Organochlorine contaminants in sea turtles: Correlations between whole blood and fat. Environmental Toxicology and Chemistry 23, 726-738.

Keller, J.M., Kucklick, J.R., McClellan-Green, P.D., 2004b, Organochlorine contaminants in loggerhead sea turtle blood: Extraction techniques and distribution among plasma, and red blood cells. Archives of Environmental Contamination and Toxicology 46, 254-264.

Keller, J.M., Kucklick, J.R., Stamper, M.A., Harms, C.A., McClellan-Green, P.D., 2004c, Associations between organochlorine contaminant concentrations and clinical health parameters in loggerhead sea turtles from North Carolina, USA. Environmental Health Parameters 112, 1074-1079.

Keller, J.M., McClellan-Green, P., 2004, Effects of organochlorine compounds on cytochrome P450 aromatase activity in an immortal sea turtle cell line. Mar. Environ. Res. 58, 347-351.

Keller, J.M., McClellan-Green, P.D., Kucklick, J.R., Keil, D.E., Peden-Adams, M.M., 2006, Turtle immunity: Comparison of a correlative field study and in vitro exposure experiments. Environmental Health Perspectives 114, 70-76.

Klima, E.F., Gitschlag, G.R., Renaud, M.L., 1988, Impacts of the explosive removal of offshore petroleum platforms on sea turtles and dolphins. Marine Fisheries Review 50, 33-42.

Kobayashi, D.R., Polovina, J.J., Parker, D.M., Kamezaki, N., Cheng, I.-J., Uchida, I., Dutton, P.H., Balazs, G.H., 2008, Pelagic habitat characteriation of loggerhead sea turtles, Caretta caretta, in the North Pacific Ocean (1997-2006): insights from satellite tag tracking and remotely sensed data. Journal of Marine Biology and Ecology 356, 96-114.

Kuller, Z., 1999, Current status and conservation of marine turtles on the Mediterranean coast of Israel. Marine Turtle Newsletter 86, 3-5.

LADEQ 2010. Beach sweep and inland waterway cleanup (Louisiana Department of Environmental Quality Litter Reduction and Public Action).

Lagueux, C.J., 1998. Marine Turtle fishery of Caribbean Nicaragua: human Use Patterns and Harvest Trends. Dissertation. University of Florida,

Lagueux, C.J., Campbell, C.L., McCoy, W.A., 2003, Nesting, and conservation of the hawksbill turtle, Eretmochelys imbricata, in the Pearl Cays, Nicaragua. Chelonian Conservation and Biology 4, 588-602.

Laist, D.W., Coe, J.M., O'Hara, K.J., 1999, Marine debris pollution, In: Twiss, J., Reeves, R.R. (Eds.) Conservation and management of marine mammals. Smithsonian Institution Press, Washington, D.C., pp. 342-366.

Lake, J., Haebler, L.R., McKinney, R., Lake, C.A., Sadove, S.S., 1994, PCBs and other chlorinated organic contaminants in tissues of juvenile Kemp's ridley turtles (Lepidochelys kempii). Marine Environmental Research 38, 313-327.

Landry, A.M. 2010. Population dynamics of sea turtle assemblages.

Landry, A.M., Jr., Costa, D., 1999, Status of sea turtle stocks in the Gulf of Mexico with emphasis on the Kemp's ridley, In: Kumpf, H., Steidinger, K., Sherman, K. (Eds.) The Gulf of Mexico large marine ecosystem: Assessment, sustainability, and management. Blackwell Science, Malden, Massachusetts, pp. 248-268.

Landry, A.M.J., Costa, D.T., Kenyon, F.L., Hadler, M.C., Coyne, M.S., Hoopes, L.A., Orvik, L.M., St.John, K.E., VanDenburg, K.J., 1996, Population Dynamics and Index Habitat Characterization for Kemp's Ridley Sea Turtles in Nearshore Waters of the Northwestern Gulf of Mexico. Report of Texas A&M Research Foundation pursuant to NOAA Award No. NA57FF0062, 153.

Landsberg, J.H., Balazs, G.H., Steidinger, K.A., Baden, D.G., Work, T.M., Russell, D.J., 1999, The potential role of natural tumor promoters in marine turtle fibropapillomatosis. Journal of Aquatic Animal Health 11, 199-210.

Law, R.J., Hellou, J., 1999, Contamination of fish and shellfish following oil spill incidents. Environmental Geoscience 6, 90-98.

Lazar, B., Gračan, R., 2010, Ingestion of marine debris by loggerhead sea turtles, Caretta caretta, in the Adriatic Sea. Marine Pollution Bulletin.

Le Gall, J., Bosc, Y.P., Chateau, D., Taquet, M., 1986, Estimation du nombre de tortues vertes femelles adultes Chelonia mydas par saison de ponte á Tromelin et Europa (Océan Indien) (1973-1985). Océanographie Tropicale 21, 3-22.

Leblanc, A.M., Wibbels, T., 2009, Effect of Daily Water Treatment on Hatchling Sex Ratios in a Turtle With Temperature-Dependent Sex Determination. J. Exp. Zool. Part A 311A, 68-72.

Lee Long, W.J., Coles, R.G., McKenzie, L.J., 2000, Issues for seagrass conservation management in Queensland. Pacific Conservation Biology 5, 321-328.

Lenhardt, M.L. 2003. Effects of noise on sea turtles. In Proceedings of the First International Conference on Acoustic Communication by Animals (University of Maryland).

LGL Ltd., 2007, Environmental Assessment of a Marine Geophysical Survey by the *R/V Marcus G. Langseth* off Central America, January–March 2008. Prepared for the Lamont-Doherty Earth Observatory, Palisades, NY, and the National Science Foundation, Arlington, VA, by LGL Ltd., environmental research associates, Ontario, Canada. LGL Report TA4342-1.

LHR 2010. Energy, oil & gas (Louisiana Hurricane Resources).

Liew, H.C., 2002. Status of marine turtle conservation and research in Malaysia. In: Western Pacific Sea Turtle Cooperative Research and Management Workshop, Honolulu, Hawaii, pp. 51-56.

Lima, S.L., 1998, Stress and decision making under the risk of predation. Advances in the Study of Behavior 27, 215-290.

Limpus, C., Chaloupka, M., 1997, Nonparametric regression modeling of green sea turtle growth rates (southern Great Barrier Reef). Marine Ecology Progress Series 149, 23-34.

Limpus, C.J., 1985. A study of the loggerhead turtle, Caretta caretta, in eastern Australia. PhD thesis. University of Queensland, Brisbane, Australia.

Limpus, C.J., Limpus, D.J., 2003, Loggerhead turtles in the equatorial, and southern Pacific Ocean: A species in decline, In: Bolten, A.B., Witherington, B.E. (Eds.) Loggerhead sea turtles. Smithsonian Books, Washington D.C., pp. 199-209.

Limpus, C.J., Miller, J.D., Limpus, D.J., Hamann, M., 2002. The Raine Island green turtle rookery: Y2K update. In: Twentieth Annual Symposium on Sea Turtle Biology and Conservation. , pp. 132-134.

Limpus, C.J., Miller, J.D., Parmenter, C.J., Limpus, D.J., 2003, The green turtle, Chelonia mydas, population of Raine Island and the northern Great Barrier Reef, 1843-2001. Memoirs of the Queensland Museum 49, 349-440.

Limpus, C.J., Nicholls, N., 1988, The Southern Oscillation regulates the annual numbers of green turtles (Chelonia mydas) breeding around northern Australia. Australian Journal of Wildlife Research 15, 157-161.

Lohoefener, R.R., Hoggard, W., Mullin, K., Roden, C., Rogers, C., 1990, Association of sea turtles with petroleum platforms in the north-central Gulf of Mexico. OCS Study, MMS 90-0025, 90 pp.

López, E., Arauz, R., 2003. Nesting records of East Pacific green turtles (*Chelonia mydas agassizii*) in south Pacific Costa Rica, including notes on incidental capture by shrimping and longline activities. In: Twenty-second Annual Symposium on Sea Turtle Biology and Conservation. , pp. 84-85.

Lordi, B., Patin, V., Protais, P., Mellier, D., Caston, J., 2000, Chronic stress in pregnant rats: effects on growth rate, anxiety and memory capabilities of the offspring. International Journal of Psychophysiology 37, 195-205.

Lubchenco, J., McNutt, M., Lehr, B., Sogge, M., Miller, M., Hammond, S., Conner, W. 2010. Deepwater Horizon/BP oil budget: What happened to the oil?, USGS, NMFS, DOI, eds.

LUMCON 2005. Mapping of dead zone completed (Chauvin, Louisiana, Louisiana Universities Marine Consortium).

Lutcavage, M.E., Plotkin, P., Witherington, B., Lutz, P.L., 1997a, Human impacts on sea turtle survival, In: The Biology of Sea Turtles. CRC Press, Boca Raton, Florida, pp. 387-409.

Lutcavage, M.E., Plotkin, P., Witherington, B.E., Lutz, P.L., 1997b, Human impacts on sea turtle survival, In: Lutz, P.L., Musick, J.A. (Eds.) Biology of sea turtles. CRC Press, New

York, New York, pp. 387-409.

MacDonald, I.R., Jr., N.L.G., Ackleson, S.G., Amos, J.F., Duckworth, R., Sassen, R., Brooks, J.M., 1993, Natural oil slicks in the Gulf of Mexico visible from space. Journal of Geophysical Research 98, 16,351-316,364.

Makowski, C., Seminoff, J.A., Salmon, M., 2006, Home range and habitat use of juvenile Atlantic green turtles (Chelonia mydas L.) on shallow reef habitats in Palm Beach, Florida, USA. Mar. Biol. 148, 1167-1179.

Mansfield, K.L., Saba, V.S., Keinath, J.A., Musick, J.A., 2009, Satellite tracking reveals a dichotomy in migration strategies among juvenile loggerhead turtles in the Northwest Atlantic. Marine Biology 156, 2555-2570.

Marcovaldi, M.A., Chaloupka, M., 2007, Conservation status of the loggerhead sea turtle in Brazil: An encouraging outlook. Endangered Species Research 3, 133-143.

Margaritoulis, D., Argano, R., Baran, I., Bentivegna, F., Bradai, M.N., Camiñas, J.A., Casale, P., De Metrio, G., Demetropoulos, A., Gerosa, G., Godley, B.J., Haddoud, D.A., Houghton, J., Laurent, L., Lazar, B., 2003, Loggerhead turtles in the Mediterranean Sea: Present knowledge and conservation perspectives, In: Bolten, A.B., Witherington, B.E. (Eds.) Loggerhead sea turtles. Smithsonian Books, Washington D.C., pp. 175-198

Marquez-M., R., 1994, Synopsis of biological data on the Kemp's ridley turtle, *Lepidochelys kempii*, (Garman, 1880). NOAA Technical Memorandum NMFS-SEFSC-343, or OCS Study MMS 94-0023. 91p.

Márquez, M.R., 1990, Sea turtles of the world. An annotated and illustrated catalogue of sea turtle species known to date. FAO Species Catalog, FAO Fisheries Synopsis 11(125):81p. .

Marquez, M.R., Villanueva, A., Burchfield, P.M., 1989. Nesting population, and production of hatchlings of Kemp's ridley sea turtle at Rancho Nuevo, Tamaulipas, Mexico. In: First International Symposium on Kemp's Ridley Sea Turtle Biology, Conservation, and Management, pp. 16-19.

Marsh, J.W., Chipman, J.K., Livingstone, D.R., 1992, Activation of xenobiotics to reactive and mutagenic products by the marine invertebrates Mytilus edulis, Carcinus maenus, and Asterias rubens. Aquatic Toxicology 22, 115-128.

Marshall, C.D., Moss, A.L., Guzman, A., 2009, Loggerhead Sea Turtle (Caretta caretta) Feeding on Mackerel-Baited Longline Hooks. Integrative and Comparative Biology 49, E266-E266.

MASGC 2010. Mississippi coastal cleanup (Mississippi Alabama Sea Grant Consortium).

Mazaris, A.D., Kallimanis, A.S., Sgardelis, S.P., Pantis, J.D., 2008, Do long-term changes in sea surface temperature at the breeding areas affect the breeding dates and reproduction performance of Mediterranean loggerhead turtles? Implications for climate change. Journal of Experimental Marine Biology and Ecology.

Mazaris, A.D., Kallimanis, A.S., Tzanopoulos, J., Sgardelis, S.P., Pantis, J.D., 2009a, Sea surface temperature variations in core foraging grounds drive nesting trends and phenology of loggerhead turtles in the Mediterranean Sea. Journal of Experimental

Marine Biology and Ecology.

Mazaris, A.D., Matsinos, G., Pantis, J.D., 2009b, Evaluating the impacts of coastal squeeze on sea turtle nesting. Ocean & Coastal Management 52, 139-145.

McCarthy, A.L., Heppell, S., Royer, F., Freitas, C., Dellinger, T., 2010, Identification of likely foraging habitat of pelagic loggerhead sea turtles (Caretta caretta) in the North Atlantic through analysis of telemetry track sinuosity. Progress in Oceanography.

McCauley, S.J., Bjorndal, K.A., 1999, Conservation implications of dietary dilution from debris ingestion: Sublethal effects in post-hatchling loggerhead sea turtles. Conservation Biology 13, 925-929.

McClellan, C.M., Braun-McNeill, J., Avens, L., Wallace, B.P., Read, A.J., 2010, Stable isotopes confirm a foraging dichotomy in juvenile loggerhead sea turtles. Journal of Experimental Marine Biology and Ecology 387, 44-51.

McClellan, C.M., Read, A.J., Price, B.A., Cluse, W.M., Godfrey, M.H., 2009, Using telemetry to mitigate the bycatch of long-lived marine vertebrates. Ecological Applications 19, 1660-1671.

McDonald Dutton, D., Dutton, P.H., 1998. Accelerated growth in San Diego Bay green turtles? In: Seventeenth Annual Sea Turtle Symposium, pp. 175-176.

McKenzie, C., Godley, B.J., Furness, R.W., Wells, D.E., 1999, Concentrations and patterns of organochlorine contaminants in marine turtles from Mediterranean and Atlantic waters. Mar. Environ. Res. 47, 117-135.

Meador, J.P., Stein, R., Varanasi, U., 1995, Bioaccumulation of polycyclic aromatic hydrocarbons by marine organisms. Reviews of Environmental Contamination and Toxicology 143, 79-165.

Mellgren, R.L., Mann, M.A., 1996. Comparative behavior of hatchling sea turtles. In: Fifteenth Annual Symposium on Sea Turtle Biology and Conservation, pp. 202-204.

Mellgren, R.L., Mann, M.A., Bushong, M.E., Harkins, S.R., Krumke, V.K., 1994. Habitat selection in three species of captive sea turtle hatchlings. In: Fourteenth Annual Symposium on Sea Turtle Biology and Conservation, pp. 259-260.

Mendonca, M.T., Pritchard, P.C.H., 1986, Offshore movements of post-nesting Kemp's ridley sea turtles (Lepidochelys kempii). Herpetologica 42, 373-380.

Meylan, A., Schroeder, B., Mosier, A., 1995, Sea turtle nesting activity in the State of Florida 1979-1992. Florida Marine Research Publications 52.

Meylan, A.B., Bowen, B.W., Avise, J.C., 1990, A genetic test of the natal homing versus social facilitation models for green turtle migration. Science 248, 724-727.

Miao, X., Balazsb, G.H., Murakawa, S.K.K., Li, Q.X., 2001, Congener-specific profile, and toxicity assessment of PCBs in green turtles (Chelonia mydas)from the Hawaiian Islands. The Science of the Total Environment 281, 247-253.

Miller, J.D., Dobbs, K.A., Limpus, C.J., Mattocks, N., Landry, A.M., 1998, Long-distance migrations by the hawksbill turtle, Eretmochelys imbricata, from north-eastern Australian. Wildlife Research 25, 89-95.

Milliken, T., Tokunaga, H. 1987. The Japanese sea turtle trade 1970-1986. A special report prepared by TRAFFIC (Japan) (Center for Environmental Education, Washington D.C.), p. 171 pages.

Mills, S.K., Beatty, J.H., 1979, The propensity interpretation of fitness. Philosophy of Science 46, 263-286.

Milton, S.L., Leone-Kabler, S., Schulman, A.A., Lutz, P.L., 1994, Effects of Hurricane Andrew on the sea turtle nesting beaches of South Florida. Bulletin of Marine Science 54, 974-981.

Milton, S.L., Lutz, P.L., 2003, Physiological and genetic responses to environmental stress, In: Lutz, P.L., Musick, J.A., Wyneken, J. (Eds.) The Biology of Sea Turtles, Volume II. CRC Press, Boca Raton, Florida, pp. 163-197.

MMS 1998. Pages III-3 to III-72 in Gulf of Mexico OCS oil and gas lease sales 171, 174, 177, and 180—Western Planning Area. In Final Environmental Impact Statement (New Orleans, Louisiana, Minerals Management Service).

MMS 2007a. Gulf of Mexico OCS oil and gas lease sale 224, Eastern planning area. Final supplemental environmental impact statement (Minerals Management Service).

MMS 2007b. Gulf of Mexico OCS oil and gas lease sales: 2007-2012, Western planning area sales 204, 207, 210, 215, and 218; Central planning area sales 205, 206, 208, 213, 216, and 222. Final environmental impact statement (Minerals Management Service).

Monagas, P., Oros, J., Anana, J., Gonzalez-Diaz, O.M., 2008, Organochlorine pesticide levels in loggerhead turtles (Caretta caretta) stranded in the Canary Islands, Spain. Marine Pollution Bulletin 56, 1949-1952.

Monzon-Arguello, C., Rico, C., Carreras, C., Calabuig, P., Marco, A., Lopez-Jurado, L.F., 2009, Variation in spatial distribution of juvenile loggerhead turtles in the eastern Atlantic and western Mediterranean Sea. Journal of Experimental Marine Biology and Ecology 373, 79-86.

Monzon-Arguello, C., Rico, C., Marco, A., Lopez, P., Lopez-Jurado, L.F., 2010, Genetic characterization of eastern Atlantic hawksbill turtles at a foraging group indicates major undiscovered nesting populations in the region. J. Exp. Mar. Biol. Ecol. in press, in press.

Moreira, L., Bjorndal, K.A., 2006. Estimates of green turtle (*Chelonia mydas*) nests on Trindade Island, Brazil, South Atlantic. In: Twenty-third Annual Symposium on Sea Turtle Biology and Conservation, p. 174.

Morreale, S.J., Plotkin, P.T., Shaver, D.J., Kalb, H.J., 2007, Adult migration and habitat utilization, In: Plotkin, P.T. (Ed.) Biology and conservation of Ridley sea turtles. Johns Hopkins University Press, Baltimore, Maryland, pp. 213-229.

Mortimer, J.A., 1982, Factors influencing beach selection by nesting sea turtles, In: Bjorndal, K. (Ed.) The biology and conservation of sea turtles. Smithsonian Institution Press, Washington, D.C., pp. 45-51.

Mortimer, J.A., Collie, J., Jupiter, T., Chapman, R., Liljevik, A., Betsy, B., 2003. Growth rates of immature hawksbills (*Eretmochelys imbricata*) at Aldabra Atoll, Seychelles (Western Indian Ocean). In: Twenty-second Annual Symposium on Sea Turtle Biology and

Conservation, pp. 247-248.

Mortimer, J.A., Donnelly, M. in review. 2007 IUCN red list status assessment: hawksbill turtle (*Eretmochelys imbricata*).

Mullner, A., Linsenmair, K.E., Wikelski, W., 2004, Exposure to ecotourism reduces survival and affects stress response in hoatzin chicks (Opisthocomus hoazin). Biological Conservation 118, 549-558.

Murakawa, S.K.K., Balazs, G.H., Ellis, D.M., Hau, S., Eames, S.M., 2000. Trends in fibropapillomatosis among green turtles stranded in the Hawaiian Islands, 1982-98. In: Nineteenth Annual Symposium on Sea Turtle Biology and Conservation.

Murphy, T.M., Hopkins, S.R., 1984, Aerial and ground surveys of marine turtle nesting beaches in the southeast region. Final Report to NOAA/NMFS/SEFC, U.S. Department of Commerce, 73p.

Musick, J.A., Limpus, C.J., 1997, Habitat utilization, and migration in juvenile sea turtles, In: Lutz, P.L., Musick, J.A. (Eds.) The biology of sea turtles. CRC Press, Boca Raton, Florida, pp. 137-163.

Mysing, J.O., Vanselous, T.M., 1989. Status of satellite tracking of Kemp's ridley sea turtles. In: First International Symposium on Kemp's Ridley Sea Turtle Biology, Conservation, and Management. , pp. 122-115.

Nichols, W.J. 2005. Following redwood logs, rubber ducks, and drift bottles: Transoceanic developmental migrations of loggerhead turtles in the North Pacific Ocean. In Proceedings of the Twenty-First Annual Symposium on Sea Turtle Biology and Conservation, Coyne, M.S., Clark, R.D., eds., p. 66.

Nichols, W.J., Resendiz, A., Seminoff, J.A., Resendiz, B., 2000, Transpacific migration of a loggerhead turtle monitored by satellite telemetry. Bulletin of Marine Science 67, 937-947.

Nishimura, W., 1994, Internesting interval and nest frequency for loggerhead turtles on Inakahama Beach, Yakushima Island, Japan. Marine Turtle Newsletter 67, 21-22.

NMFS 1988. Biological Opinion on the removal of oil and gas platforms and related structures in the Gulf of Mexico.

NMFS 2001. Stock assessments of loggerhead and leatherback sea turtles and an assessment of the impact of the pelagic longline fishery on the loggerhead and leatherback sea turtles of the western North Atlantic.

NMFS 2002. Endangered Species Act - Section 7 consultation, biological opinion. Shrimp trawling in the southeastern United States under the sea turtle conservation regulations and as managed by the fishery management plans for shrimp in the South Atlantic and Gulf of Mexico (St. Petersburg, Florida, National Marine Fisheries Service, Southeast Regional Office).

NMFS, 2005, Biological Opinion on the Issuance of ESA Section 10(a)(1)(A) Permit No. 1451 to the National Marine Fisheries Service - Office of Sustainable Fisheries for Research on Sea Turtles. National Marine Fisheries Service, Office of Protected Resources, Silver Spring, Maryland. 48p.

NMFS, 2006e, Biological Opinion on Permitting Structure Removal Operations on the Gulf of Mexico Outer Continental Shelf and the Authorization for Take of Marine Mammals Incidental to Structure Removals on the Gulf of Mexico Outer Continental Shelf. National Marine Fisheries Service, Silver Spring, Maryland. 131p.

NMFS, 2006f, National Marine Fisheries Service, Office of Protected Resources website: http://www.nmfs.noaa.gov/pr/.

NMFS, 2006g, Biological Opinion on the 2006 Rim-of-the-Pacific Joint Training Exercises (RIMPAC). National Marine Fisheries Service, Silver Spring, Maryland. 123p.

NMFS 2010. Other significant oil spills in the Gulf of Mexico, Service, N.M.F., ed. (Silver Sprirng, Maryland, National Marine Fisheries Service, Office of Response and Restoration, Emergency Response Division).

NMFS, USFWS 1991a. Recovery Plan for U.S. Population of Atlantic Green Turtle *Chelonia mydas* (Washington, D.C., National Marine Fisheries Service and U.S. Fish and Wildlife Service).

NMFS, USFWS 1993. Recovery Plan for the hawksbill turtle in the U.S. Caribbean Sea, Atlantic Ocean, and Gulf of Mexico. In National Marine Fisheries Service and U.S. Fish and Wildlife Service (St. Petersburg, Florida).

NMFS, USFWS 1998a. Recovery plan for U.S. Pacific populations of the green turtle (*Chelonia mydas*) (Silver Spring, Maryland, National Marine Fisheries Service).

NMFS, USFWS 2007a. Kemp's Ridley sea turtle (*Lepidochelys kempii*) 5-year review: Summary and evaluation (JSilver Spring, Maryland

acksonville, Florida, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources

U.S. Department of the Interior, U.S. Fish and Wildlife Service, Southeast Region, Jacksonville Ecological Services Field Office).

NMFS and USFWS, 1991b, Recovery Plan for U.S. Population of Loggerhead Turtle (*Caretta caretta*). National Marine Fisheries Service, Washington, D.C.

NMFS and USFWS 1998b. Recovery plan for U.S. Pacific populations of the loggerhead turtle (Caretta caretta) (Silver Spring, Maryland

Portland, Oregon, NMFS and USFWS).

NMFS and USFWS, 1998d, Recovery Plan for U.S. Pacific Populations of the Loggerhead Turtle (*Caretta caretta*). National Marine Fisheries Service, Silver Spring, MD.

NMFS and USFWS 2007b. Hawksbill sea turtle (*Eretmochelys imbricata*) 5-year review: Summary and evaluation (Silver Spring, Maryland

Jacksonville, Florida, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources

U.S. Department of the Interior, U.S. Fish and Wildlife Service, Southeast Region, Jacksonville Ecological Services Field Office).

NMMA 2007. 2006 Recreational boating statistical abstract (Chicago, Illinois, National Marine

Manufacturers Association).

NOAA 2003. Oil and sea turtles: Biology, planning, and response, Shigenaka, G., ed. (National Oceanic and Atmospheric Administration, National Ocean Service, Office of Response and Restoration).

NOAA 2010a. Deepwater Horizon.

NOAA 2010b. NOAA's oil spill response: Sea turtle strandings and the Deepwater oil spill, Administration, N.O.a.A., ed.

NOAA 2010c. NOAA web update July 26, 2010: Deepwater Horizon incident (National Oceanic and Atmospheric Administration).

Norrgard, J., 1995. Determination of stock composition and natal origin of a juvenile loggerhead turtle population (*Caretta caretta*) in Chesapeake Bay using mitochondrial DNA analysis. Master's thesis. College of William and Mary, Williamsburg, Virginia.

NPS 2006. Padre Island National Seashore, 2006 sea turtle nesting season (National Park Service).

NRC 1990a. Decline of the sea turtles: Causes and prevention (Washington, D.C, National Research Council).

NRC 1990b. Decline of the sea turtles: Causes and prevention. In (National Research Council) (Washington, D.C, National Academy Press).

NRC, 1990c, Decline of the Sea Turtles: Causes and Prevention. National Academy of Sciences, National Academy Press, Washington, D.C.

O'Hara, K.J., Iudicello, S., Bierce, R. 1988. A citizens guide to plastics in the ocean: More than a litter problem (Washington, D.C., Center for Marine Conservation).

Ogren, L.H., 1989. Distribution of juvenile and subadult Kemp's ridley sea turtles: Preliminary results from 1984-1987 surveys. In: First International Symposium on Kemp's Ridley Sea Turtle Biology, Conservation, and Management, pp. 116-123.

Okemwa, G.M., Wamukota, A. 2006. An overview of the status of green turtles (Chelonia mydas) in Kenya. In Book of Abstracts. Twenty-sixth Annual Symposium on Sea Turtle Biology and Conservation, Frick, M., Panagopoulou, A., Rees, A.F., Williams, K., eds. (Athens, Greece, International Sea Turtle Society), p. 311.

Okuyama, J., Abe, O., Nishizawa, H., Kobayashi, M., Yoseda, K., Arai, N., 2009, Ontogeny of the dispersal migration of green turtle (Chelonia mydas) hatchlings. Journal of Experimental Marine Biology and Ecology.

Omsjoe, E.H., Stien, A., Irvine, J., Albon, S.D., Dahl, E., Thoresen, S.I., Rustad, E., Ropstad, E., 2009, Evaluating capture stress and its effects on reproductive success in Svalbard reindeer. Can. J. Zool.-Rev. Can. Zool. 87, 73-85.

Oros, J., Gonzalez-Diaz, O.M., Monagas, P., 2009, High levels of polychlorinated biphenyls in tissues of Atlantic turtles stranded in the Canary Islands, Spain. Chemosphere 74, 473-478.

Orvik, L.M., 1997. Trace metal concentration in blood of the Kemp's ridley sea turtle (*Lepidochelys kempii*). Master's thesis. Texas A & M University, College Station, Texas.

Owens, D.W., 1999, Reproductive cycles and endocrinology in research and management techniques for the conservation of sea turtles, In: Eckert, K.L., Bjorndal, K.A., Abreu-Grobois, F.A., Donnelly, M. (Eds.) IUCN/SSC Marine Turtle Specialist Group Publication No 4.

Owens, D.W., Ruiz, G.J., 1980, New methods for obtaining blood and cerebrospinal fluid from marine turtles. Herpetologica 6, 17.

Parker, D.M., Balazs, G.H., in press. Diet of the oceanic green turtle, Chelonia mydas, in the North Pacific. In: Twenty-fifth Annual Symposium on Sea Turtle Biology and Conservation.

Parker, D.M., Cooke, W.J., Balazs, G.H., 2005, Diet of oceanic loggerhead sea turtles (*Caretta caretta*) in the central North Pacific. Fishery Bulletin 103, 142-152.

Parker, R.O., Jr., Colby, D.R., Willis, T.D., 1983, Estimated amount of reef habitat on a portion of the U.S. South Atlantic and Gulf of Mexico continental shelf. Bulletin of Marine Science 33, 935-940.

Peckham, S.H., Maldonado-Diaz, D., Koch, V., Mancini, A., Gaos, A., Tinker, M.T., Nichols, W.J., 2008, High mortality of loggerhead turtles due to bycatch, human consumption and strandings at Baja California Sur, Mexico, 2003 to 2007. Endangered Species Research 5, 171-183.

Pelletier, D., Roos, D., Ciccione, S., 2003, Oceanic survival and movements of wild and captive-reared immature green turtles (Chelonia mydas) in the Indian Ocean. Aquatic Living Resources 16, 35-41.

Perugini, M., Giammarino, A., Olivieri, V., Guccione, S., Lai, O.R., Amorena, M., 2006, Polychlorinated biphenyls and organochlorine pesticide levels in tissues of Caretta caretta from the Adriatic Sea. Diseases of Aquatic Organisms 71, 155-161.

Petersen, S.L., Honig, M.B., Ryan, P.G., Nel, R., Underhill, L.G., 2009, Turtle bycatch in the pelagic longline fishery off southern Africa. African Journal of Marine Science 31, 87-96.

Pike, D.A., 2009, Do Green Turtles Modify Their Nesting Seasons in Response to Environmental Temperatures? Chelonian Conservation and Biology 8, 43-47.

Pilcher, N.J., 2000, The green turtle, Chelonia mydas, in the Saudi Arabian Gulf. Chelonian Conservation and Biology 3, 730-734.

Plotkin, P., 2003, Adult migrations and habitat use, In: Lutz, P.L., Musick, J.A., Wyneken, J. (Eds.) Biology of sea turtles. CRC Press, Boca Raton, Florida, pp. 225-241.

Podreka, S., Georges, A., Maher, B., Limpus, C.J., 1998, The environmental contaminant DDE fails to influence the outcome of sexual differentiation in the marine turtle Chelonia mydas. Environmental Health Perspectives 106, 185-188.

Poloczanska, E.S., Limpus, C.J., Hays, G.C., 2009, Vulnerability of marine turtles in climate change, In: Advances in MArine Biology. Academic Press, New York, pp. 151-211.

Polovina, J., Uchida, I., Balazs, G., Howell, E.A., Parker, D., Dutton, P., 2006, The Kuroshio Extension Bifurcation Region: a pelagic hotspot for juvenile loggerhead sea turtles.

Deep-Sea Research II 53, 362-339.

Polovina, J.J., Balazs, G.H., Howell, E.A., Parker, D.M., Seki, M.P., Dutton, P.H., 2004, Forage and migration habitat of loggerhead (Caretta caretta) and olive ridley (Lepidochelys olivacea) sea turtles in the central North Pacific Ocean. Fisheries Oceanography 13, 36-51.

Polovina, J.J., Howell, E., Parker, D.M., Balazs, G.H., 2003, Dive-depth distribution of loggerhead (*Carretta carretta*) and olive ridley (*Lepidochelys olivacea*) sea turtles in the central North Pacific: Might deep longline sets catch fewer turtles? Fish. Bull. 101, 189-193.

Polovina, J.J., Kobayashi, D.R., Parker, D.M., Seki, M.P., Balazs, G.H., 2000, Turtles on the edge: Movement of loggerhead turtles (Caretta caretta) along oceanic fronts, spanning longline fishing grounds in the central North Pacific, 1997-1998. Fisheries Oceanography 9, 71-82.

Prieto, A., Prietol, A., Moncadal, F., Nodarse, G., Pugal, R., Leon, M.E.d., Diaz-Fernandez, R., Espinoru, G., Castillo, D., Hernandez, M., Peregrin, E., Arazoza, M.d., Salabarria, D., Morales, E., Webbs, G., Manolis, C., Gomez, R. 2001. Biological and ecological aspects of the hawksbill turtle population in Cuban waters. In Report from the Republic of Cuba. First CITES wider Caribbean hawksbill turtle dialogue meeting (Mexico City).

Pugh, R.S., Becker, P.R. 2001a. Sea turtle contaminants: A review with annotated bibliography (Charleston, South Carolina, U.S. Department of Commerce, National Institute of Standards and Technology, Chemical Science and Technology Laboratory).

Pugh, R.S., Becker, P.R., 2001b, Sea turtle contaminants: A review with annotated bibliography. U.S. Department of Commerce, National Institute of Standards and Technology, Chemical Science and Technology Laboratory, Charleston, South Carolina.

Purvis, A., Gittleman, J.L., Cowlishaw, G., Mace, G.M., 2000, Predicting extinction risk in declining species. Proceedings of the Royal Society B-Biological Sciences 267, 1947-1952.

Putman, N.F., Shay, T.J., Lohmann, K.J., 2010, Is the geographic distribution of nesting in the Kemp's Ridley turtle shaped by the migratory needs of offspring? Integrative and Comparative Biology.

Rabalais, N.N., Turner, R.E., Scavia, D., 2002, Beyond science into policy: Gulf of Mexico hypoxia and the Mississippi River. Bioscience 52, 129-142.

Rabalais, S.C., Rabalais, N.N., 1980, The Occurrence of Sea Turtles on the South Texas Coast. Contributions in Marine Science Vol. 23, 123-129.

Rankin-Baransky, K., 1997, Origin of loggerhead turtles (*Caretta caretta*) in the western North Atlantic Ocean as determined by mtDNA analysis. Masters Thesis submitted to Drexel University, June 1997. 1949p.

Rees, A.F., Margaritoulis, D., 2004, Beach temperatures, incubation durations, and estimated hatchling sex ratio for loggerhead sea turtle nests in southern Kyparissia Bay, Greece. British Chelonia Group Testudo 6, 23-36.

Rees, A.F., Saad, A., Jony, M., 2005, Marine turtle nesting survey, Syria 2004: discovery of a

"major" green turtle nesting area. Page 38 in Book of Abstracts of the Second Mediterranean Conference on Marine Turtles. Antalya, Turkey, 4-7 May 2005.

Reich, K.J., Bjorndal, K.A., Frick, M.G., Witherington, B., Johnson, C., Bolten, A.B., 2010, Polymodal foraging in adult female loggerheads (Caretta caretta). Mar. Biol. 157, 113-121.

Reid, K.A., Margaritoulis, D., Speakman, J.R., 2009, Incubation temperature and energy expenditure during development in loggerhead sea turtle embryos. Journal of Experimental Marine Biology and Ecology 378, 62-68.

Reina, R.D., Spotila, J.R., Paladino, F.V., Dunham, A.E., 2008, Changed reproductive schedule of eastern Pacific leatherback turtles Dermochelys coriacea following the 1997–98 El Niño to La Niña transition. Endangered Species Research.

Renaud, M.L., 1995a, Movements and submergence patterns of Kemp's ridley turtles (*Lepidochelys kempii*). J. Herpetol. 29, 370-374.

Renaud, M.L., 1995b, Movements and submergence patterns of Kemp's ridley turtles (*Lepidochelys kempii*). Journal of Herpetology 29, 370-374.

Renaud, M.L., Carpenter, J.A., 1994, Movements and submergence patterns of loggerhead turtles (Caretta caretta) in the Gulf of Mexico determined through satellite telemetry. Bulletin of Marine Science 55, 1-15.

Renaud, M.L., Carpenter, J.A., Williams, J.A., A.M. Landry, Jr., 1996, Kemp's ridley sea turtle (Lepidochelys kempii) tracked by satellite telemetry from Louisiana to nesting beach at Rancho Nuevo, Tamaulipas, Mexico. Chelonian Conservation and Biology 2, 108-109.

Resendiz, A., Resendiz, B., Nichols, W.J., Seminoff, J.A., Kamezaki, N., 1998, First confirmed eastwest transpacific movement of a loggerhead sea turtle, Caretta caretta, released in Baja California, Mexico. Pacific Science 52, 151-153.

Rester, J., Condrey, R., 1996, The occurrence of the hawksbill turtle, Eretmochelys imbricata, along the Louisiana coast. Gulf of Mexico Science 1996, 112-114.

Richardson, T.H., Richardson, J.I., Ruckdeshel, C., Dix, M.W., 1978, Remigration patterns of loggerhead sea turtles (*Caretta caretta*) nesting on Little Cumberland and Cumberland Islands, Georgia. Florida Marine Research Publications 33, 39-44.

Ridgeway, S.H., Wever, E.G., McCormick, J.G., Palin, J., Anderson, J.H., 1969, Hearing in the Giant Sea Turtle, Chelonia mydas. Proceedings of the National Academy of Science 64, 884-890.

Roark, A.M., Bjorndal, K.A., Bolten, A.B., 2009, Compensatory responses to food restriction in juvenile green turtles (Chelonia mydas). Ecology 90, 2524-2534.

Robinson, R.A., Crick, H.Q.P., Learmonth, J.A., Maclean, I.M.D., Thomas, C.D., Bairlein, F., Forchhammer, M.C., Francis, C.M., Gill, J.A., Godley, B.J., Harwood, J., Hays, G.C., Huntley, B., Hutson, A.M., Pierce, G.J., Rehfisch, M.M., Sims, D.W., Santos, M.B., Sparks, T.H., Stroud, D.A., Visser, M.E., 2008, Travelling through a warming world: climate change and migratory species. Endangered Species Research.

Romero, L.M., 2004, Physiological stress in ecology: lessons from biomedical research. Trends

in Ecology and Evolution 19, 249-255.

Rosman, I., Boland, G.S., Martin, L., Chandler, C., 1987, Underwater Sightings of Sea Turtles in the Northern Gulf of Mexico. OCS Study; MMS 87-0107, 37.

Ross, J.P. 1979. Sea turtles in the Sultanate of Oman.

Ross, J.P. 1998. Estimations of the nesting population size of loggerhead sea turtles, Caretta caretta, Masirah Island, Sultanate of Oman. In Proceedings of the Seventeenth Annual Sea Turtle Symposium. , Epperly, S.P., Braun, J., eds., pp. 84-87.

Ross, J.P., Barwani, M.A., 1982, Review of sea turtles in the Arabian area, In: Bjorndal, K.A. (Ed.) Biology and conservation of sea turtles. Smithsonian Institution Press, Washington, D.C., pp. 373-383.

Rostal, D.C., 2007, Reproductive physiology of the ridley sea turtle. Pages 151-165 in: Plotkin P.T., editor. Biology and conservation of ridley sea turtles. Johns Hopkins University Press, Baltimore, Maryland.

Rostal, D.C., Grumbles, J.S., Byles, R.A., Márquez, M.R., Owens, D.W., 1997, Nesting physiology of wild Kemp's ridley turtles, Lepidochelys kempii, at Rancho Nuevo, Tamaulipas, Mexico. Chelonian Conservation and Biology 2, 538-547.

Rybitski, M.J., Hale, R.C., Musick, J.A., 1995, Distribution of organochlorine pollutants in Atlantic sea turtles. Copeia 1995, 379-390.

Saad, M.A., 1999, Title Hadramaut coast importance in conservation of endangered green turtle. Marine Sciences Resources Research Center, Aden. Unpublished report. 8.

Saeki, K., Sakakibara, H., Sakai, H., Kunito, T., Tanabe, S., 2000, Arsenic accumulation in three species of sea turtles. Biometals 13, 241-250.

Sakamoto, W., Sato, K., Tanaka, H., Naito, Y., 1993, Diving patterns and swimming environment of two loggerhead turtles during internesting. Nippon Suisan Gakkaishi 59, 1129-1137.

Sakamoto, W., Uchida, I., Kureba, K., 1990, Deep diving behavior of the loggerhead turtle near the frontal zone. Nippon Suisan Gakkaishi 56, 1435-1443.

Salm, R.V. 1991. Turtles in Oman: Status, threats, and management options. In Report of the scientific results of the IUCN coastal zone management project CZMP4:F11.

Salm, R.V., Jensen, R.A.C., Papastavrou, V.A. 1993. Marine fauna of Oman: Cetaceans, turtles, seabirds, and shallow water corals (Gland, Switzerland, IUCN).

Sapolsky, R.M., Romero, L.M., Munck, A.U., 2000, How do glucocorticoids influence stress responses? Integrating permissive, suppressive, stimulatory, and preparative actions. Endocrine Reviews 21, 55-89.

Sato, K., Matsuzawa, Y., Tanaka, H., Bando, T., Minamikawa, S., Sakamoto, W., Naito, Y., 1998, Internesting intervals for loggerhead turtles, Caretta caretta, and green turtles, Chelonia mydas, are affected by temperature. Canadian Journal of Zoology 76, 1651-1662.

Schmid, J.R., 1998, Marine turtle populations on the west central coast of Florida: Results of tagging studies at the Cedar Keys, Florida, 1986-1995. Fish. Bull. 96, 589-602.

Schmid, J.R., Bolten, A.B., Bjorndal, K.A., Lindberg, W.J., 2002, Activity patterns of Kemp's ridley turtles, Lepidochelys kempii, in the coastal waters of the Cedar Keys, Florida. Mar. Biol. 140, 215-228.

Schmid, J.R., Witzell, W.N., 1997, Age and growth of wild Kemp's ridley turtles (Lepidochelys kempii): Cumulative results of tagging studies in Florida. Chelonian Conservation and Biology 2, 532-537.

Schmidt, J., 1916, Marking experiments with turtles in the Danish West Indies. Meddelelser Fra Kommissionen For Havundersogelser. Serie: Fiskeri. Bind V. Nr. 1. Kobenhavn.

Schofield, G., Bishop, C.M., Katselidis, K.A., Dimopoulos, P., Pantis, J.D., Hays, G.C., 2009, Microhabitat selection by sea turtles in a dynamic thermal marine environment. Journal of Animal Ecology 78, 14-21.

Schulz, J.P., 1984, Turtle conservation strategy in Indonesia. IUCN/WWF Report.

Schulz, J.P., 1987, Status of and trade in Chelonia mydas and Eretmochelys imbricata in Indonesia. Consultancy report prepared for IUCN Conservation Monitoring Centre.

Sea Turtle Association of Japan 2010. Sea turtles of Japan.

Sears, C.J., 1994, Preliminary genetic analysis of the population structure of Georgia loggerhead sea turtles. NOAA Technical Memorandum NMFS-SEFSC-351. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Science Center, Miami, Florida.

Sears, C.J., Bowen, B.W., Chapman, R.W., Galloway, S.B., Hopkins-Murphy, S.R., Woodley, C.M., 1995, Demographic composition of the feeding population of juvenile loggerhead sea turtles (Caretta caretta) off Charleston, South Carolina: evidence from mitochondrial DNA markers. Mar. Biol. 123, 869-874.

Seminoff, J.A. 2004. 2004 global status assessment: Green turtle (Chelonia mydas) (IUCN Marine Turtle Specialist Group Review).

Seminoff, J.A., Jones, T.T., 2006, Diel movements and activity ranges of green turtles (*Chelonia mydas*) at a temperate foraging area in the Gulf of California, Mexico. Herpetological Conservation and Biology 1, 81-86.

Seminoff, J.A., Jones, T.T., Resendiz, A., Nichols, W.J., Chaloupka, M.Y., 2003, Monitoring green turtles (Chelonia mydas) at a coastal foraging area in Baja California, Mexico: Multiple indices to describe population status. Journal of the Marine Biological Association of the United Kingdom 83, 1355-1362.

Seminoff, J.A., Resendiz, A., Nichols, W.J., 2002a, Diet of East Pacific green turtles (Chelonia mydas) in the central Gulf of California, Mexico. J. Herpetol. 36, 447-453.

Seminoff, J.A., Resendiz, A., Nichols, W.J., Jones, T.T., 2002b, Growth rates of wild green turtles (Chelonia mydas) at a temperate foraging area in the Gulf of California, México. Copeia 2002, 610-617.

Seney, E.E., Higgins, B.M., Andre M. Landry, J., 2010, Interactions between platform terminal transmitters and turtle excluder devices. Marine Fisheries Review 42, 44-47.

Seney, E.E., Landry, A.M., 2008, Movements of Kemp’s ridley sea turtles nesting on the upper

Texas coast: implications for management. Endangered Species Research 4, 73-84.

Senko, J., Lopez-Castro, M.C., Koch, V., Nichols, W.J., 2010, Immature East Pacific green turtles (Chelonia mydas) use multiple foraging areas off the Pacific Coast of Baja California Sur, Mexico: First evidence from mark-recapture data. Pacific Science 64, 125-130.

Shaver, D.J., 1999, Kemp's ridley sea turtle project at Padre Island National Seashore, Texas. Pages 342-347 in: McKay, M., and J. Nides, editors. Proceedings of the Seventeenth Annual Gulf of Mexico Information Transfer Meeting, U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, MMS 99-0042.

Shaver, D.J., 2002, Kemp's ridley sea turtle project at Padre Island National Seashore and Texas sea turtle nesting, and stranding 2001 report. U.S. Department of the Interior, U.S. Geological Survey, Corpus Christi, Texas.

Shaver, D.J., Amos, A.F., Higgins, B., Mays, J., 2005, Record 42 Kemp's ridley nests found in Texas in 2004. Marine Turtle Newsletter 108, 1-3.

Shaver, D.J., Wibbels, T., 2007a, Head-starting the Kemp's ridley sea turtle, In: Plotkin, P.T. (Ed.) Biology and Conservation of Ridley Sea Turtles. The Johns Hopkins University Press, Baltimore, MD, pp. 297-323.

Shaver, D.J., Wibbels, T., 2007b, Head-starting the Kemp's ridley sea turtle. Pages 297-323 in: Plotkin P.T., editor. Biology and conservation of ridley sea turtles. Johns Hopkins University Press, Baltimore, Maryland.

Shoop, C.R., Kenney, R.D., 1992, Seasonal distributions and abundances of loggerhead and leatherback seaturtles in waters of the northeastern United States. Herpetological Monographs 6, 43-67.

Simmonds, M.P., Eliott., W.J., 2009, Climate change and cetaceans: Concerns and recent developments. Journal of the Marine Biological Association of the United Kingdom 89, 203-210.

Snoddy, J.E., Landon, M., Blanvillain, G., Southwood, A., 2009, Blood Biochemistry of Sea Turtles Captured in Gillnets in the Lower Cape Fear River, North Carolina, USA. Journal of Wildlife Management 73, 1394-1401.

Snover, M.L., Hohn, A.A., Crowder, L.B., Heppell, S.S., 2007, Age and growth in Kemp's ridley sea turtles: Evidence from mark-recapture and skeletochronology. Pages 89-106 in: Plotkin P.T., editor. Biology and conservation of ridley sea turtles. Johns Hopkins University Press, Baltimore, Maryland.

Solow, A.R., Bjorndal, K.A., Bolten, A.B., 2002, Annual variation in nesting numbers of marine turtles: The effect of sea surface temperature on re-migration intervals. Ecology Letters 5, 742-746.

Spotila, J.R., 2004a, Sea turtles: A complete guide to their biology, behavior, and conservation. The Johns Hopkins University Press and Oakwood Arts, Baltimore, Maryland.

Spotila, J.R., 2004b, Sea turtles: A complete guide to their biology, behavior, and conservation. John Hopkins University Press, Baltimore. 227p.

Stabenau, E.K., Heming, T.A., Mitchell, J.F., 1991, Respiratory, acid-base and ionic status of Kemp's ridley sea turtles (*Lepidochelys kempi*) subjected to trawling. Comparative Biochemistry and Physiology - Part A: Molecular & Integrative Physiology 99A, 107-111.

Stabenau, E.K., Vietti, K.R.N., 2003, The physiological effects of multiple forced submergences in loggerhead sea turtles (Caretta caretta). Fishery Bulletin 101, 889-899.

STAJ 2002. Population trends and mortality of Japanese loggerhead turtles, Caretta caretta in Japan. In Western Pacific Sea Turtle Cooperative Research and Management Workshop (Honolulu, Hawaii).

Stamper, M.A., Spicer, C.W., Neiffer, D.L., Mathews, K.S., Fleming, G.J., 2009, MORBIDITY IN A JUVENILE GREEN SEA TURTLE (CHELONIA MYDAS) DUE TO OCEAN-BORNE PLASTIC. Journal of Zoo and Wildlife Medicine 40, 196-198.

Stanley, D.R., Wilson, C.A., 2003, Utilization of offshore platforms by recreational fishermen and scuba divers off the Louisiana coast. Bulletin of Marine Science 44, 767-775.

Starbird, C.H., Hillis-Starr, Z., Harvey, J.T., Eckert, S.A., 1999, Internesting movements and behavior of hawksbill turtles (Eretmochelys imbricata) around Buck Island Reef National Monument, St. Croix, U.S. Virgin Islands. Chelonian Conservation and Biology 3, 237-243.

Stearns, S.C., 1992, The evolution of life histories. Oxford University Press, 249p.

Stinson, M.L., 1984. Biology of sea turtles in San Diego Bay, California, and in northeastern Pacific Ocean. San Diego State University, San Diego, California.

Storelli, M., Barone, M.G., Marcotrigiano, G.O., 2007a, Polychlorinated biphenyls and other chlorinated organic contaminants in the tissues of Mediterranean loggerhead turtle Caretta caretta. Science of the Total Environment 273, 456-463.

Storelli, M., Barone, M.G., Marcotrigiano, G.O., 2007b, Polychlorinated biphenyls and other chlorinated organic contaminants in the tissues of Mediterranean loggerhead turtle Caretta caretta. Science of the Total Environment 273 (2-3, 456-463.

Storelli, M., Barone, M.G., Storelli, A., Marcotrigiano, G.O., 2008, Total and subcellular distribution of trace elements (Cd, Cu and Zn) in the liver and kidney of green turtles (Chelonia mydas) from the Mediterranean Sea. Chemosphere 70, 908-913.

Sunderraj, S.F., Joshua, W.J., Kumar, V.V., 2006, Sea turtles and their nesting habitats in Gujarat. Pages 156-169 in Shanker, K. and B.C. Choudhury (editors). Marine Turtles of the Indian Subcontinent. Universities Press, India.

Sutherland, W.J., Crockford, N.J., 1993, Factors affecting the feeding distribution of red breasted geese, Branta ruficollis, wintering in Romania. Biological Conservation 63, 61-65.

Talavera-Saenz, A., Gardner, S.C., Rodriquez, R.R., Vargas, B.A., 2007, Metal profiles used as environmental markers of green turtle (Chelonia mydas) foraging resources. Science of the Total Environment 373, 94-102.

Tanaka, E., 2009, Estimation of temporal changes in the growth of green turtles Chelonia mydas in waters around the Ogasawara Islands. Fisheries Science 75, 629-639.

Taquet, C., Taquet, M., Dempster, T., Soria, M., Ciccione, S., Roos, D., Dagorn, L., 2006, Foraging of the green sea turtle Chelonia mydas on seagrass beds at Mayotte Island (Indian Ocean), determined by acoustic transmitters. Marine Ecology Progress Series 306, 295-302.

TEWG 1998a. An assessment of the Kemp's ridley (Lepidochelys kempii) and loggerhead (Caretta caretta) sea turtle populations in the Western North Atlantic. In Proceedings of the Sixteenth Annual Symposium on Sea Turtle Biology and Conservation.

TEWG, 1998b, An assessment of the Kemp's ridley (*Lepidochelys kempii*) and loggerhead (*Caretta caretta*) sea turtle populations in the western North Atlantic. A report of the Turtle Expert Working Group (TEWG); NOAA Technical Memorandum NMFS-SEFSC-409. 96p.

TEWG, 2000, Assessment update for the Kemp's ridley and loggerhead sea turtle populations in the western North Atlantic. NOAA Technical Memorandum NMFS-SEFSC-444.

TGLO 2006. News release: Patterson signs lease for biggest offshore wind farm in U.S. history (Texas General Land Office).

TGLO 2010. Adopt a beach newletter (Texas General Land Office).

Thorbjarnarson, J.B., Platt, S.G., Khaing, S.T., 2000, Sea turtles in Myanmar: Past, and present. Marine Turtle Newsletter 88, 10-11.

Tiwari, M., Bjorndal, K.A., Bolten, A.B., Bolker, B.M., 2005, Intraspecific application of the mid-domain effect model: Spatial, and temporal nest distributions of green turtles, Chelonia mydas, at Tortuguero, Costa Rica. Ecology Letters 8, 918-924.

Tiwari, M., Bjorndal, K.A., Bolten, A.B., Bolker, B.M., 2006, Evaluation of density-dependent processes, and green turtle Chelonia mydas hatchling production at Tortuguero, Costa Rica. Marine Ecology Progress Series 326, 283-293.

Tomas, J., Castroviejo, J., Raga, J.A., 1999, Sea turtles in the south of Bioko Island (Equatorial Guinea). Marine Turtle Newsletter 84, 4-6.

Tomás, J., Gozalbes, P., Raga, J.A., Godley, B.J., 2008, Bycatch of loggerhead sea turtles: insights from 14 years of stranding data. Endangered Species Research 5, 161-169.

Tomas, J., Raga, J.A., 2008, Occurrence of Kemp's ridley sea turtle (Lepidochelys kempii) in the Mediterranean. Marine Biodiversity Records 1.

Tourinho, P.S., Sul, J.A.I.d., Fillmann, G., 2009, Is marine debris ingestion still a problem for the coastal marine biota of southern Brazil? Marine Pollution Bulletin in press, in press.

Troëng, S., Chaloupka, M., 2007, Variation in adult annual survival probability and remigration intervals of sea turtles. Mar. Biol. 151, 1721-1730.

Troëng, S., Rankin, E., 2005, Long term conservation efforts contribute to positive green turtle Chelonia mydas nesting trend at Tortuguero, Costa Rica. Biological Conservation 121, 111–116.

Tuato'o-Bartley, N., Morrell, T.E., Craig, P., 1993, Status of sea turtles in American Samoa in 1991. Pacific Science 47, 215-221.

Tucker, A.D., 2009, Nest site fidelity and clutch frequency of loggerhead turtles are better

elucidated by satellite telemetry than by nocturnal tagging efforts: Implications for stock estimation. Journal of Experimental Marine Biology and Ecology in press, in press.

Turkozan, O., Yilmaz, C., 2008, Loggerhead turtles, Caretta caretta, at Dalyan Beach, Turkey: Nesting activity (2004–2005) and 19-year abundance trend (1987–2005). Chelonian Conserv. Biol. 7, 178-187.

Uchida, I., Nishiwaki, M., 1995, Sea turtles in the waters adjacent to Japan, In: Bjorndal, K.A. (Ed.) Biology and conservation of sea turtles. Smithsonian Institution Press, Washington, D.C., pp. 317-319.

USACOE 2010. Sea turtle data warehouse (U.S. Army Corps of Engineers).

USAF 1996. Sea turtles in the Gulf (Air Force Material Command, Eglin Air Force Base).

USBLS 2010a. Employment and output by industry, 1998, 2008 and projected 2018, Statistics, U.S.B.o.L., ed.

USBLS 2010b. Industries with the fastest growing and most rapidly declining output, 2008 and projected 2018, Statistics, U.S.B.o.L., ed.

USCB 2008a. Cumulative estimates of population change for metropolitan statistical areas and rankings: April 1, 2000 to July 1, 2007 (CBSA-EST2007-07), Bureau, U.S.C., ed.

USCB 2008b. Estimates of population change for metropolitan statistical areas and rankings: July 1, 2006 to July 1, 2007 (CBSA-EST2007-05), Bureau, U.S.C., ed.

USCG 2003. 2002 national recreational boating survey state data report (Columbus, Ohio, United States Coast Guard).

USCG 2005. Boating statistics—2005 (Washignton D.C., United States Coast Guard).

USCOP 2004. An ocean blueprint for the 21st century. Final report (Washington, D. C., U.S. Commission on Ocean Policy).

USFWS 1999. South Florida multi-species recovery plan (Atlanta, Georgia, United States Fish and Wildlife Service).

USFWS 2000. Report on the Mexico/United States of America population restoration project for the Kemp's ridley sea turtle, *Lepidochelys kempii*, on the coasts of Tamaulipas, and Veracruz, Mexico (United States Fish and Wildlife Service).

USFWS 2001. Report on the Mexico/United States of America population restoration project for the Kemp's ridley sea turtle, *Lepidochelys kempii*, on the coasts of Tamaulipas, and Veracruz, Mexico (United States Fish and Wildlife Service).

USFWS 2002. Report on the Mexico/United States of America population restoration project for the Kemp's ridley sea turtle, *Lepidochelys kempii*, on the coasts of Tamaulipas, and Veracruz, Mexico (United States Fish and Wildlife Service).

USFWS 2003. Report on the Mexico/United States of America population restoration project for the Kemp's ridley sea turtle, *Lepidochelys kempii*, on the coasts of Tamaulipas, and Veracruz, Mexico (United States Fish and Wildlife Service).

USFWS 2004. Report on the Mexico/United States of America population restoration project for the Kemp's ridley sea turtle, *Lepidochelys kempii*, on the coasts of Tamaulipas, and

Veracruz, Mexico (United States Fish and Wildlife Service).

USFWS 2005. Report on the Mexico/United States of America population restoration project for the Kemp's ridley sea turtle, *Lepidochelys kempii*, on the coasts of Tamaulipas, and Veracruz, Mexico (United States Fish and Wildlife Service).

USFWS 2006. Report on the Mexico/United States of America population restoration project for the Kemp's ridley sea turtle, *Lepidochelys kempii*, on the coasts of Tamaulipas, and Veracruz, Mexico (United States Fish and Wildlife Service).

USFWS, NMFS 1992. Recovery plan for the Kemp's ridley sea turtle (Lepidochelys kempii) (St. Petersburg, Florida, National Marine Fisheries Service).

USFWS, N.a. 1998. Recovery Plan for U.S. Pacific Populations of the Loggerhead Turtle (*Caretta caretta*) (Silver Spring, Maryland, National Marine Fisheries Service).

USGS 2010. Hypoxia in the Gulf of Mexico.

USN 2008. Biological evaluation for the Gulf of Mexico rangle complex (U.S. Navy).

USN 2009. Gulf of Mexico range complex final environmental impact statement/overseas environmental impact statement (EIS/OEIS) volume 1 (version 3) (Norfolk, Virginia, United States Navy).

Van Dam, R.P., Diez, C.E., 1997, Diving behavior of immature hawksbill turtles (Eretmochelys imbricata) in a Caribbean reef habitat. Coral Reefs 16.

van de Merwe, J.P.V., Hodge, M., Olszowy, H.A., Whittier, J.M., Ibrahim, K., Lee, S.Y., 2009, Chemical Contamination of Green Turtle (Chelonia mydas) Eggs in Peninsular Malaysia: Implications for Conservation and Public Health. Environmental Health Perspectives 117, 1397-1401.

Vander Zanden, H.B., Bjorndal, K.A., Reich, K.J., Bolten, A.B., 2010, Individual specialists in a generalist population: results from a long-term stable isotope series. Biology Letters in press, in press.

Varanasi, U., Stein, J.E., Nishimoto, M., 1989, Biotransformation and disposition of polycyclic aromatic hydrocarbons (PAH) in fish, In: Varanasi, U. (Ed.) Metabolism of polycyclic aromatic hydrocarbons in the aquatic environment. CRC Press, Boca Raton, Florida, pp. 94-149.

Vargo, S., Lutz, P., Odell, D., Vleet, E.V., Bossart, G. 1986a. Study of the effects of oil on marine turtles (Vienna, Virginia, Minerals Management Service).

Vargo, S., Lutz, P., Odell, D., Vleet, E.V., Bossart, G. 1986b. Study of the effects of oil on marine turtles (Vienna, Virginia, Minerals Management Service).

Vargo, S., Lutz, P., Odell, D., Vleet, E.V., Bossart, G. 1986c. Study of the effects of oil on marine turtles (Vienna, Virginia, Minerals Management Service).

Velez-Zuazo, X., Ramos, W.D., Van Dam, R., Diez, C.E., Arreu-Grobois, A., McMillan, O., 2008, Dispersal, recruitment and migratory behavior in a hawksbill sea turtle aggregation. Molecular Ecology 17, 839-853.

Vera, V. 2007. Nesting of green turtles in Aves Island Wildlife Refuge. 2006 season. In Twenty-seventh Annual Symposium on Sea Turtle Biology and Conservation, Frick, M.,

Panagopoulou, A., Rees, A.F., Williams, K., eds. (Myrtle Beach, South Carolina, International Sea Turtle Society), p. 275.

Walker, B.G., Dee Boersma, P., Wingfield, J.C., 2005, Physiological and behavioral differences in magellanic Penguin chicks in undisturbed and tourist-visited locations of a colony. Conservation Biology 19, 1571-1577.

Wallace, B.P., Avens, L., Braun-McNeill, J., McClellan, C.M., 2009, The diet composition of immature loggerheads: Insights on trophic niche, growth rates, and fisheries interactions. Journal of Experimental Marine Biology and Ecology 373, 50-57.

Wallace, B.P., George, R.H., 2007, Alternative techniques for obtaining blood samples from leatherback turtles. Chelonian Conservation and Biology 6, 147-149.

Wallace, B.P., Lewison, R.L., McDonald, S.L., McDonald, R.K., Kot, C.Y., Kelez, S., Bjorkland, R.K., Finkbeiner, E.M., Helmbrecht, S.r., Crowder, L.B., 2010, Global patterns of marine turtle bycatch. Convervation Letters in press, in press.

Washington Post 2006. Offshore wind farm is approved; Plant off Texas coast to be biggest of its kind in U.S. In Washignton Post (Washington, D.C.).

Watson, K.P., Granger, R.A., 1998, Hydrodynamic effect of a satellite transmitter on a juvenile green turtle (Chelonia mydas). Journal of Experimental Biology 201, 2497-2505.

Waycott, M.B., Longstaff, J., Mellors, J., 2005, Seagrass population dynamics and water quality in the Great Barrier Reef region: A review and future research directions. Mar. Pollut. Bull. 51, 343-350.

Weijerman, M.L., Tienen, H.G.v., Schouten, A.D., Hoekert, W.E.J. 1998. Sea turtles of Galibi, Suriname. In Proceedings of the Sixteenth Annual Symposium on Sea Turtle Biology and Conservation. , Byles, R., Fernandez, Y., eds., pp. 142-144.

Wibbels, T., 2003, Critical approaches to sex determination in sea turtle biology and conservation, In: Lutz, P., Musik, J., Wynekan, J. (Eds.) Biology of sea turtles. CRC Press, pp. 103-134.

Wibbels, T., 2007, Sex determination and sex ratio in ridley turtles. Pages 167-189 in: Plotkin P.T., editor. Biology and conservation of ridley sea turtles. Johns Hopkins University Press, Baltimore, Maryland.

Wibbels, T., Marion, K., Nelson, D., Dindo, J., Geis, A., 2005, Evaluation of the bay systems of Alabama (US) as potential foraging habitat for juvenile sea turtles. Pages 275-276 in: Mosier, A., A. Foley, and B. Brost, editors. Proceedings of the Twentieth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-477.

Wilkinson, C. 2000. Status of coral reefs of the world: 2000 (Global Coral Reef Monitoring Network, Australian Institute of Marine Science).

Witherington, B., Hirama, S., Mosier, A. 2003. Effects of beach armoring structures on marine turtle nesting (Florida Fish and Wildlife Conservation Commission).

Witherington, B., Hirama, S., Mosier, A. 2007. Change to armoring and other barriers to sea turtle nesting following severe hurricanes striking Florida beaches (Florida Fish and

Wildlife Conservation Commission).

Witherington, B., Kubilis, P., Brost, B., Meylan, A., 2009, Decreasing annual nest counts in a globally important loggerhead sea turtle population. Ecological Applications 19, 30-54.

Witherington, B.E., 1992, Behavioral responses of nesting sea turtles to artificial lighting. Herpetologica 48, 31-39.

Witherington, B.E., Bjorndal, K.A., 1991, Influences of artificial lighting on the seaward orientation of hatchling loggerhead turtles Caretta caretta. Biological Conservation 55, 139-149.

Witherington, B.E., Herren, R., Bresette, M., 2006, *Caretta caretta* – Loggerhead Sea Turtle. Chelonian Research Monographs 3, 74-89.

Witzell, W.N., 1981, Predation on Juvenile Green Sea Turtles, Chelonia mydas , By a Grouper, Promicrops lanceolatus (Pisces: Serranidae) in the Kingdom of Tonga, South Pacific. Bulletin of Marine Science. Vol. 31, no. 4.

Witzell, W.N. 1983. Synopsis of biological data on the hawksbill turtle *Eretmochelys imbricata* (Linnaeus, 1766). In Food and Agriculture Organization (FAO) Fisheries Synopsis No. 137 (FAO), p. 78.

Witzell, W.N., Geis, A.A., Schmid, J.R., Wibbels, T., 2005, Sex ratio of immature Kemp's ridley turtles (Lepidochelys kempii) from Gullivan Bay, Ten Thousand Islands, south-west Florida. Journal of the Marine Biological Association of the United Kingdom 85, 205-208.

Wolfe, S.H., Reidenauer, J.A., Means, D.B. 1988. An ecological characterization of the Florida Panhandle (New Orleans, Louisiana, U.S. Fish and Wildlife Service and MMS).

Work, P.A., Sapp, A.L., Scott, D.W., Dodd, M.G., 2010, Influence of small vessel operation and propulsion system on loggerhead sea turtle injuries. J. Exp. Mar. Biol. Ecol.

Work, T.M., Dagenais, J., Balazs, G.H., Schumacher, J., Lewis, T.D., Leong, J.A.C., Casey, R.N., Casey, J.W., 2009, In vitro biology of fibropapilloma-associated turtle herpesvirus and host cells in Hawaiian green turtles (Chelonia mydas). Journal of General Virology 90, 1943-1950.

Yender, R., Michel, J., Lord, C. 2002. Managing seafood safety after an oil spill (Seattle, Washington, National Oceanic and Atmospheric Administration, National Ocean Service, Office of Response and Restoration).

Zárate, P.M., Cahoon, S.S., Contato, M.C.D., Dutton, P.H., Seminoff, J.A. 2006. Nesting beach monitoring of green turtles in the Galapagos Islands: a 4-year evaluation. In Twenty-sixth Annual Symposium on Sea Turtle Biology and Conservation, Frick, M., Panagopoulou, A., Rees, A.F., Williams, K., eds. (Athens, Greece, International Sea Turtle Society), p. 337.

Zug, G.R., Balazs, G.H., Wetherall, J.A., Parker, D.M., Murakawa, S.K.K., 2002, Age and growth of Hawaiian green sea turtles (Chelonia mydas): An analysis based on skeletochronology. Fish. Bull. 100, 117-127.

Zug, G.R., Glor, R.E., 1998, Estimates of age and growth in a population of green sea turtles

(Chelonia mydas) from the Indian River Lagoon system, Florida: A skeletochronological analysis. Canadian Journal of Zoology 76, 1497-1506.

Zug, G.R., Kalb, H.J., Luzar, S.J., 1997, Age and growth on wild Kemp's ridley sea turtles Lepidochelys kempii from skeletochronological data. Biological Conservation 80, 261-268.