Written Testimony of

Dr. Charles Innis

Director of Animal Health

New England Aquarium

Before the United States House Natural Resources Subcommittee on Water, Oceans, and Wildlife

July 21, 2022

Thank you Chairman Grijalva, Committee Ranking Member Westerman, Subcommittee Chairman Huffman, and Subcommittee Ranking Member Bentz for inviting me to testify at this hearing. I am a veterinarian and Director of Animal Health at the New England Aquarium. The New England Aquarium is a catalyst for global change through innovative scientific research, commitment to marine animal conservation, leadership in education, public engagement, and effective advocacy for vital and vibrant oceans. Our mission is to care for aquatic animals, conduct research on topics related to ocean health and conservation, and develop science-based solutions to marine conservation problems. I am here today in support of H.R.7918 – the Sea Turtle Rescue Assistance Act of 2022.

I have been a veterinarian for 28 years. I received my undergraduate degree in Biology from Cornell University and my Veterinariae Medicinae Doctoris from the University of Pennsylvania. I am one of 21 veterinarians globally that are certified as specialists in reptile medicine by the American Board of Veterinary practitioners. I am past president of the Association of Reptile and Amphibian Veterinarians, and past member of the IUCN Marine Turtle Specialist Group. For the majority of my career, I have been employed at New England Aquarium in Boston, providing care for our thousands of resident aquatic animals, as well as thousands of stranded animals from the coast of New England and beyond. This work has given me substantial experience in the veterinary management of stranded animals, particularly sea turtles. My colleagues and I have advanced the field of aquatic veterinary medicine over the past three decades. Our team at New England Aquarium has published approximately 40 peer reviewed studies and ten book chapters on the veterinary management of sea turtles, and I am co-author and co-editor of the only textbook that focuses solely on the veterinary management of sea turtles, Sea Turtle Health and Rehabilitation, which was published in 2017. I have been on site for emergency response efforts for turtles in the Philippines, Madagascar, and in Louisiana during the Deepwater Horizon oil spill. I am regularly called upon to teach veterinary students and veterinary colleagues about sea turtle veterinary care.

Turtles have existed for 250 million years. The first known marine turtle species evolved 220 million years ago, and two families including seven species survive today. Family Dermochelidae has only one remaining species, the leatherback turtle (*Dermochelys coriacea*). The leatherback evolved approximately 100 million years ago, and is the largest living turtle species, with exceptionally large adults approaching 900 kg (2000 lbs.) and over a meter (three feet) in length. Family Cheloniidae, the ‘hard-shelled’ sea turtles, has six species: the green turtle (*Chelonia mydas*), hawksbill turtle (*Eretmochelys imbricata*), loggerhead turtle (*Caretta caretta*), olive ridley turtle (*Lepidochelys olivacea*), Kemp’s ridley turtle (*Lepidochelys kempii*), and flatback turtle (*Natator depressus*).

Turtles have been important to humans for millennia. They appear in the creation stories of many Native American cultures, who believed that the surface of the earth was, in fact, the back of a giant turtle (Campbell, 2003; Hassan and Sadek, 2015). Turtles have been important in ceremony and legend, revered for their longevity, fertility, patience, and persistence (Campbell, 2003). They have been an important food source historically for people in many regions (Campbell, 2003). Today, in some areas, including Hawaii, Florida, Puerto Rico, and other Caribbean islands, sea turtles are important for the tourist industry, supporting recreational snorkeling and diving programs, and nesting beach ecotourism activities (Stewart et al., 2016; Griffin et al., 2017). Sea turtles serve important roles in our environment. They maintain the health of coral reefs by feeding on algae that would otherwise proliferate on the surface of the coral (Wabnitz et al., 2010; Goatley et al., 2012). They accumulate nutrients and energy while they feed at sea, and later deposit these into the beach in the form of their eggs and offspring. This process supports many other coastal species that prey on turtle eggs and hatchling turtles, and these nutrients and energy fertilize plants that maintain the integrity and resilience of the coastline (Bouchard and Bjorndal, 2000; Le Gouvello et al., 2017).

The life history of turtles accommodates the loss of eggs and juveniles to environmental variables and predation, but turtle populations are negatively impacted by premature adult mortality (Congdon et al., 1994). That is, female sea turtles produce thousands of eggs and offspring over their lifetime, but due to natural processes, the vast majority of those eggs and offspring do not survive. Therefore, females must have a decades-long reproductive lifespan in order to ensure that one or more of their offspring might actually survive to adulthood. It may take decades for a turtle to reach adult size and sexual maturity, and they may live as long as humans, or longer. Historically, upon reaching adulthood, turtles had a very high annual survival rate, reproduced for decades, and had a high chance of self-replacement prior to death. But human population growth, combined with bycatch in fisheries, coastal development, ocean industrialization, and climate change have added many new threats. Sea turtle populations have declined globally, and thus are categorized using terms such as ‘critically endangered’, ‘endangered’, or ‘threatened’ by various countries and global conservation organizations.

In the U.S., the U.S. Fish and Wildlife Service (USFW) and the National Marine Fisheries Service (NMFS) share responsibility for sea turtle conservation. Six of the seven sea turtle species are found within U.S. waters, and all six are protected under the U.S. Endangered Species Act of 1973 (ESA). Three species are listed as Endangered (hawksbill, Kemp’s ridley, and leatherback turtles), and three are listed as Endangered or Threatened depending on the geographic location of the population (e.g., Atlantic vs. Pacific populations) (green, loggerhead, and olive ridley turtles). Under the ESA, Endangered species are defined as an animal or plant species in danger of extinction throughout all or a significant portion of its range (USFW 1973).

Threatened species are defined as an animal or plant species likely to become endangered within the foreseeable future throughout all or a significant portion of its range (USFW 1973). After their ESA listing, an initial general recovery plan for all sea turtle species was produced by NMFS in 1984, and species-specific plans were developed in the subsequent decades (Hopkins and Richardson, 1984; e.g., NMFS USFW 1991, 1992, 1993, 1998, 2008, 2011). These recovery plans describe the many threats to sea turtle populations, such as fisheries interactions, habitat degradation, vessel trauma, and pollution. The plans propose criteria by which sea turtle species will be considered for de-listing, and describe activities that promote recovery. All of the U.S. sea turtle recovery plans recommend the existence of programs to manage stranded dead, ill, and injured sea turtles. HR7918 will provide funding to support this recommendation.

THREATS TO SEA TURTLES

Current major threats to sea turtles are largely anthropogenic.

- Fisheries interactions: Fisheries interactions include unintentional capture by hooks, trawl nets, gillnets, seine nets, pound nets, dredges, and entanglement in gear, resulting in drowning, near-drowning, "the bends" (decompression sickness) or traumatic injuries (NMFS USFW 1991; Wallace et al., 2013; Harms et al., 2020). Nationally, in the 1990's U.S. fisheries were estimated to have incidentally killed 70,000 sea turtles annually (Finkbeiner et al., 2011). This number decreased in the 2000s as mitigation measures were implemented and enforced, yet bycatch still remains of concern, and gaps remain in observations for certain fisheries (Finkbeiner et al., 2011).
- Alteration and loss of nesting habitat: Alteration of sea turtle nesting habitat has occurred through coastal development, construction of sea walls, erosion, nourishment of beaches (resulting in compacted substrate and alteration of temperature), sand mining, and excessive beach lighting (resulting in disorientation of hatchling turtles as they attempt to reach the sea) (Hirama et al., 2021; Shamblott et al., 2021; Reine 2022). Further effects are expected due to rising sea level (Lyons et al., 2021).
- Extreme weather and climate change: Extreme cold weather events and shifting environmental temperatures are leading toward more frequent and larger "cold-stunning" events, during which turtles become severely hypothermic (Roberts et al., 2014; Griffin et al., 2019). Turtles are ectothermic, thus their body temperature (with few exceptions) mirrors that of their environment. Hypothermia can kill sea turtles outright as their biological functions cannot be maintained. Those that wash to shore still alive are often nearly dead, not breathing, with extremely poor heart function and other life-threatening disorders (Innis et al., 2009a, b, 2016).
- Vessel strike (boat strike): Vessel strike of sufficient speed and force causes severe, often fatal, traumatic injury to sea turtles. In FL, between 1986 and 2014, approximately 11,000 sea turtles were found stranded due to vessel-strike injuries (Foley et al 2019a).
- Pollution: Ingestion of macro-plastics may lead to intestinal obstruction. Microplastic ingestion is ubiquitous across sea turtle species but toxicity studies are lacking. Other oceanic debris, such as abandoned fishing nets and lines may cause entanglement (NMFS USFW 1991; Wilcox et al., 2018; Stelfox et al., 2019; Meaza et al., 2021).

- Oil spills: Entrapment in oil may cause hyperthermia, drowning, or severe physiologic changes (Stacy and Innis 2012; Deepwater Horizon NRDA Trustees 2016; McDonald et al., 2017; Stacy et al., 2017; Wallace et al., 2017).
- Biotoxins: Sea turtles are adversely affected by biotoxins during “red tide” events, which are increasing in frequency and severity as land-based nutrient run-off intensifies marine algal growth. In Florida, between 1996 and 2013, an estimated 7,000-14,000 sea turtles died due to red tide events (Foley et al. 2019b).

Some past threats to sea turtles have been largely eliminated in the U.S., including directed hunting, egg harvest, and use of sea turtle shells for “tortoise shell” jewelry. There have been some positive collaborative efforts and policies that have reduced fisheries interactions and increased at least some sea turtle populations. The use of turtle excluder devices (TEDs) in trawl fisheries is estimated to have reduced mortality by 44% in some areas (Crowder et al., 1995). The binational (U.S. and Mexico) conservation efforts for Kemp’s ridley sea turtles helped to recover the species from near extinction in the 1980’s (at which time its nesting population had declined by 99%; NMFS USFW 2015). Adjustments in hook design and bait type led to the aforementioned decline in sea turtle bycatch in longline fisheries (Finkbeiner et al., 2011; Gilman et al., 2017; Swimmer et al., 2017). Nonetheless, cumulatively, these many threats result in the injury, illness, or death of thousands of sea turtles per year in the U.S. Many such turtles are found stranded on U.S. beaches or floating at sea in U.S. waters.

SEA TURTLE STRANDING

As defined by NOAA Fisheries, a "stranded" sea turtle is one that is found dead, or is alive but is unable to behave normally due to an injury, illness, or other problem; and NOAA recognizes that stranding may occur on land or at sea (NOAA Fisheries 2022). Well known recent examples of sea turtle strandings include:

- The 2010 Deepwater Horizon oil spill in the Gulf of Mexico, which is estimated to have exposed hundreds of thousands of sea turtles to oil, and to have killed up to 86,000 Kemp’s ridley turtles. (DH NRDA Trustees 2016, McDonald et al., 2017, Wallace et al. 2017). Approximately 320 stranded sea turtles were rescued from the oil field at sea and rehabilitated successfully in Louisiana and Florida (Stacy et al., 2017).
- In Texas in 2021, approximately 13,000 sea turtles stranded during an extreme winter weather event, and approximately 70% of them died (Department of Interior, 2021). A similar cold weather event in Florida resulted in approximately 4600 stranded sea turtles in 2010 (Department of Interior 2021).
- In New England, late autumn and early winter cold-stunning events affect sea turtles every year. In the 1990s and early 2000s, our hospital at New England Aquarium admitted dozens of cold-stunned turtles per year. But since 2010, stranding numbers are dramatically increasing (Griffin et al., 2019), and at New England Aquarium, we are admitting hundreds of turtles per year, with the maximum of 700 seen in 2014. Last year we admitted 500 turtles, and models suggest that this number may increase into the thousands by 2030 (Griffin et al., 2019).

SEA TURTLE ECOLOGY AND POPULATIONS

It is difficult to quantify sea turtle populations. The vast majority of their life is spent at sea, with rare exceptions (e.g., basking green sea turtles in Hawaii; Whittow and Balazs 1982). Males almost never come to shore. Females come to shore to lay eggs, and that may only occur for a few hours every few years. For the first year of life, sea turtles are very small and live far offshore. Sea turtles migrate great distances during their various life stages, and seasonally. For all of these reasons, it is very difficult to know the total population size of a sea turtle species at any given time in any given location. As a result of this uncertainty, nesting data from index nesting beaches are often used to estimate population trends. Nesting data include numbers of observed nesting females and/or nest counts, and data are collected by the combined efforts of federal, state, and territory government agencies, and private organizations. During ongoing USFW, NMFS, and independent scientific reviews, and based on nesting data, none of the U.S sea turtle recovery plans have yet met the recovery goals to de-list any of the six U.S. species (e.g., NMFS USFW 2015; Seminoff et al., 2015). As an example of ongoing concern, leatherback turtle nesting trends have been significantly decreasing in the Northwest Atlantic in recent years (Northwest Atlantic Leatherback Working Group 2018). Kemp's ridley sea turtle nesting numbers had been increasing for several decades, but have declined by 20-30% in several years since 2010 for reasons unknown (Caillouet et al., 2018).

THE ROLE OF THE SEA TURTLE STRANDING AND SALVAGE NETWORK

In light of many threats, and to advance the conservation and recovery of listed sea turtles, the Sea Turtle Stranding and Salvage Network (STSSN) was formally established by NMFS in 1980 to document strandings of sea turtles along the coastal U.S. and the U.S. Caribbean. On the West Coast and Pacific Islands, NMFS Regional Offices oversee these functions. NMFS employees are regional coordinators for these networks, as well as state coordinators for Alabama, Mississippi, Louisiana, and the Pacific networks. NMFS employees participate directly in stranding response and transportation of stranded turtles in some situations, and oversee mortality investigations. However, the number of NMFS employees that are assigned to this work is small relative to the number of strandings and associated resource needs. Thus, permitted private partners contribute the majority of the resources to respond to and document stranded sea turtles, determine causes of morbidity and mortality, and inform conservation management and recovery. While NMFS coordinates the networks, it is the participating local organizations that respond to stranded turtles, collect scientific data, transport sick and injured turtles to rehabilitation facilities, provide veterinary care, and educate the public about sea turtle conservation. The existence and activities of these networks and partners have been deemed important by each of the subsequent recovery plans. The stranding network also meets current societal expectations by providing humane care for animals in distress, and by providing structure for citizen efforts to protect sea turtles (Cornwell and Campbell 2012). This facet is very important, and often overlooked. There are no alternative plans to provide care for the thousands of stranded sea turtles that are found in the U.S. each year.

THE IMPORTANCE OF THE STSSN

My work, and the work of my colleagues, has demonstrated that injured and ill sea turtles suffer from a variety of serious physical and physiologic problems (Innis et al., 2009a, b, 2010, 2016; Manire et al., 2017; Stacy et al., 2017; Foley et al., 2019a, b; Harms et al., 2020). We manage turtles that have suffered severe traumatic injuries due to vessel strike. We perform surgery to remove fish hooks and line, balloon ribbons, and plastic from the digestive system. We treat severely compromised turtles that have life-threatening infections, such as pneumonia and septicemia. We manage severe dehydration, anemia, renal failure, and acidosis. Our success rate is high, and we often save turtles from near death. At our hospital at New England Aquarium, approximately 80% of sea turtles are successfully treated and returned to the wild. In the last thorough national review of outcomes, we documented over 11,000 turtles that were returned to the wild after rehabilitation in U.S. facilities (Innis et al., 2019).

There are several excellent examples that illustrate the importance of the stranding network in supporting Recovery Plan priorities.

- In Massachusetts, in addition to our work with stranded cold-stunned sea turtles, we fulfill recovery plan priorities of identifying current threats to sea turtles on foraging grounds, evaluating the extent and effects of entanglement in fishing gear, and monitoring and reducing incidental mortality in commercial and recreational fisheries. We have established a network to identify entangled leatherback turtles that are stranded at sea. We quantify the number of entanglements, including fatal entanglements; we characterize the physical and physiologic effects of entanglement; and we monitor the long-term outcome of turtles after disentanglement (Innis et al., 2010; Dodge et al., 2022). Our peer-reviewed literature and media outreach have raised awareness of this problem, and have stimulated ongoing studies to further understand the conservation impact of the entanglements, with the ultimate goal of mitigation. This STSSN work is especially important since the involved fisheries do not have adequate federal or state observer coverage.
- In Florida, stranding network data are routinely used to identify threats to sea turtles in foraging and nesting areas. Stranding network data are the principal source of information regarding vessel strike (Foley et al., 2019b). These investigations indicate that vessel strike disproportionately affects adult sea turtles that are in near-shore waters during their breeding period. This information is now being used for targeted outreach by state agencies and STSSN partners to educate boaters in order to reduce the likelihood of collision.
- In Texas, stranding network observations support recovery plan priorities in identifying threats to sea turtles on foraging grounds, and monitoring for incidental mortality in fisheries. Network members detected an unusual increase in sea turtle strandings in 2019, involving approximately 120 green sea turtles. Investigation indicated that these deaths were likely due to drowning, and ultimately Coast Guard surveillance confirmed the presence of illegal gillnets containing dead and live green turtles in the area. (Stacy et al., 2020).

As of March 2022, there are 58 facilities in 21 U.S. states and territories that are permitted by USFW to provide long term veterinary care, rehabilitation and release for sea turtles. Such organizations include New England Aquarium (MA), National Aquarium (MD), South Carolina Aquarium (SC), Georgia Sea Turtle Center (GA), Audubon Nature Institute (LA), Mississippi Aquarium, Gulfarium (FL), the North Carolina Aquariums, Sea Turtle Inc. (TX), and many others. There are also some permitted partners that do not provide veterinary care, but provide stranding response, disentanglement and release, initial recovery of beached turtles, and transport of turtles to long term rehabilitation facilities. Such organizations include Massachusetts Audubon Wellfleet Bay Wildlife Sanctuary and the Center for Coastal Studies (MA). Network facilities collaborate closely. We assist each other with distribution of caseload and transportation of turtles. We share data, ideas, and methods. We cross-train and teach each other. We conduct collaborative research projects, and we publish our findings. We educate veterinary students and future marine biologists. We educate the public about sea turtles and marine conservation, in general, through our public exhibits, social media platforms, and sea turtle release events. We successfully rescue and rehabilitate thousands of sea turtles amidst increasing threats.

THE COSTS OF CARE

Sea turtle rescue and rehabilitation facilities largely rely on their own operating budget and donations for the majority of expenses. Many of our facilities overly rely on volunteer labor. Our facilities must be permitted by the USFW, and therefore we must comply with rigorous permit conditions that dictate the infrastructure of our physical plant and the training and credentials of our personnel (USFW 2019). As the number of strandings increases, this is becoming an unsustainable model. The limitations of this model were made even more clear during the coronavirus pandemic, when many facilities were forced to limit their staffing and close to the public, losing their major source of revenue, yet were faced with a consistently high caseload of stranded turtles. For example, my institution was forced to close to the public for 26 weeks in 2020, just prior to our peak sea turtle stranding period. We had to lay off 40% of our staff, and we incurred a $5 million budget deficit. Yet, we continued to provide care for the nearly 400 sea turtles that stranded in MA in the subsequent months.

Stranding response and associated veterinary care for sea turtles are expensive. There are costs associated with initial recovery of turtles from the environment, transporting turtles to rehabilitation facilities, provision of veterinary care, and eventual transportation to release sites. Turtles often require intensive veterinary care for weeks to months before they can be returned to the wild. Our level of care has become quite sophisticated and continues to advance each year. We have capabilities that are on par with other more conventional realms of veterinary medicine, and we require the same equipment, drugs, and skills that are used for domestic species. We require large salt-water tanks, excellent water quality, and proper temperature and lighting. We require radiology systems, medical record systems, surgical facilities, endoscopy equipment, ultrasound machines, incubators, and facilities to support post-mortem evaluations. As with other forms of technology, such medical equipment evolves rapidly and has a functional lifespan. A funded plan to maintain and replace medical equipment is needed over time in order to meet contemporary standards. We incur costs for diagnostic services such as blood analysis and microbiological cultures. We incur costs to conduct clinical research. We investigate new ways to manage certain conditions; we determine how certain drugs are metabolized by sea turtles; we create new diagnostic methods; and we evaluate new interventions (Innis et al., 2016; Manire et al., 2017; Innis et al., 2020; Powell et al., 2021). Upon completion of rehabilitation, we incur substantial costs to transport turtles to appropriate release sites. Groups of sea turtles sometimes need to be transported hundreds or thousands of miles by vehicle or airplane in order to distribute the caseload, and to release them into thermally appropriate habitat (Hunt et al., 2020). A recent informal survey of eight sea turtle stranding and response institutions on the East Coast of the U.S., conducted by the National Aquarium and South Carolina Aquarium, found collective spending of $5 million per year and a median annual cost of more than $400,000 per institution for sea turtle stranding response and rehabilitation. At my facility, we spend approximately $1 million per year to support our sea turtle rescue program, with federal support covering less than five percent of these costs.

Sea turtles are not currently given a full suite of federal support, such as the support that is given to marine mammals by the Marine Mammal Protection Act of 1972. Associated with the MMPA, the John H. Prescott Marine Mammal Rescue Assistance Grant Program provides competitive funding to organizations that investigate and respond to stranded marine mammals. Through the Prescott Grant Program, NMFS has awarded more than $67 million over the last 20 years in competitive grant funding to marine mammal stranding network participants to respond to and care for federally protected marine mammals. Yet, there is no analogous funding source to respond to and care for threatened and endangered sea turtles that are federally protected under the Endangered Species Act.

Establishing a funding source for sea turtle rescue, rehabilitation, and research, as proposed by HR7918 (and S4432), would sustain and enhance the ongoing efforts of U.S. sea turtle stranding networks. Given the growing number of strandings, funding is needed to increase the spatial capacity and infrastructure of each facility. Funding is needed to support a sufficient paid labor force, medical care for the turtles, and transportation of turtles between stranding locations, rehabilitation centers, and release sites. Funding is needed to coordinate local, regional, and national efforts. By creating a grant program at the Department of Commerce for sea turtle rescue, recovery, and research, HR7918 would authorize $5 million in annual funding. This funding would be competitively available to all facilities that are permitted by USFW to provide stranding response and rehabilitation. Per HR7918, these funds could be used to support facility operating costs for these critical activities.

RESEARCH NEEDS AND OPPORTUNITIES

In addition to the basic premise of rescuing and rehabilitating turtles and returning them to the wild, research funding is also needed to understand post-release survival and behavior of rehabilitated turtles, in order to objectively evaluate the conservation impact of these efforts. While we successfully rehabilitate and release turtles to the wild, we have few observations on the long-term fate of the great majority of individuals (Innis et al, 2019). We must use emerging technology to gain long-term outcome data for sea turtles that are released from our programs.

And we must determine whether these turtles are eventually reproducing and contributing to the population. Our initial work with satellite and acoustic telemetry tags indicates that these tools will be important in this realm. We have successfully monitored turtles for over a year after release from rehabilitation or disentanglement (Innis et al., 2010; Dodge et al., 2014, 2022), and our very recent work with surgically implanted acoustic tags may provide data for as long as ten years after release.

Along with assessing survivorship of rehabilitated sea turtles, these new, long-term tagging techniques will allow us to use rehabilitated sea turtles as a proxy for free-ranging turtles to understand behavior and habitat use of these cryptic species. Limited post-release monitoring data from our own program and others (e.g., Robinson et al., 2020) suggest that rehabilitated sea turtles resume typical migratory and diving behaviors after release, comparable to that of wild-caught individuals. Tagging rehabilitated sea turtles will provide much-needed insight into the spatial ecology, diving behaviors, and critical habitats of sea turtles, particularly for elusive life stages and in data-poor regions where sea turtles are difficult to access. These data are currently in high demand to understand and mitigate potential conflict between wildlife and expanding industries such as offshore wind and subtidal aquaculture. While limited use of these technologies may be accomplished with funding from other sources, HR7918 would accelerate and expand this work because it explicitly creates competitive grant funding for such research.

In conclusion, HR7918 will improve our ability to provide care to stranded sea turtles in the U.S., and it will improve our ability to understand the value and long-term outcome of our efforts.

Literature Cited

Bouchard SS, Bjorndal KA. Sea turtles as biological transporters of nutrients and energy from marine to terrestrial ecosystems. Ecology. 2000 Aug;81(8):2305-13.

Caillouet Jr CW, Raborn SW, Shaver DJ, Putman NF, Gallaway BJ, Mansfield KL. Did declining carrying capacity for the Kemp's ridley sea turtle population within the Gulf of Mexico contribute to the nesting setback in 2010− 2017? Chelonian Conservation and Biology. 2018 Jun;17(1):123-33.

Campbell LM. 2003. Contemporary culture, use, and conservation of sea turtles. In Lutz P et al. (eds). The Biology of Sea Turtles, Volume 2, CRC Press, Boca Raton.

Congdon JD, Dunham AE, Sels RV. Demographics of common snapping turtles (*Chelydra serpentina*): implications for conservation and management of long-lived organisms. American Zoologist. 1994 Jun 1;34(3):397-408.

Cornwell ML, Campbell LM. Co-producing conservation and knowledge: citizen-based sea turtle monitoring in North Carolina, USA. Social Studies of Science. 2012 Feb;42(1):101-20.

Crowder LB, Hopkins-Murphy SR, Royle JA. Effects of turtle excluder devices (TEDs) on loggerhead sea turtle strandings with implications for conservation. Copeia. 1995 Dec 21:773-9.

Deepwater Horizon NRDA Trustees 2016. Deepwater Horizon oil spill: final programmatic damage assessment and restoration plan and final programmatic environmental impact statement. http://www.gulfspillrestoration.noaa.gov/restoration-planning/gulf-plan

Department of the Interior 2021. Cold-stunning statistics. Newswave, Spring 2021 issue. Page 12. https://www.doi.gov/sites/doi.gov/files/newswave-spring2021.pdf

Dodge KL, Galuardi B, Miller TJ, Lutcavage ME. Leatherback turtle movements, dive behavior, and habitat characteristics in ecoregions of the Northwest Atlantic Ocean. PLoS One. 2014 Mar 19;9(3): e91726.

Dodge KL, Landry S, Lynch B, Innis CJ, Sampson K, Sandilands D, Sharp B. Disentanglement network data to characterize leatherback sea turtle *Dermochelys coriacea* bycatch in fixed-gear fisheries. Endangered Species Research. 2022 Feb 24; 47:155-70.

Finkbeiner EM, Wallace BP, Moore JE, Lewison RL, Crowder LB, Read AJ. Cumulative estimates of sea turtle bycatch and mortality in USA fisheries between 1990 and 2007. Biological Conservation. 2011 Nov 1;144(11):2719-27.

Foley AM, Stacy BA, Hardy RF, Shea CP, Minch KE, Schroeder BA. Characterizing watercraft-related mortality of sea turtles in Florida. The Journal of Wildlife Management. 2019a Jul;83(5):1057-72.

Foley AM, Stacy BA, Schueller P, Flewelling LJ, Schroeder B, Minch K, Fauquier DA, Foote JJ, Manire CA, Atwood KE, Granholm AA. Assessing *Karenia brevis* red tide as a mortality factor of sea turtles in Florida, USA. Diseases of Aquatic Organisms. 2019b Jan 10;132(2):109-24.

Gilman E, Huang HW. Review of effects of pelagic longline hook and bait type on sea turtle catch rate, anatomical hooking position and at-vessel mortality rate. Reviews in Fish Biology and Fisheries. 2017 Mar;27(1):43-52.

Goatley CH, Hoey AS, Bellwood DR. The role of turtles as coral reef macroherbivores. PloS one. 2012 Jun 29;7(6): e39979.

Griffin LP, Brownscombe JW, Gagné TO, Wilson AD, Cooke SJ, Danylchuk AJ. Individual-level behavioral responses of immature green turtles to snorkeler disturbance. Oecologia. 2017 Mar;183(3):909-17.

Griffin LP, Griffin CR, Finn JT, Prescott RL, Faherty M, Still BM, Danylchuk AJ. Warming seas increase cold-stunning events for Kemp’s ridley sea turtles in the northwest Atlantic. PLoS One. 2019 Jan 29;14(1): e0211503.

Harms CA, Boylan SM, Stacy BA, Beasley JF, García-Párraga D, Godfrey MH. Gas embolism and massive blunt force trauma to sea turtles entrained in hopper dredges in North and South Carolina, USA. Diseases of Aquatic Organisms. 2020 Dec 17; 142:189-96.

Hassan AE, Sadek S. Animal symbolism in Indian American poetry. European Scientific Journal. 2015 Apr 1;11(11).

Hirama S, Witherington B, Kneifl K, Sylvia A, Wideroff M, Carthy R. Environmental factors predicting the orientation of sea turtle hatchlings on a naturally lighted beach: A baseline for light-management goals. Journal of Experimental Marine Biology and Ecology. 2021 Aug 1; 541:151568. https://www.sciencedirect.com/science/article/pii/S0022098121000587

Hopkins SR and Richardson JI (eds) 1983. Recovery Plan for Marine Turtles. https://www.govinfo.gov/content/pkg/CZIC-ql666-c5-r42-1984/html/CZIC-ql666-c5-r42-1984.htm

Hunt KE, Merigo C, Burgess EA, Buck CL, Davis D, Kennedy A, Lory L, Wocial J, McNally K, Innis C. Effects of ground transport in Kemp's ridley (*Lepidochelys kempii*) and loggerhead (*Caretta caretta*) turtles. Integrative Organismal Biology. 2020;2(1): obaa012.

Innis CJ, Finn S, Kennedy A, Burgess E, Norton T, Manire CA, Harms C. A summary of sea turtles released from rescue and rehabilitation programs in the United States, with observations on re-encounters. Chelonian Conservation and Biology. 2019 Jun 27;18(1):3-9.

Innis CJ, Kennedy A, McGowan JP, Buchweitz JP, McNally K. Glomerular filtration rates of naturally cold-stunned Kemp's ridley turtles (*Lepidochelys kempii*): comparison of initial vs. convalescent values. Journal of Herpetological Medicine and Surgery. 2016 Dec;26(3-4):100-3.

Innis C, Kennedy A, Wocial J, Burgess E, Papich MG. Comparison of oxytetracycline pharmacokinetics after multiple subcutaneous injections in three sea turtle species. Journal of Herpetological Medicine and Surgery. 2020 Sep;30(3):142-7.

Innis C, Merigo C, Dodge K, Tlusty M, Dodge M, Sharp B, Myers A, McIntosh A, Wunn D, Perkins C, Herdt TH. Health evaluation of leatherback turtles (*Dermochelys coriacea*) in the northwestern Atlantic during direct capture and fisheries gear disentanglement. Chelonian Conservation and Biology. 2010 Dec;9(2):205-22.

Innis C, Nyaoke AC, Williams III CR, Dunnigan B, Merigo C, Woodward DL, Weber ES, Frasca Jr S. 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. 2009a Jul;45(3):594-610.

Innis CJ, Ravich JB, Tlusty MF, Hoge MS, Wunn DS, Boerner-Neville LB, Merigo C, Weber ES. Hematologic and plasma biochemical findings in cold-stunned Kemp's ridley turtles: 176 cases (2001–2005). Journal of the American Veterinary Medical Association. 2009b Aug 15;235(4):426-32.

Le Gouvello DZ, Nel R, Harris LR, Bezuidenhout K, Woodborne S. Identifying potential pathways for turtle-derived nutrients cycling through beach ecosystems. Marine Ecology Progress Series. 2017 Nov 16; 583:49-62.

Lyons MP, von Holle B, Caffrey MA, Weishampel JF. Quantifying the impacts of future sea level rise on nesting sea turtles in the southeastern United States. Ecological Applications. 2020 Jul;30(5): e02100.

Manire C, Norton T, Innis C, Stacy B, Harms C (eds) 2017. Sea Turtle Health and Rehabilitation. J. Ross Publishing.

McDonald TL, Schroeder BA, Stacy BA, Wallace BP, et al. Density and exposure of surface-pelagic juvenile sea turtles to Deepwater Horizon oil. Endang Species Res 2017; 33:69-82. https://doi.org/10.3354/esr00771

Meaza I, Toyoda JH, Wise JP. Microplastics in sea turtles, marine mammals and humans: a one environmental health perspective. Frontiers in Environmental Science 2021; 8:575614.

NMFS, USFW 1991. Recovery Plan for U.S. Population of Atlantic Green Turtle. NMFS, Washington, D.C. https://www.fisheries.noaa.gov/resource/document/recovery-plan-us-population-atlantic-green-turtle-chelonia-mydas

NMFS, USFW 1993. Recovery Plan for Hawksbill Turtles in the U.S. Caribbean Sea, Atlantic Ocean, and Gulf of Mexico. NMFS, St Petersburg FL. https://www.fisheries.noaa.gov/resource/document/recovery-plan-hawksbill-turtles-us-caribbean-sea-atlantic-ocean-and-gulf-mexico

NMFS USFW 1992. Recovery Plan for Leatherback Turtles in the U.S. Caribbean Sea, Atlantic Ocean, and Gulf of Mexico. NMFS, Washington D.C. https://www.fisheries.noaa.gov/resource/document/recovery-plan-leatherback-turtles-us-caribbean-atlantic-and-gulf-mexico

NMFS USFW 1998. Recovery Plan for U.S. Pacific Populations of the Olive Ridley Turtle (*Lepidochelys olivacea*). NMFS, Silver Spring, MD. https://www.fisheries.noaa.gov/resource/document/recovery-plan-us-pacific-populations-olive-ridley-turtle-lepidochelys-olivacea

NMFS USFW 2019. Recovery Plan for the Northwest Atlantic Population of the Loggerhead Sea Turtle (*Caretta caretta*) Second Revision (2008): Assessment of Progress Toward Recovery, December 2019. https://media.fisheries.noaa.gov/dam-migration/final_nw_atl_cc_recovery_team_progress_review_report_508.pdf

NMFS USFW. 2008. Recovery Plan for the Northwest Atlantic Population of the Loggerhead Sea Turtle (*Caretta caretta*), Second Revision. NMFS, Silver Spring, MD. https://www.fisheries.noaa.gov/resource/document/recovery-plan-northwest-atlantic-population-loggerhead-sea-turtle-caretta-caretta

NMFS, USFW, and SEMARNAT. 2011. Bi- National Recovery Plan for the Kemp's Ridley Sea Turtle (*Lepidochelys kempii*), Second Revision. NMFS. Silver Spring, Maryland. https://www.fisheries.noaa.gov/resource/document/bi-national-recovery-plan-kemps-ridley-sea-turtle-2nd-revision

NMFS USFW 2015. Kemp's Ridley Sea Turtle (*Lepidochelys kempii*) 5-Year Review: Summary and Evaluation. https://repository.library.noaa.gov/view/noaa/17048

NOAA Fisheries 2022. Frequent Questions: Northern Gulf of Mexico Sea Turtle Strandings. https://www.fisheries.noaa.gov/southeast/marine-life-distress/frequent-questions-northern-gulf-mexico-sea-turtle-strandings

Northwest Atlantic Leatherback Working Group. 2018. Northwest Atlantic Leatherback Turtle (*Dermochelys coriacea*) Status Assessment (Bryan Wallace and Karen Eckert, Compilers and Editors). Conservation Science Partners and the Wider Caribbean Sea Turtle Conservation Network (WIDECAST). WIDECAST Technical Report No. 16. Godfrey, Illinois. 36 pp. https://www.widecast.org/Resources/Docs/16_NWA_Leatherback_Working_Group_(2018)_NWA_Leatherback_Status_Assessment.pdf

Powell AL, Tuxbury KA, Cavin JM, Stacy BA, Frasca S, Stacy NI, Brisson J, Solano M, Williams SR, McCarthy RJ and Innis CJ. Osteomyelitis in cold-stunned Kemp's ridley sea turtles (*Lepidochelys kempii*) hospitalized for rehabilitation: 25 cases (2008–2018). Journal of the American Veterinary Medical Association, 2021; 259(10): 1206-1216.

Reine KJ. 2022. A literature review of beach nourishment impacts on marine turtles. Army Corps of Engineers, Engineer Research and Development Center, ERDC/EL TR-22-4. https://erdc-library.erdc.dren.mil/jspui/bitstream/11681/43829/1/ERDC-EL%20TR-22-4.pdf

Roberts K, Collins J, Paxton CH, Hardy R and Downs J. Weather patterns associated with green turtle hypothermic stunning events in St. Joseph Bay and Mosquito Lagoon, Florida. Physical Geography 2014; 35:134-50.

Robinson NJ, Deguzman K, Bonacci-Sullivan L, DiGiovanni Jr RA, Pinou T. Rehabilitated sea turtles tend to resume typical migratory behaviors: satellite tracking juvenile loggerhead, green, and Kemp’s ridley turtles in the northeastern USA. Endangered Species Research. 2020 Sep 24; 43:133-43.

Seminoff JA, Allen CD, Balazs GH, Dutton PH, Eguchi T, Haas HL, Hargrove SA, Jensen MP, Klemm DL, Lauritsen AM, MacPherson SL, Opay P, Possardt EE, Pultz SL, Seney EE, Van Houtan KS, Waples RS. 2015. Status Review of the Green Turtle (*Chelonia mydas*) Under the U.S. Endangered Species Act. NOAA Technical Memorandum, NOAANMFS-SWFSC-539. 571pp. https://repository.library.noaa.gov/view/noaa/4922

Shamblott KM, Reneker JL, Kamel SJ. The thermal impacts of beach nourishment across a regionally important loggerhead sea turtle (*Caretta caretta*) rookery. Ecosphere. 2021 Mar;12(3): e03396.

Stacy B, Hardy R, Shaver D, Purvin C, Howell L, Wilson H, Devlin M, Krauss A, Macon C, Cook M, Wang Z, Flewelling L, Keene J, Walker A, Baker P, Yaw T. 2020. 2019 Sea Turtle Strandings in Texas: A Summary of Findings and Analyses. Department of Commerce, National Marine Fisheries Service, NOAA Technical Memorandum NMFS OPR-66, 64 p. https://media.fisheries.noaa.gov/2020-11/OPR_TM66_508.pdf

Stacy NI, Field CL, Staggs L, MacLean RA, Stacy BA, Keene J, Cacela D, Pelton C, Cray C, Kelley M, Holmes S, Innis CJ. Clinicopathological findings in sea turtles assessed during the Deepwater Horizon oil spill response. Endangered Species Research 2017; 33:25-37.

Stacy NI, Innis C. 2015. Analysis and interpretation of hematology and blood chemistry values in live sea turtles documented by response operations during the 2010 BP Deepwater Horizon oil spill response. DWH sea turtles NRDA technical working group report. DWH Sea Turtles NRDA Technical Report https://www.fws.gov/doiddata/dwh-ar-documents/894/DWH-AR0149939.pdf

Stelfox M, Bulling M, Sweet M. Untangling the origin of ghost gear within the Maldivian archipelago and its impact on olive ridley (*Lepidochelys olivacea*) populations. Endangered Species Research. 2019 Dec 12; 40:309-20.

Stewart KM, Norton T, Tackes DS, and Mitchell MA. Leatherback ecotourism development, implementation, and outcome assessment in St. Kitts, West Indies. Chelonian Conservation and Biology 2016;15(2): 197-205.

Swimmer Y, Gutierrez A, Bigelow K, Barceló C, Schroeder B, Keene K, Shattenkirk K, Goster DG. Sea turtle bycatch mitigation in U.S. longline fisheries. Frontiers in Marine Science 2017; 4:260.

USFW 1973. Endangered Species Act of 1973. https://www.fws.gov/sites/default/files/documents/endangered-species-act-accessible.pdf

USFW 2019. U.S. Fish and Wildlife Services' Standard Conditions for Care and Maintenance of Captive Sea Turtles. https://www.fws.gov/sites/default/files/documents/seaturtle-standard-conditions-for-care-2019.pdf

Wabnitz CC, Balazs G, Beavers S, Bjorndal KA, Bolten AB, Christensen V, Hargrove S, Pauly D. Ecosystem structure and processes at Kaloko Honokōhau, focusing on the role of herbivores, including the green sea turtle *Chelonia mydas* in reef resilience. Marine Ecology Progress Series. 2010 Dec 16; 420:27-44.

Wallace BP, Brosnan T, McLamb D, Rowles T, Ruder E, Schroeder B, *et al*. Effects of the Deepwater Horizon oil spill on protected marine species. Endangered Species Research 2017; 33:1-7.

Wallace BP, Kot C, DiMatteo AD, Lee T, Crowder LB and Lewison RL. Impacts of fisheries bycatch on marine turtle populations worldwide: toward conservation and research priorities. Ecosphere 2013; 4:40.

Whittow, G.C., Balazs, G.H. Basking behavior of the Hawaiian green turtle (*Chelonia mydas*). Pacific Science 1982;36(2).

Wilcox C, Puckridge M, Schuyler QA, Townsend K, Hardesty BD. A quantitative analysis linking sea turtle mortality and plastic debris ingestion. Scientific Reports. 2018 Sep 13;8,12536. https://doi.org/10.1038/s41598-018-30038-z