# Original document can be found at <https://drive.google.com/file/d/0B9PjRUPQzr6nYWtGTlp3cHB3SnFXUHEtN2tRZTkwdDFPSnNn/view>

# Globally endangered sea turtles of the

# Palmyra Atoll National Wildlife Refuge:

# A Focus on Scientific Analysis

Exercise

Eugenia Naro-Maciel, Katherine Holmes, Peter J. Ersts, Katherine McFadden,

Nora Bynum and Eleanor Sterling

Reproduction of this material is authorized by the recipient institution for nonprofit/non-commercial educational use and distribution to students enrolled in course work at the institution. Distribution may be made by photocopying or via the institution's intranet restricted to enrolled students. Recipient agrees not to make commercial use, such as, without limitation, in publications distributed by a commercial publisher, without the prior express written consent of AMNH.

All reproduction or distribution must provide full citation of the original work and provide a copyright notice as follows:

“Copyright 2009, by the authors of the material, with license for use granted to the Center for Biodiversity and Conservation of the American Museum of Natural History. All rights reserved.”

These educational materials were developed with the support of grants from the National Oceanic and Atmospheric Administration of the US Department of Commerce, the Royal Caribbean Ocean Fund, and the Regina Bauer Frankenberg Foundation for Animal Welfare. We acknowledge the Palmyra Atoll National Wildlife Refuge, US Fish and Wildlife Service, Department of the Interior.

Any opinions, findings and conclusions, or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the American Museum of Natural History, the granting agencies, or the Palmyra Atoll National Wildlife Refuge.

# Globally endangered sea turtles of the

# Palmyra Atoll National Wildlife Refuge:

# A Focus on Scientific Analysis

Eugenia Naro-Maciel, Katherine Holmes, Peter J. Ersts, Katherine McFadden,

Nora Bynum and Eleanor Sterling

## 

(Source: Wikimedia Commons, CC-BY-SA 4.0, Brocken Inaglory)

## Overview

Little is known about sea turtles and their habitats at the remote Palmyra Atoll National Wildlife Refuge (PANWR) in the Central Pacific. This lack of knowledge may hinder management and conservation efforts. To help provide insights into protection strategies, in this exercise you will make suggestions for designing a comprehensive research program on globally endangered sea turtles of the Palmyra Atoll National Wildlife Refuge. You will then use existing survey data to answer questions about the relative abundance of endangered sea turtles along the atoll, and critically analyze your results. Finally, you will carry out research to devise your own methods for studying sea turtles at the PANWR.

## Introduction

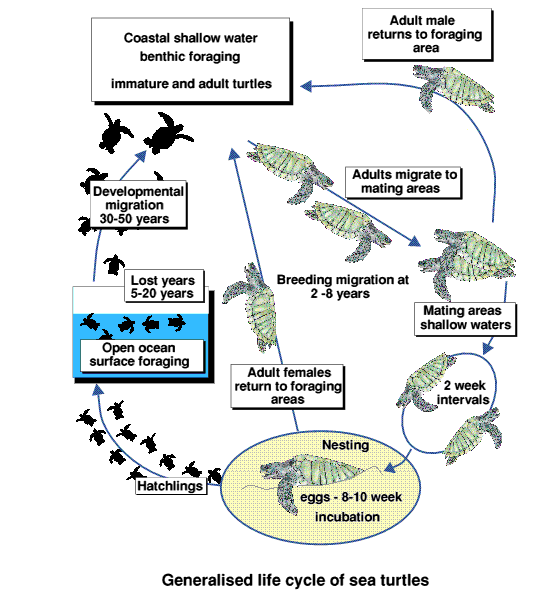
The world’s oceans and seas, which span about three quarters of the earth’s surface and contain a substantial part of the planet’s biodiversity, are under threat. Systems are strained by unsustainable fishing practices, habitat degradation, coastal development, climate change, and other factors. Over the course of their lives, sea turtles play important ecological roles in many marine systems. These charismatic animals have long been important elements of diverse cultures, and their conservation can benefit humans as well through, for example, ecotourism or environmental employment. Even so, many of these ancient reptiles are now endangered worldwide due to harvest, fisheries interaction, habitat loss, pollution and disease, climate change, and other threats. Sea turtles are flagship species, whose conservation can also protect the vast, diverse, and often threatened habitats they utilize.

Sea turtles, also known as marine turtles, have inhabited the earth for over 100 million years, since the Cretaceous Period (Hirayama 1998). The fossil record reveals that four families were established during this period, two of which have survived into the present (Pritchard 1996). The family Dermochelyidae contains only the leatherback turtle, *Dermochelys* *coriacea*, while the second family, the Cheloniidae, is commonly thought to include six species classified into five genera. These include the critically endangered hawksbill turtle, *Eretmochelys* *imbricata*, a tropical species and one of the few animals known to feed on sponges. Also in this family are the primarily herbivorous green sea turtle (*Chelonia* *mydas*), and the carnivorous loggerhead (*Caretta* *caretta*), found in tropical and temperate areas worldwide. The flatback (*Natator* *depressus*) has a restricted distribution, nesting mainly in Australia. Another species with a restricted distribution is the Kemp’s ridley (*Lepidochelys kempii*), found only in the Atlantic Ocean. Although they may look similar, many studies support recognition of the Kemp's ridley, *L. kempii*, and the olive ridley, *Lepidochelys olivacea*, as separate species (Bowen et al. 1991; Bowen et al. 1993; Dutton et al. 1996).

Throughout their highly migratory life cycles, sea turtles are known to serve as prey for some species such as sharks, as consumers and habitat modifiers, and as nutrient transporters (Bjorndal and Jackson 2003). In the latter capacity, turtles carry nutrients (elements needed for survival, growth, or metabolism) between different ecosystems by, for example, laying eggs. After hatching from eggs on nesting beaches, young sea turtles disperse into the ocean. As juveniles, some species, including green and hawksbill sea turtles, leave the pelagic environment and move to coastal feeding grounds (Musick and Limpus 1997). Adults undertake breeding migrations that may span thousands of kilometers between feeding grounds and nesting areas. Many females return to nest in the vicinity of their natal beach (Carr 1967; Figure 1). Although there is much information about sea turtles, scientific knowledge about some topics and populations remains scarce.

**Figure 1**. The sea turtle life cycle spans diverse ecosystems sometimes separated by thousands of miles. Palmyra Atoll is a foraging area for green and hawksbill sea turtles.

Source: http://www.euroturtle.org/biology/lifec.htm



### Sea turtles at Palmyra Atoll

Little is known about threatened sea turtles and their habitats at the remote Palmyra Atoll National Wildlife Refuge (PANWR), located in the Central Pacific about halfway between Hawaii and American Samoa (5°53′N 162°05′W, Figure 2). It is known that the two species found to date at Palmyra (Figure 3) are listed under the US Endangered Species Act. The green sea turtle (*Chelonia mydas*) is listed as Threatened except where Endangered (nesting colonies in Florida and Pacific Mexico), and the hawksbill sea turtle (*Eretmochelys imbricata*) is listed as Endangered. In addition, these species, along with all other marine turtles, are included on the World Conservation Union’s IUCN Red List of Threatened Species. Preliminary reports by government personnel and our research team have underscored the paucity of knowledge about sea turtles and their ecosystems at Palmyra. This dearth of information hinders effective conservation, recovery and management.

**Figure 2**. Map showing the location of Palmyra Atoll, Central Pacific (Credit: Peter Ersts, CBC).



**Figure 3**. Satellite image of Palmyra Atoll, Central Pacific (center; credit: IKONOS), with green (left; credit: Dan Brumbaugh, CBC) and hawksbill (right; credit: Palmyra Atoll National Wildlife Refuge) sea turtles found there.



Protected areas such as Palmyra form the cornerstone for biological conservation and can safeguard biodiversity from genes to ecosystems. However, protection of an area does not automatically ensure the well being of its organisms or habitats, particularly of migratory species such as sea turtles. It is necessary to understand species biology and ecological processes within a protected area, as well as the links among populations that may move across area boundaries. Highly migratory sea turtles, for example, may face serious threats when they depart protected borders, including those of the PANWR, on their breeding or developmental migrations. These migrations may be as far as several thousand kilometers from their feeding grounds. Significantly, Palmyra Atoll is thought not to be a major nesting area, but rather, a year-round feeding ground for both adults and juveniles, meaning that the departure of turtles from its waters can place them in endangerment from outside factors.

The Refuge offers unique opportunities for sea turtle conservation research because of the interdisciplinary research efforts of the Palmyra Atoll Research Consortium (PARC), and its unusual history. Palmyra Atoll is an incorporated territory of the United States. Portions of the terrestrial areas of the atoll are privately owned by The Nature Conservancy and managed as a nature reserve. The neighboring islets and surrounding waters, out to the 12-mile limit, were transferred to the United States Fish and Wildlife Service and designated as the Palmyra Atoll National Wildlife Refuge in 2001. The Refuge was established by the Department of the Interior and is managed by the FWS. During World War II, however, Palmyra Atoll was heavily altered as a result of the US Government occupation. Extensive dredging, and connection of the islets that made up the atoll into causeways changed the hydrological and oceanographic features of the atoll. Efforts to restore the original hydrodynamic flow, which are currently being considered for the lagoon system (Figure 3), could involve breaching these causeways. However, these restoration efforts may release toxic plumes and other pollutants left behind by the US government occupation into the marine environment, potentially negatively impacting sea turtle feeding grounds and other habitats.

In recent years, the atoll has been uninhabited except for management or research personnel, including members of the multi-institutional PARC, which carries out integrative studies of biodiversity and environmental physics along the Atoll. Relatively few sea turtle studies are carried out in marine systems under as intense scientific attention as Palmyra, and this broader research context should help address priority questions about the ecological roles of sea turtles and ecosystem approaches to sea turtle conservation and management. Because sea turtles at Palmyra forage in a unique environment currently removed from direct, pervasive human influence, this research can expand our knowledge of these reptiles where they are relatively unaffected by people, providing an essential baseline for understanding natural processes, ecological roles, and human impacts.

## Exercise

### A) Asking questions about sea turtle research at Palmyra Atoll

Why study sea turtles at Palmyra?

Based on the information above, can you formulate three scientific or management/conservation questions that can be addressed through research at the PANWR?

### C) Methods and results: focus on sea turtle surveys at Palmyra Atoll

To advance the research and conservation of sea turtles at Palmyra Atoll, studies began there in 2005. One major objective of the early research at Palmyra was to gain some understanding of sea turtle distribution and abundance there. To this end, surveys were carried out to document the occurrence of sea turtles along the atoll about every three months from August 2005 to September 2006, and approximately annually thereafter. Survey counts were conducted by 5 to 10 researchers who simultaneously traveled by kayak and boat along non-linear transects, each counting the number of turtles that they encountered on the transect. The total number of turtles counted was influenced by weather and visibility conditions, and as many as 120 turtles were seen during the roughly 2-hour survey period.

To help provide insights into conservation and management, you will use data from the first survey to investigate the abundance of endangered sea turtles along the atoll. The coordinates of sea turtle sightings were recorded in this survey using Global Positioning System (GPS) technology and overlaid with satellite images to investigate ecological interactions. Below are the results of this survey, which took place in August 2005 (Appendix 1: Figures 4-8). Use these data to reply to the following questions. For each question, also consider what some limitations might be in only using these survey data to formulate your answers.

1. Which species appears to be most common along the atoll?
2. Are sea turtles found randomly throughout the atoll? If not, identify areas where sea turtles are most commonly seen.
3. Assuming the data are correct, what might be some explanations to account for their distribution?
4. ~~Identify strengths and weaknesses of using this survey to assess turtle distribution at the PANWR.~~
5. ~~How would you carry out future surveys to improve the quality of conclusions drawn from these data?~~
6. Now look at the results of additional surveys, which followed a more defined survey design (Appendix 2: Figures 9-11).
   1. Do they confirm the conclusions based on the first survey?
   2. Are these data sufficient to estimate distribution and relative abundance of sea turtles along the atoll?
   3. ~~Based on these data, design three testable hypotheses for future studies investigating distribution and abundance.~~

### D) Current Turtle Data

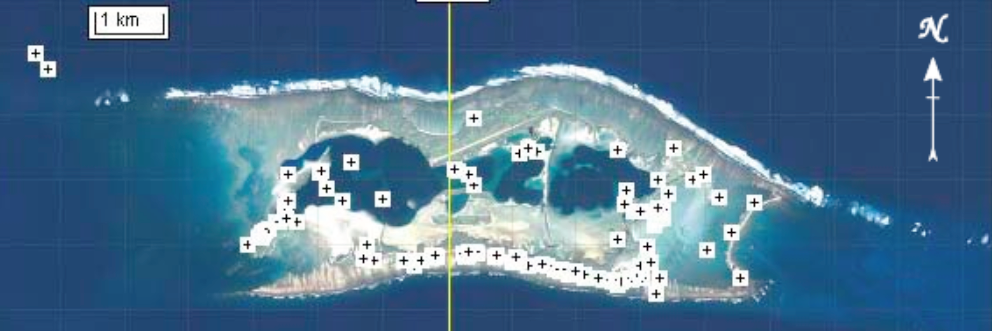
This research was conducted over 10 years ago. What are the turtle numbers now? Use the information provided in this paper and the Internet to ‘update’ the numerical data on the green sea turtle (*Chelonia mydas*) and the hawksbill sea turtle (*Eretmochelys imbricata*). Other turtle sightings? What other ecological or environmental issue/data (containments, predators, invasive organisms….Etc?) can you present that might influence the current number of sea turtles?

Report should include:

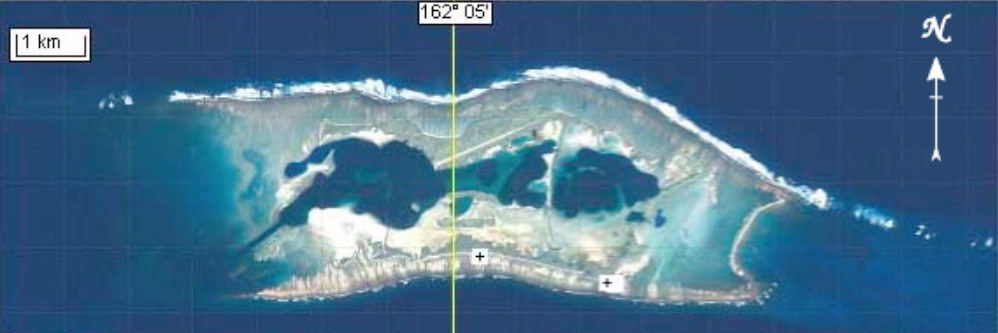
* Self-generated graphs
* Narrative (two to three paragraphs)
* References (APA format)

Appendix 1.

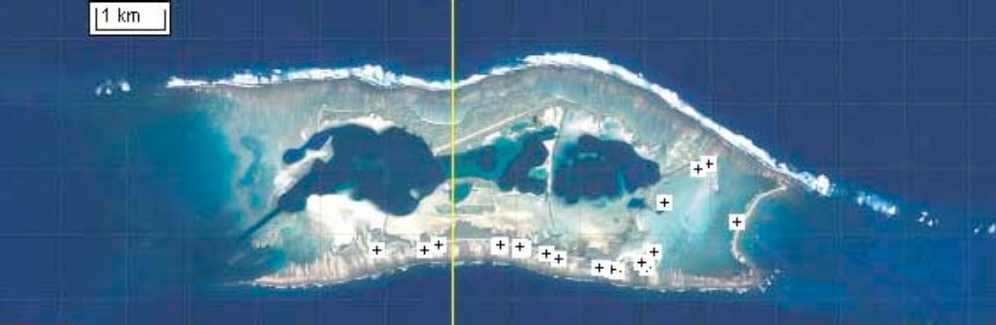
**Figure** **4**. GPS locations of sea turtle sightings (+) from the August 2005 survey (number of turtle sightings (n) = 224). Note: For many of these turtles, it was not possible to assign a size or species classification, although all individuals captured in subsequent studies were green sea turtles.



**Figure 5**. GPS location of confirmed or possible hawksbill sea turtle sightings (+) observed during the August 2005 survey. The sightings in the southeast consist of multiple turtle observations, while the one along the central south flats was one possible hawksbill.



**Figure 6**. Locations where algae, the likely main diet of green sea turtles, were observed. These sites were noted opportunistically during the 2005 sea turtle survey, which was not directed specifically at identifying locations of algal growth. In later years, researchers again surveyed the habitat along the algal-covered, shallow-water reef flats where sea turtles were most commonly observed, in order to investigate sea turtle habitat associations. It is important to keep in mind that the presence of the animals in a particular habitat does not necessarily mean they prefer that habitat. Algae sampling was conducted on these flats to explore the distribution, abundance and dominance of this key diet item for green sea turtles. Results from this study documented various genera of algae, including items often ingested by green turtles.



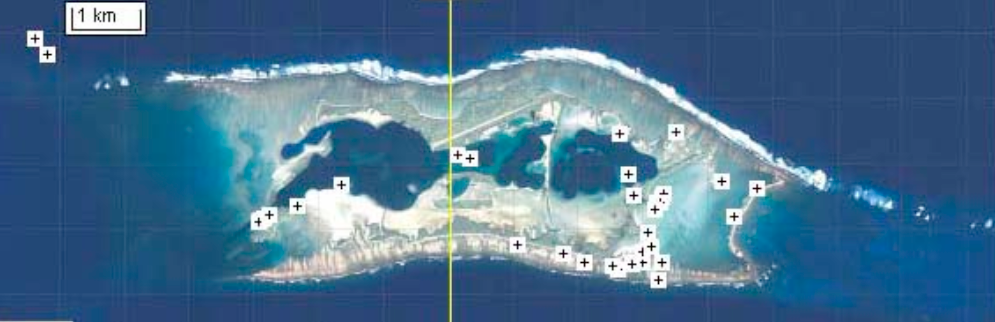
**Figure 7**. GPS location of sea turtle sightings (+) at high and low tides. Note: For many of these turtles, it was not possible to assign a size or species classification. Tide classifications were based on computer generated tide charts for Palmyra Atoll provided by the station staff, with height in feet rounded to integers to account for site-specific variability.



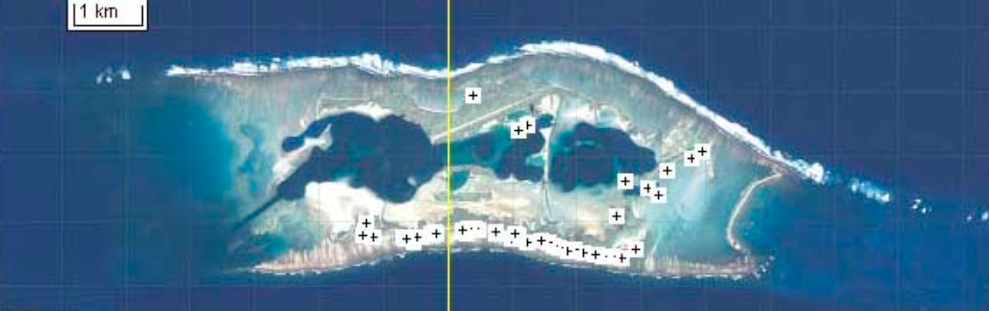
1. Tide height 0 feet, rising and falling (n=18)



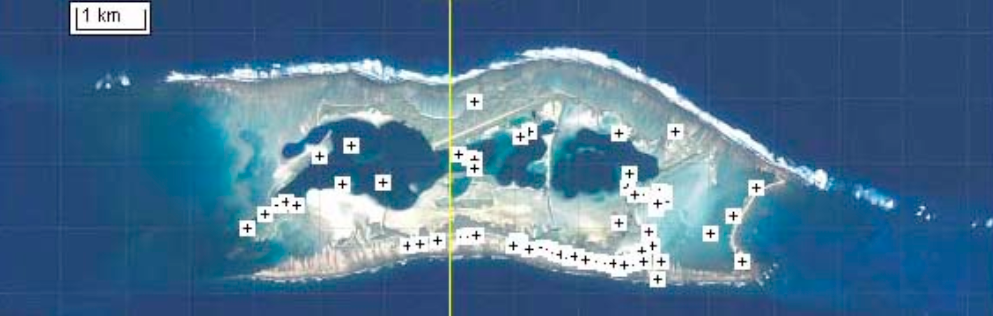
1. Tide height 1 foot, rising and falling (n=56).



1. Tide height 2 feet, rising and falling (n=56).



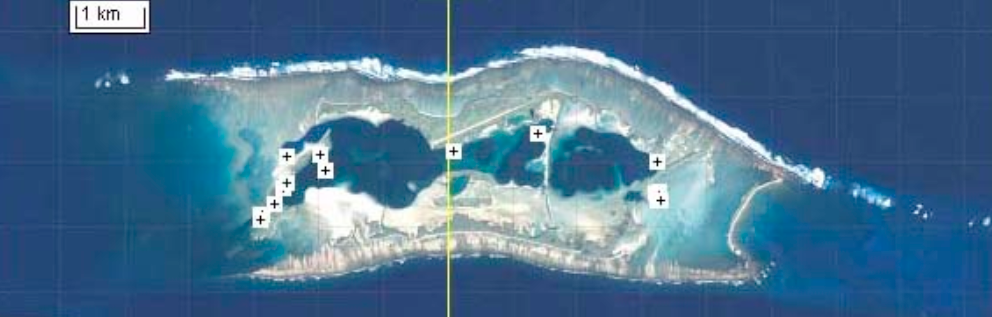
1. Tide height 3 feet, rising and falling (n=99).



1. Rising tide (all heights)



1. Falling tide (all heights)



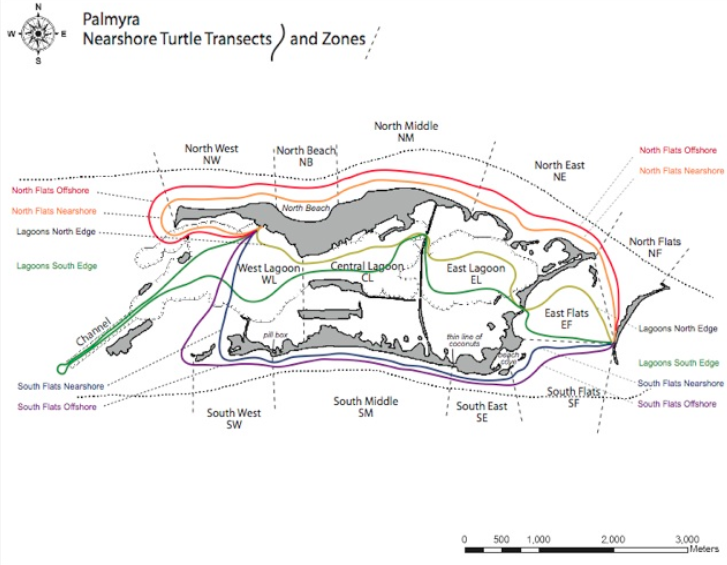
1. Falling tide (0-1 feet)

**Figure 8**. Tracks showing the path of survey vessels during the August 2005 survey.

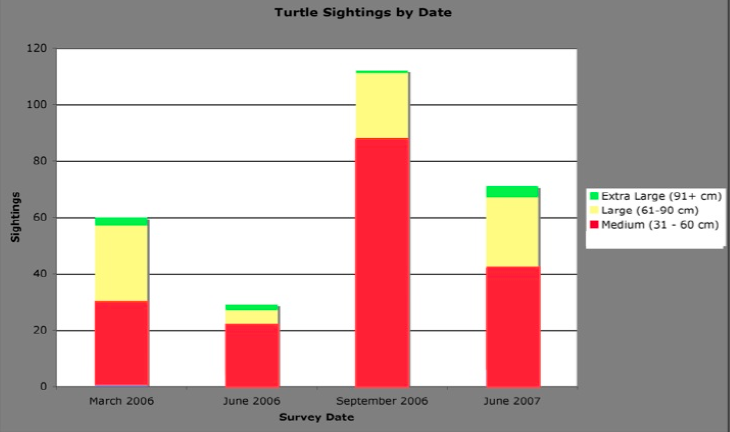


## Appendix 2.

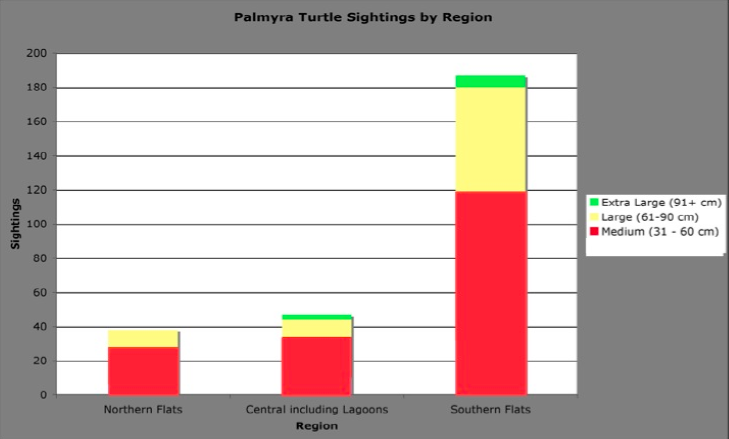
**Figure 9**. Search paths defined for the surveys (2006 to present).



**Figure 10.** Summary of survey results – turtle sightings by date. *Note*: For many of these turtles, it was not possible to assign a species classification, and all size categories are estimates since the turtles were not measured.



**Figure 11**. Summary of survey results – turtle sightings by region on the atoll.



## Additional resources

* Palmyra Atoll National Wildlife Refuge: <https://www.fws.gov/refuge/palmyra_atoll/>
* Palmyra Atoll Research Consortium: <http://www.palmyraresearch.org/about/what-is-parc>
* Sea Turtle Research at Palmyra: <https://www.amnh.org/our-research/center-for-biodiversity-conservation/research-and-conservation/biodiversity-exploration-and-monitoring/sea-turtles-of-palmyra-atoll>
* See real sea turtle satellite tracks worldwide, download sea turtle images, and learn about sea turtles: [http://www.seaturtle.org](http://www.seaturtle.org/)

**References and other citations**

Addison, D.S., J. Gore, J. Ryder, and K. Worley. 2002. Tracking post-nesting movements of loggerhead turtles (*Caretta caretta*) with sonic and radio telemetry on the southwest coast of Florida, USA. Marine Biology **141**:201-205.

Balazs, G.H. 1975. Marine turtles in the Phoenix Islands. Atoll Research Bulletin **184**:1-7.

Balazs, G.H. 1980. Synopsis of biological data of the green sea turtle in the Hawaiian Islands, NOAA-TM-NMFS.

Balazs, G.H. 1982b. Growth rates of immature green turtles in the Hawaiian Archipelago. Pages 117-125 in KA Bjorndal, editor. Biology and conservation of sea turtles. Smithsonian Institute Press, Washington, D.C., USA.

Balazs, G. 1985. Status and ecology of marine turtles at Johnston Atoll. Atoll Research Bulletin 285.

Balazs, G. 1995. Status of sea turtles in the Central Pacific Ocean. Pages 243-252 in K.A. Bjorndal, Editor. Biology and conservation of sea turtles 2nd edition. Smithsonian Institute Press, Washington, D.C.

Balazs, G.H. 1999. Factors to consider in the tagging of sea turtles. Pages 101- 109 in K.L. Eckert, K.A. Bjorndal, F.A. Abreu-Grobois, and M. Donnelly, editors. Research and management techniques for the conservation of sea turtles. IUCN/SSC Marine Turtle Specialist Group Publication No. 4, Washington D.C., USA.

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**(2):195-199

Bass, A.L., C.J. Lagueux, and B.W. Bowen. 1998. Origin of green turtles, *Chelonia mydas*, at "Sleeping Rocks" off the northeast coast of Nicaragua. Copeia **1998**:1064-69.

Bass, A.L. and W.N. Witzell. 2000. Demographic composition of immature green turtles (*Chelonia mydas*) from the east central Florida coast: evidence from mtDNA markers. Herpetologica **56**:357-367.

Bass, A.L., S.P. Epperly, and J. Braun-McNeill. 2006. Green Turtle (*Chelonia mydas*) Foraging and Nesting Aggregations in the Caribbean and Atlantic: Impact of Currents and Behavior on Dispersal. Journal of Heredity **97**:346-354.

Beerli, P. 1998. Estimation of migration rates and population sizes in geographically structured populations. Pages 39-54 in G.R. Carvalho, editor. Advances in Molecular Ecology. IOS Press, Amsterdam, Netherlands.

Bjorndal, K.A. 1997. Foraging ecology and nutrition of sea turtles. Pages 237-283 in P. Lutz and J.A. Musick, editors. Biology of sea turtles. CRC Press, Boca Raton, Florida, USA.

Bjorndal, K.A. and J.B.C. Jackson. 2003. Roles of sea turtles in marine ecosystems: reconstructing the past. Pages 259-274 in P.L. Lutz, J.A. Musick, and J. Wyneken, editors. The biology of sea turtles, volume II (s). CRC Press, Boca Raton, Florida, USA.

Bligh, E.G., and W.J. Dyer. 1959. A rapid method of total lipid extraction and purification. Canadian Journal of Biochemistry and Physiology **37**:911-917.

Bossart, J.L. and D.P. Prowell. 1998. Genetic estimates of population structure and gene flow: limitations, lessons and new directions. TREE **13**(5):202-205.

Bowen, B.W., A.B. Meylan, J.P. Ross, C.J. Limpus, G.H. Balazs, and J.C. Avise. 1992. Global population structure and natural history of the green turtle (*Chelonia mydas*) in terms of matriarchal phylogeny. Evolution **46**:865-81.

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

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

Broderick, D., and C. Moritz. 1998. Considerations for mixed stock analysis using mtDNA markers. Pages 162-164 in S.P. Epperly and J. Braun, compilers. Proceedings of the Seventeenth Annual Sea Turtle Symposium. U.S. Department of Commerce. NOAA Tech Memo. NMFS-SEFSC-415.

Broderick, D., C. Moritz, J.D. Miller, M. Guinea, R.I.T. Prince, and C.J. Limpus. 1994. Genetic studies of the hawksbill turtle *Eretmochelys imbricata*: evidence for multiple stocks in Australian waters. Pacific Conservation Biology **1**:121-131.

Carr, A.F. 1967. So excellent a fishe: a natural history of sea turtles. Scribner, New York, USA.

Chapman, R.W. 1996. A mixed stock analysis of the green turtle: the need for null hypotheses. Pages 137-146 in B.W. Bowen and W.N. Witzell, editors. Proceedings of the International Symposium on Sea Turtle Conservation Genetics, Miami, FL, 12-14 September 1995. NOAA Technical Memorandum NMFS-SEFSC-396.

Chassin-Noria, O., A. Abreu-Grobois, P.H. Dutton, and K. Oyama. 2004. Conservation genetics of the east Pacific green turtle (*Chelonia mydas*) in Michoacan, Mexico.  Genetica **1891**:1-12.

DeNiro, M.J. and S. Epstein. 1978. Influence of diet on the distribution of carbon isotopes in animals. Geochemica Cosmochimica Acta **42**:496-506.

DeNiro, M.J. and S. Epstein. 1981. Influence of diet on the distribution of nitrogen isotopes in animals. Geochemica Cosmochimica Acta **45**:341-351.

Depkin, C. 2002. 2001-2002 Palmyra Trip Report. USFWS.

Dethmers, K.E.M., D. Broderick, C. Moritz, N.N. Fitzsimmons, C.J. Limpus, S. Lavery, S. Whiting, M. Guinea, R.I.T. Prince, and R. Kennett. 2006. The genetic structure of Australasian green turtles (*Chelonia mydas*): exploring the geographical scale of genetic exchange. Molecular Ecology **15**:3931-3946.

Dutton, P.H. 1996. Methods for collection and preservation of samples for sea turtle genetic studies. Pages 17-24 in B.W. Bowen and W.N. Witzell, editors. Proceedings of the International Symposium on Sea Turtle Conservation Genetics, Miami, FL, 12-14 September 1995. NOAA Technical Memorandum NMFS-SEFSC-396.

Dutton, P., D. Broderick, and N. FitzSimmons. 2002. Defining management units: molecular genetics. Pages 93-101 in I. Kinan, editor. Proceedings of the Western Pacific Sea Turtle Cooperative Research and Management Workshop, Honolulu, Hawaii, USA, February 5-8, 2002, Western Pacific Regional Fishery Management Council.

Eckert, K.L., K.A. Bjorndal, F.A. Abreu-Grobois, and M. Donnelly, editors. 1999. Research and management techniques for the conservation of sea turtles. IUCN/SCC Marine Turtle Specialist Group Publication No. 4, Washington D.C., USA.

Ehrhart, L.M. and L.H. Ogren. 1999. Studies in foraging habitats: capturing and handling turtles. Pages 61-64 in K.L. Eckert, K.A. Bjorndal, F.A. Abreu-Grobois, and M. Donnelly, editors. Research and management techniques for the conservation of sea turtles. IUCN/SSC Marine Turtle Specialist Group Publication No. 4, Washington D.C., USA.

Excoffier, L., G. Laval, and S. Schneider. 2005. Arlequin version. 3.0: an integrated software package for population genetics data analysis. Evolutionary Bioinformatics Online **1**:47-50.

Fantle, M.S., A.I. Dittel, S.M. Scwalm, C.E. Epifanio, and M.L. Fogel. 1999. A food web analysis of the juvenile blue crab *Callinectes sapidus*, using stable isotopes in whole animals and individual amino acids. Oecologia **120**:416-426.

Fefer, S. 1987. Palmyra survey report. USFWS.

FitzSimmons, N.N., C.J. Limpus, J.A. Norman, A.R. Goldizen, J.D. Miller, and C. Moritz. 1997a. Philopatry of male marine turtles inferred from mitochondrial DNA markers. Proceedings of the National Academy of Sciences of the USA **94**:8912-8917.

FitzSimmons, N.N., C. Moritz, C.J. Limpus, L. Pope, and R. Prince. 1997b. Geographic structure of mitochondrial and nuclear gene polymorphisms in Australian green turtle populations and male-biased gene flow. Genetics **147**:1843-1854.

Forbes, T. 1999. Diet sampling and diet component analysis. Pages 144-148 in K.L. Eckert, K.A. Bjorndal, F.A. Abreu-Grobois, and M. Donnelly, editors. Research and management techniques for the conservation of sea turtles. IUCN/SSC Marine Turtle Specialist Group Publication No. 4, Washington D.C., USA.

Frazier, J. 1999. Community based conservation. Pages 15-18 in K.L. Eckert, K.A. Bjorndal, F.A. Abreu-Grobois, and M. Donnelly, editors. Research and management techniques for the conservation of sea turtles. IUCN/SSC Marine Turtle Specialist Group Publication No. 4, Washington D.C., USA.

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 Biology **205**:115-135.

Godley, B. 2007. Tracking marine vertebrates for their conservation. In: Book of Abstracts, Twenty Seventh Annual Symposium on Sea Turtle Biology and Conservation. Myrtle Beach, South Carolina, USA, February 2007.

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

Herbst, L.H. and E.R. Jacobson. 2003. Practical approaches for studying sea turtle health and disease. Pages 385-410 in P.L. Lutz, J.A. Musick, and J. Wyneken, Editors. The biology of sea turtles, volume II. CRC Press, Boca Raton, Florida, USA.

Herbst, L.H. and E.R. Jacobson. Undated. Recommendations for Activities involving brief captivity with non-invasive or minimally invasive procedures. http://accstr.ufl.edu/cmttp\_health\_&\_handling.html

Hilton-Taylor, C. 2000. 2000 IUCN Red List of threatened species. IUCN (World Conservation Union), Gland, Switzerland.

Hirth, H.F. 1997. Synopsis of the biological data on the green turtle *Chelonia mydas* (Linnaeus 1758). Fish and Wildlife Service, U.S. Department of the Interior, Washington D.C., USA.

Hughes, G.R. 1995. Nesting cycles in sea turtles - typical or atypical? Pages 81-89 in K.A. Bjorndal, editor. Biology and conservation of sea turtles 2nd Edition. Smithsonian Institution Press, Washington D.C., USA.

Knowles, R. and T.H. Blackburn. 1993. Nitrogen isotope techniques. Academic Press, London, UK.

Kwak, T.J. and J.B. Zedler. 1997. Food web analysis of southern California coastal wetlands using multiple stable isotopes. Oecologia **110**:263-277.

Lahanas, P.N., K.A. Bjorndal, A.B. Bolten, S.E. Encalada, M.M. Miyamoto, R.A. Valverde, and B.W. Bowen. 1998. Genetic composition of a green turtle (*Chelonia mydas*) feeding ground population: evidence for multiple origins. Marine Biology **130**:345-52.

Limpus, C.J. and P.C. Reed. 1985. The green turtle, *Chelonia mydas* in Queensland: a preliminary description of the population structure in a coral reef feeding ground. Pages 47-52 in G. Grigg, R. Shine, and H. Ehmann, editors. Biology of Australasian frogs and reptiles. Surrey Beatty and Sons and The Royal Zoological Society Of New South Wales, Chipping Norton, New South Wales, Australia.

Luke, K., J.A. Horrocks, R.A. Le Roux, and P.H. Dutton. 2004. Origins of green turtle (*Chelonia mydas*) feeding aggregations around Barbados, West Indies. Marine Biology **144**:799-805.

McConnaughey, T. and C.P. McRoy. 1979. Food-web structure and the fractionation of carbon isotopes in the Bering Sea. Marine Biology **53**:257-262.

Meylan, A. 1995*.* Sea turtle migration - evidence from tag returns. Pages 91-100 in K.A. Bjorndal, editor. Biology and conservation of sea turtles, 2nd ed. Smithsonian Institution Press, Washington D.C., USA.

Moritz, C., D. Broderick, K. Dethmers, N. FitzSimmons, and C. Limpus. 2002. Population genetics of southeast Asian and Western Pacific green turtles, *Chelonia mydas*. Final report to UNEP/CMS.

MTSG (Marine Turtle Specialist Group). 2006. Marine turtle mysteries. IUCN Marine Turtle Specialist Group, Washington D.C., USA.

Musick, J.A. and C.J. Limpus. 1997. Habitat utilization and migration in juvenile sea turtles. Pages 137-163 in P.L. Lutz and J.A. Musick, editors. The biology of sea turtles. CRC Press, Boca Raton, Florida, USA.

Naro-Maciel, E. 2006. Connectivity and structure of Atlantic green sea turtles (*Chelonia mydas*): a genetic perspective (PhD dissertation). Columbia University, New York, New York, USA.

Naro-Maciel, E. and A. Formia. 2006. Sea turtle subpopulations and the IUCN Red List: a complementary role for conservation genetics. Marine Turtle Newsletter **114**:6-8.

Naro-Maciel, E., J.H. Becker, E.H.S.M. Lima, M.A. Marcovaldi, and R. DeSalle. 2007a. Testing dispersal hypotheses in foraging green sea turtles (*Chelonia mydas*) of Brazil. Journal of Heredity **98**(1):29-39.

Naro-Maciel, E., E. Sterling, and N. Bynum. 2007b. Advancing conservation through research and education: a focus on the sea turtles of Palmyra Atoll. In: Book of abstracts, twenty seventh annual symposium on sea turtle biology and conservation, Myrtle Beach, South Carolina, USA, February 2007.

Naro-Maciel, E., K. McFadden, P. Ersts, K. Holmes, and E. Sterling. 2007c. Sea Turtles of the Palmyra Atoll National Wildlife Refuge, Central Pacific: Distribution And Habitat Associations. In: Proceedings of the Society for Conservation Biology 21st Annual Meeting, Port Elizabeth, South Africa, July 2007.

NMFS (National Marine Fisheries Service) and USFWS (United States Fish and Wildlife Service), 1998a. Recovery Plan for U.S. Pacific Populations of the Green Turtle (*Chelonia mydas*). National Marine Fisheries Service, Silver Spring, Maryland, USA.

NMFS (National Marine Fisheries Service) and USFWS (United States Fish and Wildlife Service), 1998b. Recovery Plan for U.S. Pacific Populations of the East Pacific Green Turtle (*Chelonia mydas*). National Marine Fisheries Service, Silver Spring Maryland, USA.

NMFS (National Marine Fisheries Service) and USFWS (United States Fish and Wildlife Service), 1998c. Recovery Plan for U.S. Population of Pacific Hawksbill Turtle. National Marine Fisheries Service, Washington D.C., USA.

Norman, J.A., C. Moritz, and C.J. Limpus. 1994. Mitochondrial DNA control region polymorphisms: genetic markers for ecological studies of marine turtles.  Molecular Ecology **3**:363-373.

Owens, D.W. and G.J. Ruiz. 1980. New methods of obtaining blood and cerebrospinal fluid from marine turtles. Herpetologica **36**:17-20.

Pearse, D.E. and K.A. Crandall. 2004. Beyond FST: analysis of population genetic data for conservation. Conservation Genetics **5**:585-602.

Pella, J. and M. Masuda. 2001. Bayesian methods for analysis of stock mixtures from genetic characters. Fishery Bulletin **9**:151-167.

Peterson, B.J. 1999. Stable isotopes as traces of organic matter input and transfer in benthic food webs: a review. Acta Oecologia **20**:479-487.

Peterson, B. and B. Fry. 1987. Stable isotopes in ecosystem studies. Annual Review of Ecological Systems **17**:293-320.

Piry, S., A. Alapetite, J-M. Cornuet, D. Paetkau, L. Baudouin, and A. Estoup. 2004. GeneClass2: a software for genetic assignment and first-generation migrant detection. Journal of Heredity **95**:536-539.

Pritchard, J.K., M. Stephens, and P. Donnelly. 2000. Inference of population structure using multilocus genotype data. Genetics **155**:945-959.

Raymond, M. and F. Rousset. 1995. An exact test for population differentiation. Evolution **49**:1280-1283.

Revellas, M., L. Cardona, A. Aguilar, A. Borrell, G. Fernandez, and M. Felix. 2007. Stable C and N isotope concentration in several tissues of the loggerhead sea turtle *Caretta caretta* from the western Mediterranean and dietary implications. Scientia Marina **71**:87-93.

Seminoff, J., T. Jones, T. Eguchi, D. Jones, and P. Dutton. 2006. Stable isotope discrimination between soft tissues of the green sea turtle *Chelonia mydas* and its diet. Marine Ecology Progress Series **308**:271-278.

Stabenau, E.K., P.F. Moon, and T.A. Heming. 2001. Resuscitation in sea turtles. Marine Turtle Newsletter **62**:3-5.

Sterling, E. and E. Naro-Maciel. 2005. Endangered and threatened sea turtles of Palmyra and the Line Islands. Report to USFWS

Sterling, E. and E. Naro-Maciel. 2006a. Sea turtles of Palmyra Atoll, Line Islands. In M. Frick, A. Panagopoulou, A.F. Rees, and K. Williams, compilers. Book of Abstracts, Twenty Sixth Annual Symposium on Sea Turtle Biology and Conservation, Crete Greece, April 2006.

Sterling, E. and E. Naro-Maciel. 2006b. Distribution and abundance of endangered marine turtles at Palmyra Atoll, Central Pacific. In: Proceedings of the Society for Conservation Biology 20th Annual Meeting, San Jose, California, June 2006.

Tieszen, L.L., T.W. Boutton, K.G. Tesdahl, and N.A. Slade. 1983. Fractionation and turnover of stable carbon isotopes in animal tissues: Implications for δ 13 C analysis of diet. Oecologia **57**(1-2):32-37.

Troëng, S., P.H. Dutton, and D. Evans. 2005. Migration of hawksbill turtles *Eretmochelys imbricata* from Tortuguero, Costa Rica. Ecography **28**(3):394–402.

Vogel, J.C. 1978. Isotopic assessment of the dietary habits of ungulates. South African Journal of Science **74**:298-459.

Wallace, B., J. Seminoff, S. Kilham, J. Spotila, and P. Dutton. 2006. Leatherback turtles as oceanographic indicators: stable isotope analyses reveal a trophic dichotomy between ocean basins. Marine Biology **149**:953-960.

Weir, B.S. and C.C. Cockerham.1984. Estimating F-statistics for the analysis of population structure. Evolution **38**:1358-1370.

White, G.C. and K.P. Burnham. 1999. Program MARK: survival estimation from populations of marked animals. Bird Study **46**:120-138.

Whiting, S.D. and J.D. Miller. 1998. Short term foraging ranges of adult green turtles (*Chelonia mydas*). Journal of Herpetology **32**(3):330-337.