Biological Conservation 176 (2014) 117–125

Contents lists available at ScienceDirect

Biological Conservation

journal homepage: www.elsevier.com/locate/biocon

Increased nesting, good survival and variable site fidelity for leatherback turtles in Florida, USA

Kelly R. Stewart [a,b,*], Kelly J. Martin [c,d], Chris Johnson [c,d], Nicole Desjardin [e], Scott A. Eckert [f], Larry B. Crowder [g]

[a] Marine Mammal and Turtle Division, Southwest Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, 8901 La Jolla Shores Drive, La Jolla, CA 92037, USA
[b] The Ocean Foundation, 1320 19th Street, NW, 5th Floor, Washington, DC 20036, USA
[c] Loggerhead Marinelife Center, 14200 US Hwy One, Juno Beach, FL 33408, USA
[d] Project Leatherback Inc., 3330 Fairchild Gardens Ave #31061, Palm Beach Gardens, FL 33410, USA
[e] Ecological Associates Inc., P.O. Box 405, Jensen Beach, FL 34958, USA
[f] Wider Caribbean Sea Turtle Conservation Network (WIDECAST), 348 Rusticview Drive, Ballwin, MO 63011, USA
[g] Center for Ocean Solutions, Stanford University, 99 Pacific Street, Suite 155A, Monterey, CA 93940, USA

ARTICLE INFO

Article history:
Received 3 February 2014
Received in revised form 9 May 2014
Accepted 9 May 2014

Keywords:
Dermochelys coriacea
Survival
Abundance
Florida
Nesting range
Clutch frequency
Site fidelity
Population size

ABSTRACT

Despite facing serious threats of extinction in the Eastern Pacific, the leatherback turtle (*Dermochelys coriacea*) appears to be thriving in the Atlantic basin based on increasing nest counts at several rookeries. In particular, Florida's nest numbers have been increasing by 10.2% per year since standardized counts began in 1979. The US Recovery Plan for leatherbacks calls for vital rates and population parameters to be determined for the three leatherback rookeries under US jurisdiction: St. Croix (USVI), Puerto Rico, and the east coast of Florida. Based on mark-recapture data gathered over eleven years, we determined important population parameters for nesting female leatherbacks at Juno Beach, one of the most densely nested beaches in Florida. Average annual survival was 88.9%. The average female nesting population size for Juno Beach is estimated at 100 ± 41 individuals each season; statewide we expect the estimate to be higher. The average remigration interval was 2.7 ± 1.0 years. In addition, we report observed clutch frequency (2.1 ± 1.4 clutches/year), estimated clutch frequency (4.4 ± 1.1 nests/year), and observed internesting period (10.2 ± 1.3 days between nests). The probability of observing an individual female at least once during the season was 73.0%, likely due to variable site fidelity, even though sea turtles do exhibit natal homing. Using opportunistic observations at additional beaches, we found that 72 females observed nesting within the Juno Beach study area were also observed nesting outside the study area. Thirty-three individuals laid clutches both inside and outside the survey area within a single season; these nests were separated by as much as 463.5 km. Although the population in Florida is relatively small compared to other rookeries throughout the Western Atlantic, it is increasing at such a rapid pace that it has the potential to become more important regionally, thereby contributing to the abundance of leatherbacks in the Atlantic.

1. Introduction

Understanding population demography for long-lived marine animals is important for evaluating and predicting what changes may occur in populations under climate change scenarios, or how changes in vital rates may affect the viability of threatened species. For species being managed specifically for recovery, and for implementing good planning and management objectives, assessing the capacity of a population to grow depends on understanding vital rates. For example, in a study of a declining harbor seal (*Phoca vitulina*) population, using satellite telemetry and tags, Hanson et al. (2013) demonstrated that the decline was not likely due to an increase in pup mortality but rather changes in adult survival were the likely cause. Similarly, Regehr et al. (2010) assessed vital rates for polar bears (*Ursus maritimus*) over several years and evaluated how differences in annual ice cover would affect adult survival and breeding probability. Long-term mark-recapture

* Corresponding author at: Marine Mammal and Turtle Division, Southwest Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, 8901 La Jolla Shores Drive, La Jolla, CA 92037, USA. Tel.: +1 858 334 2850; fax: +1 858 546 7003.
E-mail address: Kelly.Stewart@noaa.gov (K.R. Stewart).

http://dx.doi.org/10.1016/j.biocon.2014.05.008
0006-3207/

studies represent an investment in understanding complexities and variation in life history characteristics and parameters. In particular, these studies are especially useful for long-lived, iteroparous and capital breeders that may not breed annually and whose vital rates are closely coupled to environmental conditions.

Sea turtles, all species of which are listed under the US Endangered Species Act (ESA, 1973), have complex life histories requiring multiple habitats for various life stages. Additionally, sea turtles are long-lived and migrate long distances across international boundaries. These factors have made it difficult to collect population parameters to gain a full understanding of their life history and then to plan for recovery or management. Addressing research objectives in recovery plans is essential for managing these threatened species because basic population parameters must be established to provide the framework under which to focus conservation efforts and funding.

The leatherback turtle (*Dermochelys coriacea*) is the largest turtle in the world, nesting globally on subtropical and tropical beaches. These turtles deposit their eggs on open, dark beaches, generally above the high tide line (Mrosovsky, 1983; Whitmore and Dutton, 1985; Kamel and Mrosovsky, 2004). They nest approximately every nine to 10 days within a season (internesting interval) (Miller, 1997) and on average, return every two to three years (remigration interval) (Miller, 1997). Depending on the population, they may lay up to 14 nests each during a single nesting season (clutch frequency) (Girondot and Fretey, 1996) but the average is generally five or six nests per year (van Buskirk and Crowder, 1994). Once considered Critically Endangered worldwide by the International Union for the Conservation of Nature (IUCN, 2012), leatherback status varies by population and is now considered Vulnerable globally, while still facing various natural and anthropogenic threats depending on locality. Because they migrate long distances between foraging and nesting grounds, these turtles face potential risks to survival during all life stages. It is therefore essential to determine nesting trends, evaluate threats and estimate population parameters such as survival rates and abundance to manage this species effectively. In the Eastern Pacific, the leatherback faces a population crisis and it is only because long-term studies have been done that it has been possible to study population dynamics and to derive estimates for critical parameters, unfortunately even if the purpose is to document declining populations there. In the Atlantic basin, the leatherback is experiencing a quite different reality, with most small populations increasing rapidly and large populations maintaining their size or increasing slightly (Turtle Expert Working Group, 2007; Stewart et al., 2011).

The need to establish baseline life history data for leatherbacks in the USA was first specifically outlined in a National Marine Fisheries Service (NMFS) stock assessment report (NMFS-SEFSC, 2001), and again in a 2007 report (Turtle Expert Working Group, 2007). More recently it was recommended by the Committee on the Review of Sea-Turtle Population Assessment (National Research Council, 2010) that vital rates for sea turtle populations in the United States be determined for developing more accurate assessments of population status and for predicting the capacity of species to recover. Specific objectives for each leatherback population at three US rookeries (Culebra, Puerto Rico; St. Croix, US Virgin Islands; east coast of Florida) were described in the 1992 recovery plan. Initially, the NMFS was only able to complete a preliminary stock assessment of leatherback turtles in US waters because the appropriate data (survival rates, remigration interval, internesting interval, and population size) simply did not exist for leatherbacks nesting in the US. Since the leatherback recovery plan was written (NMFS and USFWS, 1992), good information has been published on two important US rookeries (St. Croix, USVI and Puerto Rico), based on long term monitoring of leatherback nesting and individual turtle identification. Population vital rates have been lacking for Florida to date, with the exception of nest counts and resulting rough estimates of population size. The current recovery plan requires that by 2017 an increase in the number of leatherbacks or the number of nests must be evident to meet the objective of recovery, however the current status must be evaluated. Efforts to determine population sizes for sea turtles have been hampered by the difficulty in counting individuals within populations. Assessing stocks on nesting beaches has been constrained by the very nature of sea turtle life history; they exhibit extensive variability in the regularity with which they nest and setting up research in remote locations has proven difficult.

Florida's beaches are extensive (>500 km on the east coast) and provide important nesting habitat for loggerhead (*Caretta caretta*), green (*Chelonia mydas*), and leatherback turtles each summer. The number of leatherbacks currently nesting in Florida is unknown. Previous population size estimates derived from nest numbers and clutch frequency data ranged from 10–15 individuals (Carr, 1952) to 16–31 individuals nesting each year (Meylan et al., 1995). Leatherback nesting has been recorded in 20 of 34 coastal counties, although the densest nesting occurs in three contiguous counties (Palm Beach, Martin, and St. Lucie) along ~200 km of the Atlantic coastline. These counties have received 83.8% of all leatherback nesting recorded in the state since 1979 (Stewart et al., 2011). Palm Beach County has the highest proportion of nests (38.7%) followed by Martin County (32.1%) and St. Lucie County (13.0%) (Stewart et al., 2011). Some nesting occurs along the panhandle (FWRI, 2007), and sporadic nesting has been documented along the beaches of Georgia, South Carolina, and North Carolina (Rabon et al., 2003). Leatherback nest counts have increased dramatically at 10.2 ± 1.9% per year over the past 30 years in Florida (Stewart et al., 2011).

The purpose of this study was to estimate a nesting population size for Florida by sampling a portion of the coastline where leatherbacks regularly nest. We aimed to develop empirical estimates for life history parameters such as remigration interval, internesting interval, clutch frequency (observed and estimated), and to derive estimates of population size. Because sea turtles are long-lived and are assumed to have long reproductive lives with thousands of offspring each having low survival, adult survival should be relatively high; we were able to estimate this parameter for the Florida rookery. In addition, we had an opportunity to document the distance that an individual leatherback may travel between nests (to spread reproductive risk), thus quantifying the potential nesting range of individual females.

2. Materials and methods

2.1. Study site and leatherback tagging

Leatherback turtles were observed during nightly (2100–0600 h) patrols from mid-March to late June each year from 2001–2011; this covers ~95% of the nesting season annually. Using all-terrain vehicles (ATVs), the team surveyed a 19.4 km segment of Florida's east coast at the Juno Beach study area from Jupiter Inlet (26°56′36″N, 80°04′15″W) south to Lake Worth Inlet (26°46′24″N, 80°01′53″W) (Fig. 1). Nesting turtles were approached after egg deposition had begun and all flippers were inspected for existing metal or plastic tags or tagging scars. Turtles were also thoroughly examined using a Passive Integrated Transponder (PIT) tag reader (Destron Fearing Pocket Reader-EX or similar) passed over each flipper and the neck. For each turtle, curved carapace length and width were measured according to procedures in Bolten (1999), and any distinguishing marks or injuries were noted. If the turtle had no identifying characters or tags, it was marked with tags for subsequent identification. Following