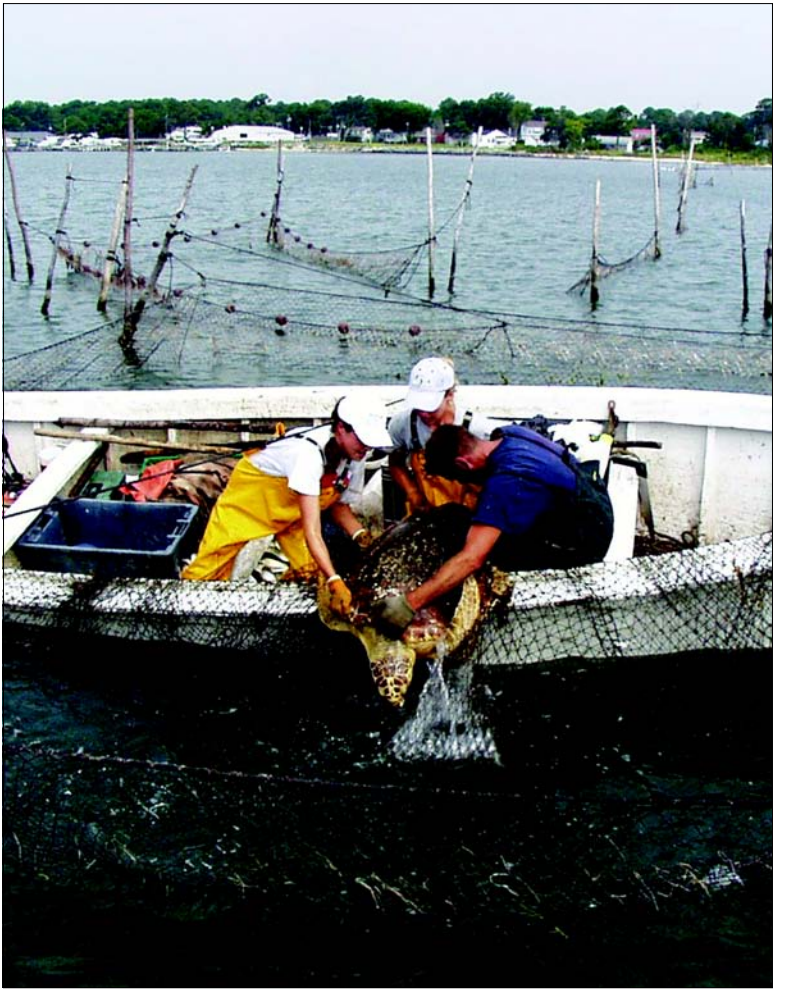
Southeastern Naturalist

Volume 6 2007 Number 2



The *Southeastern Naturalist* . . .

- A quarterly peer-reviewed and edited interdisciplinary natural history science journal with a regional focus on the southeastern United States (ISSN #1528-7092).

- Featuring research articles, notes, and research summaries on terrestrial, freshwater, and marine organisms, and their habitats. The journal's versatility also extends to publishing longer manuscripts as separate monographs and symposium proceedings or other collections of related papers as special issues.

- Focusing on field ecology, biology, behavior, biogeography, taxonomy, evolution, anatomy, physiology, geology, and related fields. Manuscripts on genetics, molecular biology, archaeology, anthropology, etc., are welcome, especially if they provide natural history insights that are of interest to field scientists.

- Indexed in Biological Abstracts (BIOSIS), BIOSIS Previews, CAB Abstracts, Cambridge Scientific Abstracts, EBSCOhost, Environmental Knowledgebase (formerly Environmental Periodicals Bibliography), FISHLIT (Aquatic Biology, Aquaculture, and Fisheries Resources; Fish and Fisheries Worldwide), ISI Services (Current Contents/Agriculture, Biology, and Environmental Sciences, ISI Alerting Service, Science Citation Index-Expanded), Wildlife Review Abstracts, and Zoological Record (BIOSIS UK). Arrangements for indexing in Elsevier BIOBASE (Current Awareness in Biological Sciences) are pending.

- The journal staff is pleased to discuss ideas for manuscripts and to assist during all stages of manuscript preparation. The journal has a mandatory page charge to help defray a portion of the costs of publishing the manuscript. Instructions for Authors are available online on the journal's website (www.eaglehill.us) or by e-mail (office@eaglehill.us).

- Co-published with the *Northeastern Naturalist* (ISSN #1092-6194), published since 1997. Both journals are identical in focus, format, quality, and features. The journals together serve as a matched-pair of regional journals that provide an integrated publishing and research resource for the eastern part of North America.

- Printed by Allen Press, printer of many journals in the biological and environmental sciences, especially those whose parent organization is a member of the American Institute of Biological Sciences (AIBS).

- Available online in full-text version in the BioOne database (www.bioone.org, a collaborative effort of Allen Press, AIBS, et al.), EBSCOhost product line, and the Proquest Information and Learning databases (www.il.proquest.com).

- May be ordered through any major subscription service. A full listing of Tables of Contents is available online on the journal's website.

Cover Photograph: Sea turtle researchers with the National Marine Fisheries Service remove a *Caretta caretta* (Loggerhead Turtle) from a pound net set in Core Sound, NC. Photograph © by Craig Harms.

Summer Abundance Estimates of *Caretta caretta* (Loggerhead Turtles) in Core Sound, NC

Christopher R. Sasso[1,*], Joanne Braun-McNeill[2], Larisa Avens[2], and Sheryan P. Epperly[1]

Abstract - We estimated summer abundance of juvenile Loggerhead Turtles at our study site in Core Sound, NC with a Horvitz-Thompson type estimator, which uses count data and recapture probability to estimate abundance. Abundance ranged from 192 (95% CI = 88–1047) to 633 (95% CI = 219–1047) turtles over the six years of this study. These results provide preliminary estimates of juvenile Loggerhead Turtle abundance during the summer in Core Sound.

Introduction

Monitoring of sea turtle population abundance often focuses on nesting beaches where it can be more easily assessed than on foraging grounds (Bjorndal et al. 2005), but estimates of population abundance from other habitats and life stages are needed to assist with assessing the effects of management actions for sea turtles (Chaloupka and Musick 1997, Heppell et al. 2003).

Heppell et al. (2003) noted that more information is needed about juvenile *Caretta caretta* L. (Loggerhead Turtles, hereafter Loggerheads) in foraging habitats in order to improve the understanding of the status of this species. Along the US Atlantic coast, juvenile Loggerheads range from 50 to 80 cm straight carapace length and occupy foraging areas in both inshore and nearshore waters (Musick and Limpus 1997). In North Carolina, sea turtles are seasonally present in the inshore sounds when the water temperatures are suitable, but migrate to warmer waters when water temperatures decline (Epperly et al. 1995a, b). To date, there are no estimates of abundance for juvenile Loggerheads, the most abundant sea turtle species inhabiting the North Carolina sounds (Epperly et al. 1995b). The incidental capture of these turtles in commercial fishing gear in the North Carolina sounds offers an opportunity to assess population size for this life stage in foraging habitats.

The National Marine Fisheries Service (NMFS) has conducted a study to monitor sea turtles inhabiting North Carolina's Core Sound since 1998. During their residence in the Sound, turtles are often incidentally captured in pound nets set inshore of the barrier islands. Pound nets are a stationary fishing gear (Higgins and Pearson 1928) that allow incidentally captured

[1]NOAA Fisheries, SEFSC, 75 Virginia Beach Drive Miami, FL 33149. [2]NOAA Fisheries, 101 Pivers Island Road, Beaufort, NC 28516. [*]Corresponding author - chris.sasso@noaa.gov.

turtles to surface, breathe, and be released alive. Herein we present estimates of summer abundance in our study area.

Materials and Methods

Monitoring

We sampled 5 to 8 pound nets twice per week, June through August, from 1998 to 2004. The study site encompassed an area of 18.68 km^2 in central Core Sound, NC. We double-tagged turtles with Inconel Style 681 tags (National Band and Tag Company, Newport, KY) applied to the trailing edge of each rear flipper. In addition, we tagged all turtles with 125 kHz unencrypted Passive Integrated Transponder (PIT) tags (Destron-Fearing Corp. South, St. Paul, MN) injected subcutaneously above the second most proximal scale of the trailing margin of the left front flipper to ensure identification of the turtle in the event that both Inconel tags were shed. Application of the three tags in this manner resulted in negligible (0.005%) total tag loss (Braun-McNeill et al. 2003). A unique capture history was created for each individual each year, resulting in seven annual trapping periods.

Abundance Estimates

Using recapture probabilities from the mark-recapture data (Sasso et. al 2006), we combined recapture probabilities in a Horvitz-Thompson type estimator to estimate annual abundance in the summer (Seber 1982). This estimator, whose merits and details for use with sea turtle populations have been discussed in Bjorndal et al. (2005), Chaloupka (2000), and Chaloupka and Limpus (2001), uses turtle-count data divided by recapture probability to estimate abundance:

$$N_i = (n_i / p_i),$$

where N_i is the number of turtles in the sampling population in year i, n_i is the number of turtles captured in the ith year, and p_i is the recapture probability in the ith year. We determined approximate 95% confidence intervals (CI) of N_i as $N_i \pm 1.96\mathrm{SE}(N_i)$, calculating the standard error of N_i (Loery et al. 1997) as

$$\mathrm{SE}(N_i) = \{(n_i / p_i)^2[(\mathrm{var}(p_i) / p_i)^2]\}^{0.5},$$

where $\mathrm{var}(p_i)$ is the variance of the recapture probability in the ith year.

Results and Discussion

We tagged 693 Loggerheads from 42.3 cm to 102.0 cm in straight carapace length (mean = 63.6 ± 7.4 cm), with 63 individuals recaptured at least once (Sasso et al. 2006).

Sasso et al. (2006) found the best model of the data had time-independent apparent survival and proportion of residents with time-dependent capture probabilities. They estimated survival was estimated to be 0.81 (95% CI =

0.69–0.92), with approximately 75% (95% CI = 67–83) of newly captured individuals estimated to be transients (Sasso et al. 2006). Recapture probabilities (Table 1) ranged from 0.15 (95% CI = 0.05–0.25) to 0.64 (95% CI = 0.42–0.86) (Sasso et al. 2006).

Summer population estimates of juvenile Loggerheads for our study site in Core Sound ranged from 192 (95% CI = 127–257) to 633 (95% CI = 219–1047) turtles (Table 1). While providing a reasonable range of the number of Loggerheads at our study site, the point estimates should not be interpreted literally, as there is uncertainty around these estimates and no real differences given the confidence intervals (Table 1). Our highest estimate of population size was the year with the lowest recapture probability, while our lowest population estimate was in the year with the highest recapture probability (Table 1). The large variability in recapture probability among years precludes using these estimates for any predictive trend in Loggerhead abundance in Core Sound, especially given the relationship between recapture rates and population size estimates. Increasing the recapture probability would yield more accurate and precise estimates, but may not be possible given the transient behavior of juvenile Loggerheads in North Carolina (Sasso et al. 2006).

Even though our estimates likely represent the population from an area larger than the 18.68 km^2 study site as turtles are likely to use an area larger than the study site, they may not be an estimate for all of Core Sound. Furthermore, our estimates are certainly not reflective of the juvenile Loggerhead population likely to be present in the entire sound system of North Carolina because our study site is relatively small in comparison to the entire sound system in which turtles are present. However, our study does provide preliminary estimates of summer abundance in central Core Sound and indicates that large numbers of juvenile turtles are likely to utilize the sounds of North Carolina when water temperatures are suitable.

An increase in the spatial scale of monitoring efforts within the sounds could provide total abundance estimates for North Carolina's sounds and would likely maximize recapture probabilities. The establishment of a network of monitoring sites along the US Atlantic coast may make it possible to estimate Loggerhead population size across the entire range of the species and for other age classes as well.

Table 1. Summer population estimates for Loggerhead Sea Turtles in Core Sound, NC. 95% confidence intervals are in parentheses.

Year	Turtles captured	Recapture probability	Abundance estimate
1999	94	0.35 (0.11–0.58)	269 (88–449)
2000	123	0.64 (0.42–0.86)	192 (127–257)
2001	118	0.38 (0.22–0.54)	311 (182–438)
2002	121	0.25 (0.11–0.39)	484 (218–749)
2003	147	0.30 (0.14–0.46)	490 (233–746)
2004	95	0.15 (0.05–0.25)	633 (219–1047)

Acknowledgments

We wish to thank all those that helped us in the collection of this data: Joel Bell, Ruth Boettcher, Bonnie Brown, Wendy Cluse, Tim Ellis, Matthew Godfrey, Rebecca Goldman, April Goodman, Lisa Goshe, Kristen Hart, Jennifer Keller, Matt Kimball, Roger Mays, Catherine McClellan, Glen Montgomery, Erica Nichols, Zoe Pettitt, Melissa Snover, Sabrina Varnam, and Jerald Weaver. We also wish to thank all the commercial pound-net fishermen that cooperated with us, specifically Leonard Goodwin. Paul Richards and Liz Brooks provided comments on an earlier draft of this manuscript.

Literature Cited

Bjorndal, K.A., A.B. Bolten, and M.Y. Chaloupka. 2005. Evaluating trends in abundance of immature Green Turtles, *Chelonia mydas*, in the greater Caribbean. Ecological Applications 15:304–314.

Braun-McNeill, J., L. Avens, and S.P. Epperly. 2003. Estimated tag retention rates for PIT and Inconel tags in juvenile Loggerhead (*Caretta caretta)* sea turtles. P. 104, *In* J.A. Seminoff (Comp.). Proceedings of the Twenty-Second Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-503. National Oceanic and Atmospheric Administration, Miami, FL. 308 pp.

Chaloupka, M.Y. 2000. Capture-recapture modeling of sea turtle population abundance. Pp. 16–35, *In* K.A. Bjorndal and A.B. Bolten (Eds.). Proceedings of a Workshop on Assessing Abundance and Trends for In-Water Sea Turtle Populations. NOAA Technical Memorandum NMFS-SEFSC-445. Miami, FL. 83 pp.

Chaloupka, M.Y., and C.J. Limpus. 2001. Trends in the abundance of sea turtles resident in southern Great Barrier Reef waters. Biological Conservation 102:235–249.

Chaloupka, M.Y., and J.A. Musick. 1997. Age, growth, and population dynamics. Pp. 275–306, *In* P.L. Lutz and J.A. Musick (Eds.). The Biology of Sea Turtles Vol. I. CRC Press, Boca Raton, FL. 448 pp.

Epperly, S.P., J. Braun, and A.J. Chester. 1995a. Aerial surveys for sea turtles in North Carolina inshore waters. Fishery Bulletin 93:254–261.

Epperly, S.P., J. Braun, and A. Veishlow. 1995b. Sea turtles in North Carolina waters. Conservation Biology 9:384–394.

Heppell, S.S., M.L. Snover, and L.B. Crowder. 2003. Sea turtle population ecology. Pp 275–306, *In* P.L. Lutz , J.A. Musick, and J. Wyneken (Eds.). The Biology of Sea Turtles Vol. II. CRC Press, Boca Raton, FL. 496 pp.

Higgins, E., and J.C. Pearson. 1928. Examination of the summer fisheries of Pamlico and Core Sounds, NC, with special reference to the destruction of undersized fish and the protection of the gray trout *Cynnoscion regalis* (Bloch and Schneider). Appendix II Report of the United States Commissioner of Fisheries for the Fiscal Year 1927 with Appendixes. Bureau of Fisheries Document No. 1019:29–65.

Loery, G., J.D. Nichols, and J.E. Hines. 1997. Capture-recapture analysis of a wintering Black-capped Chickadee population in Connecticut, 1958–1993. The Auk 114:431–442.

Musick, J.A., and C.J. Limpus CJ. 1997. Habitat utilization and migration in juvenile sea turtles. Pp. 137–163, *In* P.L. Lutz and J.A. Musick (Eds.). The Biology of Sea Turtles Vol. I. CRC Press, Boca Raton, FL. 448 pp.

Sasso, C.R., J. Braun-McNeill, L. Avens, and S.P. Epperly. 2006. Effects of transients on estimating survival and population growth in Loggerhead Turtles. Marine Ecology Progress Series 324:287–292.

Seber, G.A.F. 1982. The Estimation of Animal Abundance and Related Parameters. 2nd Edition. Griffin, London, UK. 654 pp.