

**BIOLOGY OF PELAGIC SEA TURTLES:  
EFFECTS OF MARINE DEBRIS**

**Final Report to**

**Florida Cooperative Fish and Wildlife Research Unit  
University of Florida  
Research Work Order 118**

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## **BIOLOGY OF PELAGIC SEA TURTLES:**

### **EFFECTS OF MARINE DEBRIS**

#### **Objectives:**

1. Quantify the sub-lethal effect of debris ingestion (nutrient dilution) on nutrient gain
2. Model sub-lethal effects of debris ingestion on nutrient intake and growth
3. Evaluation of stress from entanglement on the loggerhead sea turtle
4. Movement patterns and behavior of pelagic-stage loggerheads in the eastern Atlantic
5. Document the genetic relationships of pelagic-stage loggerheads in the eastern Atlantic with rookeries in the southeast US

#### **Results:**

All of the project objectives were met. The results have been analyzed and presented in the publications and Masters Theses listed below. The results of this project have also been presented at many international meetings, some of which are indicated below as publications in proceedings from those meetings. The success of this project is evident in the quality of the publications and Masters Theses that are based on data collected during the completion of the objectives of this project. These manuscripts are either in press or have been published. Cover pages and abstracts of the Masters Theses and manuscripts that are still in press are enclosed.

#### **Publications Based on Results from RWO 118**

- Bjorndal, K.A., A.B. Bolten, J. Gordon and J.A. Camiñas. 1994. *Caretta caretta* (loggerhead) growth and pelagic movement. *Herpetological Review* 25:23-24.
- Bjorndal, K.A., A.B. Bolten and C.J. Lagueux. 1994. Ingestion of marine debris by juvenile sea turtles in coastal Florida habitats. *Marine Pollution Bulletin* 28:154-158.
- Bolten, A.B. and G.H. Balazs. 1995. Biology of the early pelagic stage--the "lost year." Pages 575-581 in K.A. Bjorndal (ed.), *Biology and conservation of sea turtles*, revised edition. Smithsonian Institution Press, Washington, D.C.

- Bolten, A.B., K.A. Bjorndal and H.R. Martins. 1994. Life history model for the loggerhead sea turtle (*Caretta caretta*) population in the Atlantic: Potential impacts of a longline fishery. Pages 48-54 in G.H. Balazs and S.G. Pooley (eds.), Research Plan to Assess Marine Turtle Hooking Mortality: Results of an Expert Workshop Held in Honolulu, Hawaii, November 16-18, 1993. NOAA Technical Memorandum NMFS-SWFSC-201.
- Bolten, A.B., K.A. Bjorndal and H.R. Martins. 1994. Biology of pelagic-stage loggerheads in the Atlantic. Pages 19-20 in K.A. Bjorndal, A.B. Bolten, D.A. Johnson and P.J. Eliazar (compilers), Proceedings of the 14th Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-351.
- Bolten, A.B., K.A. Bjorndal and H.R. Martins. 1995. Life history of the loggerhead sea turtle, *Caretta caretta* (Reptilia: Cheloniidae), in the Atlantic. In A. Domingo Abreu and M. Biscoito (eds.), Proceedings of the First Symposium Fauna and Flora of Atlantic Islands. Boletim do Museu Municipal do Funchal, Madeira, Portugal, Sup. no. 4:115-122.
- Bolten, A.B., K.A. Bjorndal, H.R. Martins and G.H. Balazs. 1996. Satellite telemetry of pelagic-stage juvenile loggerheads in the eastern Atlantic. Pages 39-41 in J.A. Keinath, D.E. Barnard, J.A. Musick and B.A. Bell (compilers), Proceedings of the Fifteenth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-387.
- Bolten, A.B., K.A. Bjorndal, H.R. Martins, T. Dellinger, M.J. Biscoito, S.E. Encalada and B.W. Bowen. 1998. Transatlantic developmental migrations of loggerhead sea turtles demonstrated by mtDNA sequence analysis. Ecological Applications 8:1-7.
- Bolten, A.B., H.R. Martins, K.A. Bjorndal and J. Gordon. 1993. Size distribution of pelagic-stage loggerhead sea turtles (*Caretta caretta*) in the waters around the Azores and Madeira. Arquipélago 11A:49-54.
- Encalada, S.E., K.A. Bjorndal, A.B. Bolten, J.C. Zurita, B. Schroeder, E. Possardt, C.J. Sears and B.W. Bowen. 1998. Population structure of loggerhead turtle (*Caretta caretta*) nesting colonies in the Atlantic and Mediterranean as inferred from mitochondrial DNA control region sequences. Marine Biology 130:567-575.
- Gregory, L.F. 1994. Capture stress in the loggerhead sea turtle (*Caretta caretta*). Masters Thesis, University of Florida, Gainesville, Florida. 59 pages.
- Gregory, L.F., T.S. Gross, A.B. Bolten, K.A. Bjorndal and L.J. Guillette, Jr. 1996. Plasma corticosterone concentrations associated with acute captivity stress in

wild loggerhead sea turtles (*Caretta caretta*). General and Comparative Endocrinology 104:312-320.

Gregory, L.F. 1994. Acute captivity stress in the loggerhead sea turtle (*Caretta caretta*). Page 49 in K.A. Bjorndal, A.B. Bolten, D.A. Johnson, and P.J. Eliazar (compilers), Proceedings of the Fourteenth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-351.

McCauley, S.J. 1997. Effects of dietary dilution in chelonians: implications for their ecology and conservation. Masters Thesis, University of Florida, Gainesville, Florida. 75 pages.

McCauley, S.J. and K.A. Bjorndal. In press. Conservation implications of dietary dilution from debris ingestion: sublethal effects in post-hatchling loggerhead sea turtles. Conservation Biology.

McCauley, S.J. and K.A. Bjorndal. In press. Response to dietary dilution in an omnivorous freshwater turtle: implications for ontogenetic dietary shifts. Physiological and Biochemical Zoology 72(1).

**In Press, *Conservation Biology***

**Conservation Implications of Dietary Dilution from Debris Ingestion:  
Sublethal Effects in Post-hatchling Loggerhead Sea Turtles**

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**Running Head: Effects of dietary dilution in loggerheads**

**Word Count: 2493**

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**Abstract:** Ingestion of anthropogenic debris by marine species has been documented extensively; fewer studies have attempted to quantify the sublethal effects caused by debris ingestion. One potential sublethal effect is reduced nutrient gains from diets diluted by consumption of debris. Post-hatchling and juvenile loggerhead sea turtles (*Caretta caretta*) consume substantial quantities of debris. Effects of dietary dilution on voluntary intake were evaluated in post-hatchling loggerheads to assess their ability to compensate for the presence of inert diluents in their diet by increasing dry mass intakes to maintain nutrient gains. Mean daily intakes of dry mass did not increase significantly with dietary dilution. As a result, intakes of energy and nitrogen on a 50% dilution diet were significantly lower than on a 10% dilution diet. Therefore, post-hatchling loggerheads have an extremely limited ability to compensate for dietary dilution and would experience sublethal effects from decreased energy and nitrogen gains on dilute diets. Decreased nutrient intakes have serious conservation implications because of decreased growth rates, longer developmental periods at sizes most vulnerable to predation, depleted energy reserves, reduced reproductive output, and decreased survivorship.

**In Press, *Physiological and Biochemical Zoology***

**Response to Dietary Dilution in an Omnivorous Freshwater Turtle:  
Implications for Ontogenetic Dietary Shifts**

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Running head: Response to Dietary Dilution in an Omnivorous Turtle

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## ABSTRACT

Several species of freshwater turtles in the family Emydidae undergo an ontogenetic dietary shift; as juvenile turtles mature they change from a primarily carnivorous to a primarily herbivorous diet. It has been hypothesized that this shift results from an unfavorable ratio of gut capacity to metabolic rate that prevents small reptiles from processing adequate volumes of plant material to meet their energetic demands. Effects of dietary dilution on intake were evaluated in 2 size classes of red-eared sliders (Trachemys scripta elegans) to test whether small reptiles have a lower capacity to compensate for low-quality diets through increased intake than do larger conspecifics. Artificial diets with an inert diluent were offered to 2 size classes of turtles, and mass-specific intakes of dry matter, energy, and nitrogen were calculated. Both small ( $28.7 \pm 4.9$  g body mass, mean mass  $\pm$  SD) and large ( $1230 \pm 94$  g body mass) turtles compensated for dietary dilution and maintained constant energy and nitrogen intakes on diets with lower energy content than common aquatic plants. Thus, body size did not affect the ability to respond to nutritional dilution, which suggests that processing limitations imposed by small body size do not constrain juveniles from adopting an herbivorous diet.



**CAPTURE STRESS  
IN THE LOGGERHEAD SEA TURTLE  
(*CARETTA CARETTA*)**

**By**

**LISA FLORES GREGORY**

**A THESIS PRESENTED TO THE GRADUATE SCHOOL  
OF THE UNIVERSITY OF FLORIDA IN PARTIAL FULFILLMENT  
OF THE REQUIREMENTS FOR THE DEGREE OF  
MASTER OF SCIENCE**

**UNIVERSITY OF FLORIDA**

**1994**

Abstract of Thesis Presented to the Graduate School  
of the University of Florida in Partial Fulfillment of the  
Requirements for the Degree of Master of Science

CAPTURE STRESS  
IN THE LOGGERHEAD SEA TURTLE  
(*CARETTA CARETTA*)

By

Lisa Flores Gregory

April, 1994

Chairman: Dr. Louis J. Guillette Jr.  
Major Department: Zoology

Glucocorticoids and other secretions from the hypothalamic-pituitary-adrenal system have been used extensively as indices of the presence of stress. Minimal published data exist on the stress response in marine turtles. Given their endangered status, it is of interest to examine the effects of stress on sea turtle physiology. This study provided baseline data on circulating concentrations of corticosterone, and determined the effects of acute captivity (capture, repeated bleeding, and restraint up to six hours) on plasma corticosterone concentrations in wild, free ranging *Caretta caretta*. The effects of capture method, season, size class, and sex were examined.

Initial blood samples were taken from *C. caretta* captured in a trawl (Port Canaveral ship channel, FL) or tangle net (east of Cedar Key, FL). Serial blood samples were taken from all net-caught turtles, and from turtles trawl-caught in June-August (summer) and January-March (winter). Plasma corticosterone concentrations dramatically increased over time with highest concentrations generally occurring at three hours after capture. Initial

corticosterone concentrations were significantly higher in trawl-caught than in net-caught turtles. One hour after capture, corticosterone concentrations were not significantly different between capture methods. Due to small sample size, effects of sex, season, or size class could not be assessed utilizing data from turtles captured in a tangle net.

No effect of sex on corticosterone concentrations was observed for turtles captured in a trawl. Plasma corticosterone concentrations of small turtles were significantly higher in summer than in winter. No significant difference in corticosterone concentrations of large turtles was observed between seasons until one hour after capture. Analysis of the data indicated that the variability between seasons was associated with temperature. Mean corticosterone concentrations were significantly higher in small versus large turtles within each season. It is suggested that the lower adrenocortical response of large turtles may be associated with reproductive condition.

EFFECTS OF DIETARY DILUTION IN CHELONIANS: IMPLICATIONS FOR  
THEIR ECOLOGY AND CONSERVATION

By

SHANNON J. McCAULEY

A THESIS PRESENTED TO THE GRADUATE SCHOOL OF  
THE UNIVERSITY OF FLORIDA  
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF  
MASTER OF SCIENCE

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Abstract of Thesis Presented to the Graduate School  
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EFFECTS OF DIETARY DILUTION IN CHELONIANS: IMPLICATIONS FOR  
THEIR ECOLOGY AND CONSERVATION

By

Shannon J. McCauley

December 1997

Chair: Karen Bjorndal

Major Department: Zoology

Effects of dietary dilution on voluntary intake were evaluated in two size classes of a freshwater turtle, the red-eared slider (*Trachemys scripta elegans*), and in one size class of juvenile marine turtle, the loggerhead (*Caretta caretta*). Artificial diets with inert diluents were used, and mass-specific dry matter intakes, energy intakes, and nitrogen intakes were calculated.

Slider turtles undergo an ontogenetic dietary and habitat shift; as juvenile turtles mature they move into deeper water and shift from a primarily carnivorous diet to one dominated by plant material. It has been hypothesized that this shift is the result of an unfavorable ratio of gut capacity to metabolic rate which prevents small reptiles from processing adequate volumes of plant material to meet their energetic demands on herbivorous diets. The ability of both small ( $28.74 \pm 4.89$ g body mass, mean mass  $\pm$

standard deviation) and large ( $1230.35 \pm 93.96$ g body mass, mean mass  $\pm$  standard deviation) slider turtles in this study to compensate for dietary dilution and maintain constant energy and nitrogen intakes on diets less concentrated than common aquatic plants suggests that both size classes of slider turtle are capable of subsisting on an herbivorous diet.

Juvenile loggerheads had a limited ability to compensate for dietary dilution by increasing intake. Consequently, they experienced reduced energy and nitrogen gains on diets diluted below 11.5 kJ/g dry matter and 8.4% nitrogen. The limited ability of juvenile loggerheads to compensate for dietary dilution suggests that they may be vulnerable to sub-lethal effects from anthropogenic debris ingestion. Substantial amounts of anthropogenic debris have been found in the digestive tracts of post-hatchling and juvenile loggerheads. The results of this study suggest that the consumption of debris may result in decreased nitrogen and energy intakes. Decreased nutrient intakes may result in decreased growth rates, a longer developmental period at sizes most vulnerable to predation, depleted energy reserves, and decreased survivorship due to starvation.