Marine Turtle Trauma Response Procedures: A Husbandry Manual

Michelle G. Pasquin (c) 1998. Bermuda Aquarium Museum & Zoo

Prepared by the Wider Caribbean Sea Turtle Conservation Network (WIDECAST)

Jessie E. Bluvias and Karen L. Eckert

WIDECAST Technical Report No. 10

2010

For bibliographic purposes, this document should be cited as:

Bluvias, Jessie E. and Karen L. Eckert. 2010. Marine Turtle Trauma Response Procedures: A Husbandry Manual. Wider Caribbean Sea Turtle Conservation Network (WIDECAST) Technical Report No. 10. Ballwin, Missouri. 100 pp.

ISSN: 1930-3025

Copies of this publication may be obtained from:

Wider Caribbean Sea Turtle Conservation Network (WIDECAST)
1348 Rusticview Drive
Ballwin, Missouri 63011 USA
Phone: + (314) 954-8571
Email: keckert@widecast.org

Online at www.widecast.org

Generously supported by:

HUMANE SOCIETY INTERNATIONAL

ATLANTIS
PARADISE ISLAND, BAHAMAS™

Pegasus Foundation

THE BEVERLY FOUNDATION

Marine Turtle Trauma Response Procedures: A Husbandry Manual

Jessie E. Bluvias, MEM
Project Officer, WIDECAST

Karen L. Eckert, Ph.D.
Executive Director, WIDECAST

2010

WIDECAST
Wider Caribbean Sea Turtle Conservation Network

PREFACE AND INTENT

For three decades the Wider Caribbean Sea Turtle Conservation Network (WIDECAST), with Country Coordinators in more than 40 Caribbean nations and territories, has linked scientists, conservationists, resource managers, resource users, policy-makers, industry groups, educators, and other stakeholders together in a collective effort to develop a unified management framework, and to promote a regional capacity to design and implement scientifically sound sea turtle management programs.

As a Partner Organization of the UNEP Caribbean Environment Programme and its Regional Programme for Specially Protected Areas and Wildlife (SPAW), WIDECAST is designed to address research and management priorities at national and regional levels, both for sea turtles and for the habitats upon which they depend. We focus on bringing the best available science to bear on contemporary management and conservation issues, empowering stakeholders to make effective use of that science in the policy-making process, and providing an operational mechanism and a framework for cooperation at all levels, both within and among nations.

Network participants throughout the region are committed to working collaboratively to develop their collective capacity to manage shared sea turtle resources. By bringing people together, and by encouraging inclusive management planning, WIDECAST is helping to ensure that utilization practices, whether consumptive or non-consumptive, do not undermine sea turtle survival over the long term.

Among these capacity building initiatives is WIDECAST's regional "Sea Turtle Trauma Response Corps" (STTRC). The aim of the STTRC is to strengthen and coordinate the efforts of people throughout the Wider Caribbean Region to respond to sea turtles in crisis, whether at sea or stranded along the shoreline. Based on recommendations of the 2004 Annual General Meeting of WIDECAST (held in San José, Costa Rica), the STTRC initiative includes the development of standard guidelines and criteria, reporting forms, database management software, and training for field staff and volunteers, natural resource managers, veterinarians, and animal rescue practitioners.

Following our 2006 "first response" field guide, it became clear that procedures and strategies were also needed to guide necessary efforts to provide adequate housing and care for sea turtles requiring a period of supervised rehabilitation after experiencing the effects of physical trauma or environmental stressors. Through literature research and extensive peer-review, we have summarized best practices related to human health and safety, sea turtle handling and transport, facilities design and requirements (maintaining turtles in and out of water, lighting and photoperiod, temperature control, life support systems, water system set-up, water quality testing, sanitization), diet and feeding, enrichment, emergency procedures, and release. Appendices provide a species identification guide, documentation forms, various plans and diagrams (sea turtle stretcher, tank dividers, water systems), recipes, quarantine protocols, and euthanasia. It is the first resource of its kind.

Nothing in this manual should be construed as an endorsement of keeping sea turtles in captivity unnecessarily, or for reasons of profiteering. Nor do we suggest that every Caribbean nation invest in a professional rescue or rehabilitation facility. We do, however, believe that when good can be done for a sick or injured animal, it is important that the actions taken are in line with professional and humane practices. The survival of every endangered sea turtle is important in today's world, and we hope that the information provided herein increases the probability that a sick or injured turtle will be given a "second chance" to resume a normal life in the wild.

Karen L. Eckert, Ph.D.
Executive Director
WIDECAST

ACKNOWLEDGEMENTS

For contributing their time, assistance, and expert guidance in the early development of these standards, the authors are very grateful to Eric Anderson, Lynne Byrd, Petra Cunningham-Smith, Charles Manire, Kelly Martin, Molly Pastorello, Renee Romanowski, and David Smith of Mote Marine Laboratory; Caitlin Cisek and Kelly Thorvalson of the South Carolina Aquarium (SCA); Robert George, Tracy Heard, Mark Swingle, and the Fishes Department at the Virginia Aquarium and Marine Science Center (VAMSC); Wendy Walton and the Stranding Response Team of the Virginia Aquarium Stranding Response Program; the staff of the North Carolina Aquarium at Pine Knoll Shores; Michelle Bauer of the Volusia County Marine Science Center; Rhema Bjorkland of Duke University's Center for Marine Conservation in Beaufort, North Carolina; and Jeanette Wyneken of Florida Atlantic University.

The document benefited significantly from a thorough peer-review by Jean Beasley (Director, Karen Beasley Sea Turtle Rescue and Rehabilitation Center, USA), Flegra Bentivegna (Curator, Naples Aquarium, Italy), Shane Boylan, DVM (Veterinarian, South Carolina Aquarium, USA), Claire Cayol, DVM (Veterinarian, DIREN, Martinique, French West Indies), Scott Eckert, Ph.D. (Research Scientist, Duke University), Beth Firchau (Curator of Fishes, VAMSC), Robert George, DVM (Head Veterinarian, VAMSC), Hedelvy Guada (CICTMAR, Venezuela), Craig Harms, DVM (North Carolina State University College of Veterinary Medicine, USA), Julia Horrocks, Ph.D. (Director, Barbados Sea Turtle Project; Professor, University of the West Indies), Michelle Kaylor (Rehabilitation Coordinator, Georgia Sea Turtle Center, USA), Frédéric Leveque, DVM (Veterinarian, l'Aquarium de Guadeloupe, French West Indies), Carl Lloyd (Ocean Spirits, Grenada), Charles Manire, DVM (Veterinarian, Mote Marine Laboratory, USA, and Atlantis Paradise Island, Bahamas), Nancy Mettee, DVM (Loggerhead Marine-Life Center, USA), Terry Norton, DVM (Director, Georgia Sea Turtle Center, USA), Maria Luz Parga, DVM (Veterinarian, SUBMON, Spain), Michelle Sattler (Collections Supervisor, John G. Shedd Aquarium, USA), Lory Scott (Old Dominion University, USA), Andrew Stamper, DVM (Veterinarian, Mote Marine Laboratory, USA), Mark Swingle (Director, Research and Conservation, VAMSC), Lesley Stokes and Wendy Teas (NOAA Southeast Fisheries Science Center), Kelly Thorvalson (Manager, Sea Turtle Rescue Program, SCA), Jeanette Wyneken, Ph.D. (Florida Atlantic University, USA), and Stuart Wynne (Department of Fisheries and Marine Resources, Anguilla).

Edward Lockhart and Michele Lamping (North Carolina Aquarium at Pine Knoll Shores) created the holding environment diagrams, and Michele Lamping co-authored *Section V: Holding Environment*. Lisa Wright (VAMSC) contributed her knowledge on creating tank dividers. Stuart May (North Carolina Aquarium at Pine Knoll Shores), Barbara Bergwerf and Kelly Thorvalson (SCA), Kelly Martin and Renee Romanowski (Mote Marine Laboratory), and Mark Swingle (VAMSC), among others, kindly donated photographs and other illustrations.

The senior author's research and summer internships in 2007-2008 would not have been possible without a grant from the Nicholas School of the Environment's *Environmental Internship Fund* (Duke University), and the kindness of those who provided me with local housing: Deb and Rick LaStella in Bradenton, Florida; Diane Lauritsen in Mount Pleasant, South Carolina; and Maylon and Charlotte White in Virginia Beach, Virginia. Major funding for the development, peer-review, and printing of this Manual was provided by the WIDECAST network (http://www.widecast.org), The Beverly Foundation, Atlantis Paradise Island (http://www.atlantis.com/), Humane Society International (http://www.hsi.org/), and the Pegasus Foundation (http://www.pegasusfoundation.org/). Finally, I gratefully acknowledge Dr. Karen Eckert for introducing me to this project, advising me along the way, and giving me endless support and enthusiastic encouragement; James for his patience and encouragement; and my friends and family for their constant love and support – thank you all for believing in me and for being a part of my journey. *As I promised years ago, this one is dedicated to you, Mom, with love.*

TABLE OF CONTENTS


Photo by Jessie Bluvias

SUMMARIES AND CHECK LISTS

Photos (clockwise): South Carolina Aquarium; WIDECAST; Nature Foundation of Sint Maarten; Sea Turtle Conservation Bonaire

I. OVERVIEW

Phelan and Eckert (2006) established basic guidelines and procedures for responding to sea turtles affected by a variety of natural (e.g., predator attacks, mating wounds, parasite infestations) and man-induced (e.g., boat strikes, entanglement and hooking, oil contamination, trash ingestion) traumas. In some cases the animal could be released; for example after having been cleansed of oil or released from an entanglement. In other cases the recommendation was to transport the animal to a rescue/ rehabilitation center or willing veterinarian for observation and/or treatment.

The purpose of a rescue/rehabilitation center is to provide both immediate and longer-term care to sick and/or injured animals. The expected outcome is always that the animal will be returned to the sea as soon as practicable, enabling it to fulfill its ecological roles. Wildlife rehabilitation is sometimes ridiculed as a waste of time by numerically minded conservationists who may view the effort as inconsequential in the larger scheme of things, but for endangered and threatened species, including six species of Caribbean sea turtle (see *Appendix A: Species Identification*), every individual, especially of (or close to) breeding age, released back to the wild is another step toward species survival.

Even when presenting severely infected injuries and/or shock, wild animals appear to demonstrate a great capacity to cope with these injuries and will often recover if given the necessary supportive treatment (Stocker, 2005). Notwithstanding, bringing a sea turtle into captivity, even for a short time, should be done only when absolutely necessary. Captivity requires special considerations with regard to the physical plant (e.g., access to running seawater, large animal capacity), human resources (e.g., attendants will require a knowledge of reptile medicine and care), and the law (e.g., sea turtles are protected in most Caribbean countries and their handling and care may require a special permit).

Sick and injured sea turtles require special medical attention. Never bring a sea turtle home with the intention of caring for it yourself. In every Caribbean country it is illegal to capture, transport, and/or possess a sea turtle during a legally enforced closed season, which for most countries is year-around.

Subjected to undue stress and without proper attention to their specific husbandry needs, the condition of a sick or injured sea turtle may worsen rather than improve. For example, incorrect intake of calcium and phosphorous and certain single food diets can cause metabolic bone disease and iron deficiency, respectively (George, 1997); overfeeding can contribute to intestinal blockages, floating or bloating problems (Higgins, 2003); and inappropriate food items can contribute to parasitic infections (George, 1997). Physical plant issues can also compromise proper nutrition. A lack of UV light exposure may contribute to vitamin D deficiency, limiting the amount of calcium uptake in the intestines (Norton, 2005a; George, 1997). Turtles housed together are vulnerable to aggression, injuries related to aggression, and the spread of disease, any or all of which can decrease appetite or the ability to eat (George, 1997; Higgins, 2003). Finally, if the holding facility is poorly designed and maintained, foreign objects can be swallowed or cause physical trauma, and poor water quality can cause eye irritations, all of which can contribute to malnutrition (George, 1997; Higgins, 2003).

Non-nutritional related disorders can also be acquired in captivity and are directly related to common husbandry errors and facility design. Flow-through open water systems and closed systems can introduce or amplify bacteria, fungi, viral diseases, and parasites if water quality is not properly maintained. Constant high water temperatures can facilitate an outbreak of grey-patch disease by degrading the turtles' immune system (Haines and Keese, 1977), and prolonged periods out of water can result in carapace drying and scute peeling, creating a canvas for bacteria and fungi (Higgins, 2003). Turtles housed together can develop injuries (eye infections, skin lesions) from aggression or induce stress between individuals, exacerbating their vulnerability to infection (George, 1997; Higgins, 2003). General contact between turtles and the sharing of water systems can also aid in spreading disease.

The number and variety of disorders and other problems that can occur in a disorganized or unmanaged environment can significantly hinder the ability of staff to properly rehabilitate and release sea turtles back into the wild. Therefore, correct measures must be taken to ensure the best overall practices and management, including record-keeping and documentation. **With all of this in mind, the purpose of this Husbandry Manual is to offer basic guidelines and procedures for individuals who rehabilitate sick and injured sea turtles.** The guidelines are also useful when caring for sea turtles retained at facilities permitted to house them for educational display.

Designed to address the needs of sea turtles suffering from the effects of physical trauma or environmental stressors, the following sections will help prevent common problems associated with rehabilitation by providing guidance on handling and transport, facilities requirements, diet and feeding, enrichment, emergency procedures, and release. Appendices provide a species identification guide, documentation forms, water system diagrams, recipes, and quarantine protocols. Written for lay and professional audiences, it is the first such resource in the Wider Caribbean Region, and is intended to meet the needs of the Sea Turtle Trauma Response Corps organized by the Wider Caribbean Sea Turtle Conservation Network (WIDECAST).

WIDECAST Sea Turtle Trauma Response Corps (STTRC)[1]

WIDECAST, with Country Coordinators in more than 40 States and territories, is uniquely designed to address national and regional research, conservation, and management priorities, both for sea turtles and for the variety of habitats upon which they depend. One such priority is to reduce the negative consequences of human interactions with sea turtles, as well as to facilitate the rescue and rehabilitation of injured and traumatized turtles.

Delegates from more than 30 Caribbean States and territories unanimously agreed at the 2004 Annual General Meeting (AGM) of WIDECAST that a “Sea Turtle Trauma Response Corps” (STTRC) be created to strengthen and coordinate the efforts of people throughout the Wider Caribbean Region to respond to sea turtles in crisis, whether at sea or stranded on the shoreline. The Meeting envisioned that the STTRC would embrace interested sea turtle project staff and volunteers; veterinarians; zoo and aquaria personnel; “animal rescue” center staff; divers, fishermen and coastal residents; and park and natural resource managers.

Specifically, the AGM recommended that each WIDECAST Country Coordinator identify a National STTRC Coordinator to organize and maintain a national Trauma Response Network (TRN), and to link members of the TRN with the resources of the regional STTRC. In turn, each National STTRC Coordinator is tasked with identifying (i) local experts and relevant facilities, equipment, and resources to contribute to the national TRN; (ii) a mechanism (such as an e-newsletter or list-serve) to keep TRN members informed of current events, resources, training, etc.; (iii) a sponsor for a 24-hour “Sea Turtle Hotline” to invite citizen reports and to encourage and facilitate emergency assistance; and (iv) a Lead Organization to inventory data related to stranding events.

Each National STTRC Coordinator ensures that the TRN operates in full compliance with national permit requirements relative to conducting necropsies, collecting and storing tissue samples, holding sea turtles captive for the purposes of rehabilitation, and so on.

[1] This section was adapted from Phelan and Eckert (2006): “Marine Turtle Trauma Response Procedures: A Field Guide.”

WIDECAST maintains a website (http://www.widecast.org/What/Regional/Medicine.html) featuring a roster of National STTRC Coordinators and other experts, and rehabilitation centers located in the Caribbean region, including the US; documentation, such as this Husbandry Manual, of standard guidelines and procedures; data forms and reporting protocols; training opportunities and internships; and other relevant contacts and resources. Networking among rescue and rehabilitation personnel is important, and WIDECAST offers training opportunities and peer-exchanges designed to build capacity (e.g., stranding response procedures, standardized data collection and analysis, necropsy techniques, animal transport guidelines, and sample and tissue collection, analysis, inventory and storage) among veterinarians, caregivers, and project directors. MARVET (http://www.marvet.org/), SeaVet (http://conference.ifas.ufl.edu/ame/seaveti/), and AquaVet (http://www.vet.cornell.edu/aquavet/) offer professional training in aquatic veterinary medicine.

Cautionary Remarks

Nothing in this manual should be construed as an endorsement of keeping endangered sea turtles in captivity unnecessarily, or for reasons of profiteering. Nor do we suggest that every Caribbean nation invest in a professional sea turtle rehabilitation facility. We do, however, want to emphasize that when good can be done for a sick or injured animal, it is important that the actions taken are in line with professional and humane practices. It is also important to recognize when the illness or injury is beyond the skill of local caregivers, in which case the difficult decision to release the animal to its fate or to euthanize it should be considered.

The rehabilitation process is both difficult and time consuming, but also very rewarding. The survival of every endangered sea turtle is important in today's world, and we hope that the information provided herein increases the probability that a sick or injured sea turtle will be given a second chance to resume a normal life in the wild.

Even without the professional capacity of the rescue centers pictured here in Italy (1), the USA (2), and Costa Rica (3), no sea turtle should ever be kept in the unfortunate (but all too common) condition of a filthy, crowded enclosure without access to the simple necessities of clean water, shade, an adequate diet, and medical attention. The information in this Husbandry Manual is designed to empower local caregivers to innovate simple, clean amenities that meet the need at an appropriate scale.

Photos by (1) F. Bentivegna, Naples Aquarium; (2) The Turtle Hospital, Marathon Key, Florida; (3) D. Chacón, WIDECAST.

Want to Know More?

In developing this Husbandry Manual the authors have drawn on the cumulative expertise of the published literature, personal interviews with rehabilitation experts, veterinarians and other professionals, and extensive peer-review. The Internet is also a useful source of information (see below); for complete bibliographic references for these and other cited materials, see *Section XII: Literature Cited*.

INTERNET RESOURCES TO INFORM & GUIDE HUSBANDRY EFFORTS

American Zoo & Aquarium Association (AZA) Nutrition Advisory Group, "Feeding Program Guidelines" (Bernard and Allen, 2002): http://www.nagonline.net/Feeding%20Guidelines/feeding_guidelines.htm and Technical Papers: http://www.nagonline.net/Technical%20Papers/technical_papers.htm

Florida Fish & Wildlife Conservation Commission, "Marine Turtle Conservation Guidelines" (FFWCC, 2007a): http://myfwc.com/wildlifehabitats/managed/sea-turtles/conservation-guidelines/

Section IV: Holding Marine Turtles in Captivity

IUCN/SSC Marine Turtle Specialist Group, "Research and Management Techniques for the Conservation of Sea Turtles" (Eckert et al., 1999): http://iucn-mtsg.org/publications/techniques-manual-en/

Taxonomy, external morphology, and species identification (Pritchard & Mortimer)
Factors to consider in the tagging of sea turtles (Balazs)
Techniques for measuring sea turtles (Bolten)
Stranding and salvage networks (Shaver & Teas)
Rehabilitation of sea turtles (Walsh)
Infectious diseases of marine turtles (Herbst)

Herpetological Animal Care and Use Committee (HACC, 2004), "Guidelines for the Use of Live Amphibians and Reptiles in Field and Laboratory Research, second edition." American Society of Ichthyologists and Herpetologists: http://www.asih.org/files/hacc-final.pdf

UNEP Mediterranean Action Plan, "Guidelines to Improve the Involvement of Marine Rescue Centers for Marine Turtles" (RAC/SPA, 2004): http://www.rac-spa.org/sites/default/files/doc_turtles/glrs.pdf

University of Florida, "Sea Turtle Biopsy & Necropsy Techniques":
http://www.vetmed.ufl.edu/college/departments/sacs/research/SeaTurtleBiopsyandNecropsyTechniques.html

US NOAA NMFS, "The Anatomy of Sea Turtles" (Wyneken, 2001):
http://courses.science.fau.edu/~jwyneken/sta/

US NOAA National Ocean Service, "Oil & Sea Turtles: Biology, Planning, and Response" (Shigenaka, 2003): http://response.restoration.noaa.gov/book_shelf/35_turtle_complete.pdf

WIDECAST, "Marine Turtle Tagging: A Manual of Recommended Practices" (Eckert & Beggs, 2006):
http://www.widecast.org/Resources/Docs/Phelan_and_Eckert_2006_Sea_Turtle_Trauma_Response_Field_Guide.pdf

INTERNET LINKS FOR SEA TURTLE RESCUE & REHABILITATION FACILITIES

Clearwater Marine Aquarium (USA): http://www.seewinter.com/what-we-do/rescue-rehab-release

Fundación para la conservación y Recuperación de Animales Marinos (Spain): http://www.cram.org

Georgia Sea Turtle Center (USA): http://www.georgiaseaturtlecenter.org

Gumbo Limbo Nature Center (USA): http://www.gumbolimbo.org/Sea-Turtle-Rehabilitation

Karen Beasley Sea Turtle Rescue and Rehabilitation Center (USA): http://www.seaturtlehospital.org/

Loggerhead MarineLife Center (USA): http://www.marinelife.org/hospital

Marine Animal Rescue Program, New England Aquarium (USA): http://www.neaq.org/conservation_and_research/projects/conservation_medicine/rescue_and_rehabilitation/index.php

Mote Marine Lab Sea Turtle Rehabilitation Hospital (USA): http://www.mote.org/seaturtlehospital

Programa para la Rehabilitación de Tortugas Marinas (Uruguay): http://www.karumbe.org/

Sea Turtle, Inc. (USA): http://www.seaturtleinc.org/

Sea Turtle Rescue Center (Greece): http://www.archelon.gr/eng/pedio_rescue.php?row=row5

Sea Turtle Rescue Center of the Stazione Zoologica (Italy): http://www.szn.it

South Carolina Aquarium Sea Turtle Rescue Program (USA): http://www.scaquarium.org/STR/

The Turtle Hospital (USA): http://www.turtlehospital.org/index.htm

Virginia Aquarium Stranding Response Center (USA): http://www.virginiaaquarium.com/research-conservation/Pages/stranding-response-program.aspx

Volusia County Marine Science Center (USA): http://echotourism.com/msc/msc3.htm

As a result of the vigilance and caring of fishers who reported this injured hawksbill, and the efforts of a veterinarian guided by earlier drafts of this Husbandry Manual, Sea Turtle Conservation Bonaire (STCB) was able to rescue, rehabilitate and release this turtle. Photos © STCB

II. THE ESSENTIALS

Human Health and Safety[2]

Responding promptly, compassionately and appropriately to an injured sea turtle is important, and in many cases an informed response may be sufficient to enable the animal's quick release. That said, it is equally important to remember that responding to an injured animal carries risk. A rescue worker may be cut or bitten, slapped or knocked down by a flailing flipper, suffer sunstroke, aches, strains and bruises, or catch a face full of sand.

Sea turtles, particularly critically ill sea turtles, can harbor a variety of bacteria, viruses, and parasites (e.g., Norton, 2005a; Santoro et al., 2006). Care should always be taken to minimize all categories of risk, both to the already traumatized turtle and to the rescue workers.

The following preventive measures are recommended by Geraci and Lounsbury (1993) for persons handling marine mammals and should be applied to sea turtles:

- Wear latex or nitrile gloves[3] when handling sea turtles, carcasses, tissues or fluids
- Wear waterproof outerwear to protect clothing from contamination
- Cover surface wounds with protective dressings
- Wash exposed skin and clothing after handling sea turtles
- Seek medical attention for bites, cuts, and other injuries, and inform medical attendants of the injury's source

Staff Qualifications and Responsibilities

Rehabilitation Specialist: Persons involved in the rehabilitation of sick or injured sea turtles must be licensed with an appropriate permit that allows them to house, feed, and/or medically treat the animals under their care.

Veterinarian: A licensed veterinarian should be either on staff or on call to conduct initial health assessments and weekly (or other regular) exams to monitor progress, condition, diet, and medications; respond to medical emergencies; and oversee a final screening prior to release.

Life-Support Technician: A technician or maintenance expert either on staff or on call must have proper knowledge and capabilities to monitor, maintain, and repair the physical plant, including any life-support equipment.

General Requirements: Rehabilitation requires handling turtles for procedures, medication, monitoring, food preparation and feeding, tank cleaning, etc. Staff members should be physically capable of lifting and restraining adult turtles weighing several hundred pounds, and should be dedicated to the time and attention required to care for the animal on a 24-hour basis.

Patience is essential, as health progress and stability may require several days, months or longer.

[2] This section (as well as the Sea Turtle Anatomy Guide on the next page) was excerpted from Phelan and Eckert (2006): "Marine Turtle Trauma Response Procedures: A Field Guide."

[3] Wearing gloves reduces the risk of disease transfer and protects both the handler and the turtle. The normal gram positive fauna of humans is a potential threat to sea turtle health; likewise, normal gram negative fauna of sea turtles is a zoonotic concern for the handler. If gloves are not worn, hands should be washed thoroughly before and after handling a sea turtle.

Facility Requirements and Supplies

The success of the rehabilitation effort, like any medical care initiative, requires clean water, adequate supplies, trained staff, and proper equipment. The physical plant need not be technologically advanced nor expensive to construct or maintain, but it must be located with care (e.g., near a clean water source and preferably near the sea) and it must be easily accessible by technical and security personnel, and other professional partners (e.g., veterinarians, mechanics).

In addition, the facility should:

- Operate with proper legal authority with respect to animal care/veterinary procedures, operational inspections (e.g., water quality, medical waste), and endangered species permits
- Have the capacity to access (or make) and maintain running saltwater for use and storage
- Provide adequate shade and/or shelter, whether it be indoors or outdoors
- Provide adequate holding tanks, including treatment and convalescent (recovery) pools
- Have access to a surgical site, basic radiology equipment (including processor), and a diagnostic laboratory for blood, biopsy, and fecal samples
- Conduct routine water quality tests, or have access to a testing facility
- Designate a kitchen or similarly suitable clean, sanitized area for food preparation and storage
- Guarantee access to high quality food, whether fresh, frozen, or processed
- Develop animal transport and handling protocols
- Maintain an inventory of necessary equipment and supplies for food storage, preparation and feeding, animal holding and transport, water quality testing and maintenance, basic medical care, measuring and weighing (scales, calipers, rulers, flexible tapes), and so on
- Maintain a supply of clean towels, and disinfecting and cleaning supplies
- Provide and maintain appropriate "life support" equipment, including pumps, filters, plumbing, and tanks associated with a proper water holding system
- Establish procedures for emergency preparation and response

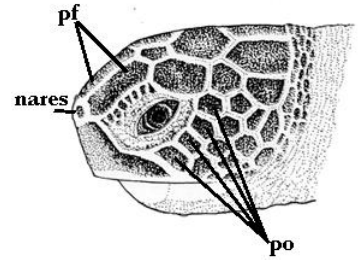
Record-Keeping and Documentation


Always document and retain food and medical records

Document the animal's condition and progress at all stages, from first encounter to death or successful release. Always record complete contact information for the person(s) who first encountered or reported the animal. Basic record-keeping forms (see *Appendix B: Sample Documentation Forms*) include first encounter forms, medical records (medicines prescribed and dispensed, veterinary charts), feeding logs, tank maintenance and water quality records, and final release forms. Accompanying photographs are always helpful. An organized relational database is an essential component of professional animal care, as well as an invaluable reference for future cases and a basis for communication among caregivers.

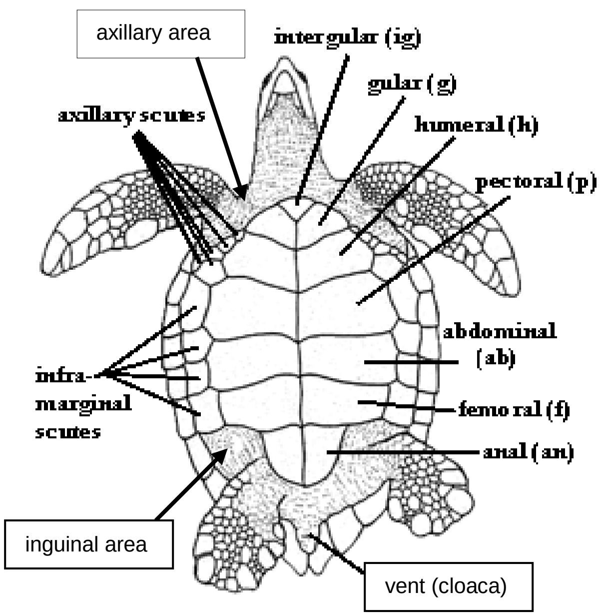
Photo credit: All uncredited photos were taken by the senior author. All photos credited to the South Carolina Aquarium of Charleston, South Carolina, are credited as "SCA." All photos credited to the North Carolina Aquarium at Pine Knoll Shores, are credited as "NCA-PKS." All photos credited to the Volusia County Marine Science Center, in Ponce Inlet, Florida, are credited as "VCMSC." All photos credited to the Loggerhead MarineLife Center of Juno Beach, Florida, are credited as "LMLC." All photos credited to the Virginia Aquarium and Marine Science Center Foundation in Virginia Beach, Virginia, are credited as Virginia Aquarium Foundation or "VAF." Others: Office National de la Chasse et de la Faune Sauvage (ONCFS); National Oceanographic and Atmospheric Administration (NOAA).

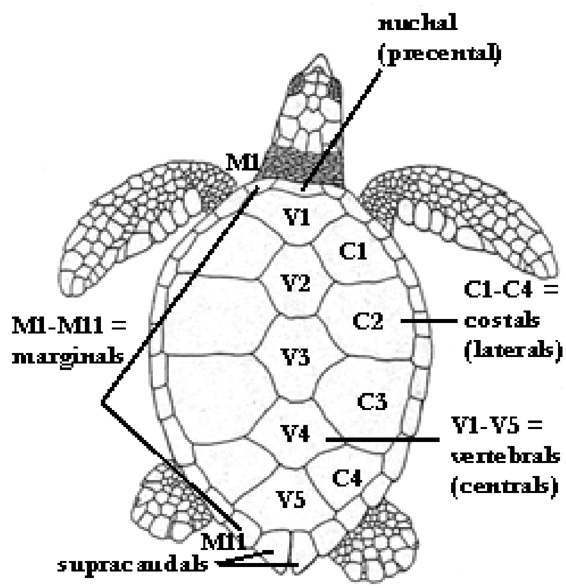
Sea Turtle Anatomy Guide

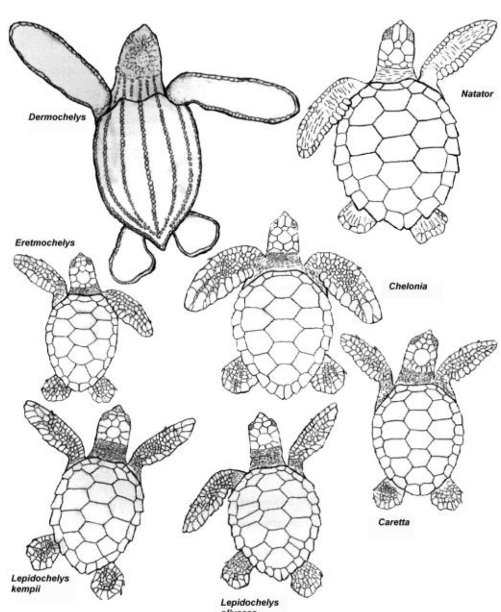


The identification of sea turtles to species (see *Appendix A*) relies on a combination of factors, mainly the scute pattern on the carapace (i.e., the number of costals and vertebrals) and scale patterns between and behind the eyes; e.g., distinctively, green sea turtles have two large pre-frontal scales (*pf*, see insert).

The assessment and treatment of injured sea turtles may call for a measurement of the *carapace* (top shell) from *nuchal* notch to the *supracaudals*, recording the distance between the edge of the *plastron* (lower, or belly shell) and the *vent*, examination of the *inguinal* area for leeches, examination of the *axillary* area for fibropapilloma tumors, and so on. We have tried to keep the use of technical jargon to a minimum, but sometimes it is unavoidable. The following diagrams (from Pritchard and Mortimer, 1999) provide a simple overview. For more detail, see Work (2000) and Wyneken (2001, 2003).







Note: Hatchlings display many of the same diagnostic characteristics, such as the scute pattern on the carapace, as do adults of the same species.

Vertebral and costal carapace scutes on green sea turtle hatchlings, © S. Stapleton, WIDECAST

III. HANDLING AND TRANSPORT

Procedures and Advice: Handling a Live Turtle

If required by law, licensed rehabilitators should carry the necessary permits that allow them to handle and transport protected species, including sea turtles. Sea turtles should not be handled unnecessarily, and should not be encouraged to become habituated to human contact and interaction. Whenever handling is required, the animal must be retrieved, restrained (positioned for procedures), kept calm, and returned safely to the holding facility.

SITUATIONS REQUIRING HANDLING

- Initial recovery of a sea turtle from a beach or other location
- Removing a sea turtle from a tank for examination, medical procedures, or topical medication
- Properly restraining a sea turtle for examinations and diagnostic procedures
- Transporting a sea turtle to an off-site facility for radiographs, ultrasounds, or surgeries
- Cleaning a sea turtle, as necessary, of debilitating epibiota and parasites
- Applying identification marks, including flipper and/or PIT tags
- Properly releasing a sea turtle to the ocean

Retrieve

The first step in handling is to retrieve the sea turtle from its tank or enclosure. Turtle and tank size will determine the course of action.

Coaxing turtle with net frame, © VAF

Smaller sea turtles that can be handled by 1-2 people: The best options are to (i) reach into the tank and grab the carapace securely, placing one hand just behind the head and the other at the rear, or (ii) embrace the front flippers, pinning them against the sides of the carapace, and positioning the turtle against the handler's body. Turtles out of reach can be coaxed into range using a net frame (without netting) gently positioned around the head and/or a front flipper. Juveniles can be caught using a net (with netting, small mesh). If these methods do not work, one or two people may have to enter the tank to retrieve the turtle. To do this, *slowly surround turtle and close in*, grasp the carapace, move the turtle to the tank edge, and lift. Make sure there is someone on the outside of the tank to receive the animal.

Retrieving small turtle with net, © VAF

Turtles too large to be handled by 1-2 people: (i) Three or four people are positioned around the turtle in order to lift it out of the tank, or (ii) the turtle is herded into a net or stretcher, and then lifted out of the tank by assisting personnel. *Beware*: flapping front flippers can cause you to lose your grasp and/or balance, endangering both you and the turtle. If the turtle is too large to safely remove from the tank, drain the tank and hoist the turtle atop a rubber tire for the duration of the examination. Alternatively, use floats, stretchers, nets, or physical restraint to hold the animal at the surface of the water for examination or treatment.

Retrieving turtle with cargo net, © VAF

Restrain

Transport within a facility can be done by hand-holding the turtle or using a cargo net, stretcher, wagon, or any other safe, secure transport mechanism that will not jostle the animal or allow the flippers to flail. Individuals with open wounds fare best with mechanisms that minimize contact with these wounds. Whatever mechanism is used, it must be strong enough for large turtles and made of materials that will not damage the animal or allow smaller turtles to become entangled. See *Appendix C: Customized Turtle Stretcher*.

Holding a turtle with a large hoop (rigid frame) net, © VAF

Turtles should only be restrained when necessary, usually during transport or during diagnostic procedures. Most strength comes from the front flippers, so restraint is usually focused there. To properly restrain a turtle, maintain a firm hold on the front flippers, near the shoulders. Flippers can also be held or bound to the carapace to restrict movement. Small turtles, in particular, can break a humerus bone if not restrained properly. For injections and blood draws, the head is held to the opposite side (e.g., the head should be directed left for an injection in the right shoulder) or firmly held down to prevent movement. *Hint*: a bucket placed between the head and shoulder can protect the handler from being bitten when the turtle becomes aware of the injection.

Restraining a turtle, note position of hands on shoulders, © VAF

Comfort

Use some sort of padding, such as towels or foam sheeting, during transport and on surfaces (e.g., floors, tables, flatbed truck) used for examinations. The materials used should be reusable and easily cleaned. Padding provides comfort, leverage, and a layer for sanitization. Rubber tires also make for comfortable padding and can aid in restricting movement (do not leave the turtle unattended on the tire). If the turtle becomes stressed and irritable, we recommend the following procedures, which are designed to calm the turtle and maintain your control: (i) place a towel, blanket, or other cloth over the animal's head, or (ii) place slight pressure on the back of the head and lean your body against the middle of the carapace, being careful not to restrict breathing or place undue pressure on the plastron against hard surfaces.

Placing a sea turtle on a tire, © B. Bergwerf, SCA

Return

Safety for both the turtle and the handler is an important concern. When handling, all movements should be smooth and steady. When returning a turtle to a tank after a procedure, do not angle the body head-first into water or the turtle will swim into the opposite tank wall. Instead, release the turtle with its nose touching the tank wall or orient the turtle along the side of the tank and give it a slight push, encouraging it to swim along the wall. Larger turtles may require staff to enter the tank, following similar steps as in the retrieve. Once released, staff should exit tank immediately. Equipment used for handling should be disinfected or sanitized. Wash hands/change gloves before handling another turtle.

T-shirt over turtle's head, © VAF

Procedures and Advice: Transporting a Live Turtle

If you need to transport a sick or injured sea turtle, make every effort to keep the animal from overheating (e.g., keep it in the shade) while waiting for the vehicle to arrive. Provide a smooth ride, keep the animal moist, and protect the animal from extremes of heat and cold. The following guidelines are intended for local ground transport, typically from the point of encounter to the location of a rescue/ rehabilitation center or veterinary clinic.

Wooden box carrier, © VAF

Always place the sea turtle in a container (e.g., wooden crate, large cooler, animal kennel) for transport. Container dimensions should allow normal flipper position and head extension (including raising the head to breathe); the turtle should *not* be able to turn around. *Containers should be handled and secured during transport in an upright position.* The top of the container should be clearly marked. Containers should be ventilated and padded (at least on the bottom), be free of material that could be accidentally ingested, and accommodate the fact that turtles must be kept moist. The best range of temperature for transport is 18º-26ºC (65º-79ºF) (IATA-LAR, 2006).

Note: If a suitable container is not available, place the turtle on a foam pad or blanket with a damp towel over its head to keep it quiet on a flatbed truck.

Plastic transportation box,
© Mote Marine Lab

To prevent the turtle from drying out during long-distance transport, apply a *very thin layer* of lubricating jelly (such as KY®, which has the advantage of being water-soluble, or Vaseline®), except around the eyes, nose, and mouth and avoiding any open wounds, and cover with wet towels. If wet towels are used, protect the turtle from becoming too cold due to evaporative cooling – *turtles covered with wet towels must not be kept in an air-conditioned environment* (FFWCC, 2007b).

Air Transport

To ensure the welfare and safety of animals being transported by air, access information about containers, and ensure that your transportation procedures are compliant with international regulations, visit http://www.iata.org/ps/publications/live-animals.htm to review the IATA Live Animals Regulations (IATA-LAR, 2006). The LAR are enforced by the European Union, U.S. Fish and Wildlife Service, and generally meet or exceed the intent of the U.S. Animal Welfare Act. The Convention on International Trade in Endangered Species (CITES) and the World Organization for Animal Health also officially recognize these regulations.

Concerns and Warnings

For all handling/ transport, **face the turtle forward** (in the direction of motion). Watch flippers while going through doorways. Pay careful attention – never abrade open wounds, sores, or skin irritations.

Confirm that **containers are secured** during transport, such that they do not slide around or tip over.

International shipments require a **CITES permit** (http://www.cites.org/eng/res/12/E12-03R14A2.pdf) and must follow strict transportation guidelines (www.cites.org/eng/resources/transport/index.shtml).

IV. ADMITTING A PATIENT[4]

Critically ill or injured sea turtles should be taken to a permitted health care facility immediately. They should be transported "right side up" (positioned on their plastrons) on a padded surface and be kept moistened with wet towels, misters, or some sort of irrigation. A traumatized sea turtle may be in an anoxic state and comatose; see Phelan and Eckert (2006) for detailed resuscitation procedures. *Note*: Placing a sea turtle on its back (on the carapace) is very stressful. It reduces respiration and increases the likelihood of gastrointestinal torsion or volvulus (Shane Boylan, DVM, pers. comm.).

Assessment and Documentation

On arrival, a standard protocol should be used for all animals. The initial diagnostic evaluation should include a complete history (as much as possible). Knowledge of how and where the turtle was recovered often gives clues as to the medical problems. Before medical intervention is initiated, appropriate agencies should be notified and a stranding report completed (see *Appendix B: Sample Documentation Forms*). The physical assessment should be performed following a prescribed routine each time to ensure that nothing is missed. Hernandez-Divers (2006) presents detailed, well-illustrated diagnostic techniques for reptiles, including common differential diagnoses by symptoms, and these are adaptable to sea turtles (see also Norton, 2005a). Saving the obvious problems (e.g., fish hook, fractured carapace) for last is recommended so that other abnormalities are not overlooked. All animals should be weighed, measured (straight and curved carapace length and width, straight plastron length), and the core body temperature recorded (measured from the cloaca).

A minimum database should be assembled, including a complete laboratory analysis (complete blood count, plasma chemistries), whole body radiographs (x-rays), and, whenever possible, microbiologic cultures. Plasma and whole blood should be collected, clearly labeled, and banked. Published normal hematologic and biochemical values for sea turtles are few.[5] See Wyneken et al. (2006) for a data summary and a discussion of techniques (cytologic analyses, diagnostic imaging, endoscopy), common medical problems (trauma, fibropapillomatosis, fish hooks and gastrointestinal injury, entanglements, buoyancy abnormalities, oil contamination, parasites, infectious diseases, neoplasia, anorexia, lethargy), and therapeutics (anesthesia, pain management, surgery).

A comprehensive neurologic examination should be performed on all patients with neurologic abnormalities or spinal or head trauma. The sea turtle nervous system is "similar enough in form and function to mammals that a general neurologic examination, including a cranial nerve evaluation, should be effective in determining location of neurologic damage or disease" (Wyneken et al., 2006). Start with a quiet observation of the animal free swimming in water, if possible, followed by an aquatic and a terrestrial assessment of condition and ability. See Chrisman et al. (1997) for details.

Therapeutics

Principles of treatment should follow standard guidelines, including sea turtle specific drug dosages (see Stamper et al., 1999; Manire et al., 2003; Rhinehart et al., 2003; Mitchell, 2006) and general reptile protocols (Carpenter, 2005), discussion of which is not within the scope of this manual. After initial diagnostics and establishment of a treatment plan, sea turtles should be housed in isolation pools.

[4] "Admitting a Patient" is distilled from Wyneken et al. (2006), "Medical Care of Sea Turtles," which is Chapter 76 *in* Mader (2006), "Reptile Medicine and Surgery, Second Edition." This invaluable reference should always be on hand.
[5] For example, see Bolten and Bjorndal, 1992; Gelli et al., 2004; Gicking et al., 2004; Deem et al., 2006; Kakizoe et al., 2007; online: http://accstr.ufl.edu/blood_chem.htm

If a patient is too weak to raise its head out of the water to breathe, it should be made comfortable on a foam pad to protect the plastron and placed in a shower pool (a drained tank with overhead spray) or covered with petrolatum jelly and moist towels to prevent dehydration (see also *Section V: Holding Environment – Maintaining Turtles out of Water*). Animals with slightly more energy can be placed in shallow tanks, and those with normal activity should be housed in deep pools to promote swimming and exercise. Dehydrated and epibiont-covered turtles should receive a 24-hour soaking in a fresh-water pool, both to correct dehydration and aid in the shedding of epibionts, including ectoparasites.

Normal seawater should be used in the rehabilitation and hospitalization tanks. Salinity should be maintained at 20-35 parts per thousand (ppt). An open water system with high flow rates can reduce bacterial and algal growth. A less desirable method of controlling bacterial and algal growth is the use of chlorine added to the saltwater (0.5 mg/L to achieve a level of 0.5 parts per million, ppm). If using chlorine, test the water regularly (at least daily) – free chlorine[6] levels greater than 1.0 ppm can irritate the turtle's eyes (Campbell, 1996; see also *Section V: Holding Environment – Water Quality Testing*).

Indoor pools should be kept between 25º-30ºC (77º-86ºF). Water that is too cold can be immunosuppressive, depress appetite, and delay healing, and water that is too warm can cause hyperthermia and also have other metabolic consequences. Partial shade is required in outdoor tanks (see also *Section V: Holding Environment – Temperature Control*). Chilled patients should be warmed slowly (5 degrees/day). Rapid warming (or cooling) can cause significant shifts in blood pH and electrolytes.

Medications are generally administered either orally (PO), intramuscularly (IM), intracoelomically (ICe), or intravenously (IV). The general adage "if the mouth works, use it," does apply to sea turtles. However, in animals that are debilitated, have gastrointestinal stasis, or are large and dangerous, the oral route may not be practical. Controversy exists regarding the best fluid to give reptile patients (for a detailed discussion beyond the scope of this Husbandry Manual, refer to Mader and Rudloff, 2006 and Mitchell, 2006). Remember that no single best fluid exists for all reptile patients, and that fluid choice should be based on patient assessment and blood results.

A Note about Emergency Care

According to Mader and Rudloff (2006), "it is a rare reptile case that cannot wait 24 hours for the initiation of antibiotic treatment while the patient is properly warmed. Medications, fluids, enterals, and so on, have little effect in the cold patient." Every effort should be made to evaluate a sea turtle's body temperature, and then adjust it (slowly) up or down as needed. Receiving facilities should have appropriate protocols and devices for warming a critically ill sea turtle. For details concerning emergency diagnostics, therapeutics, and fluid therapy, which are beyond the scope of this Husbandry Manual, see Mader and Rudloff (2006). WIDECAST is in the process of developing a veterinary handbook, including general specimen and data collection methods, sea turtle formulary and indications, anesthesia, radiographic and surgical techniques, and case studies.

Concerns and Warnings

Handle with caution – even ill, injured, or otherwise weakened or impaired sea turtles may **inflict a severe bite** or flipper slap to an unsuspecting or inexperienced handler or bystander.

If wet towels are used to keep the turtle moist, **avoid air-conditioned environments**; there is the danger that body temperature will drop dangerously low due to evaporative cooling.

[6] Total chlorine = free chlorine + combined chlorine

PUBLISHED DRUG DOSING STUDIES IN SEA TURTLES

Selected References

Carpenter, J.W. 2005. Exotic Animal Formulary, Third Edition. Elsevier Saunders, St. Louis. 564 pp. *Note*: This reference includes a listing of drugs that have been used safely and successfully in a wide range of reptiles, with notations as to whether a recommended drug dose is based on a specific pharmacokinetic paper for a species, or if it is extrapolated or anecdotal.

Clauss, T., M.G. Papich, S. Coy, S. Hernandez-Divers, I.K. Berzins and S.C. Budsberg. 2007. Pharmacokinetics of meloxicam in loggerhead sea turtles (*Caretta caretta*) after single dose intravenous administration. Proc. IAAAM, 228.

Harms, C.A., M.G. Papich, M.A. Stamper, P.M. Ross, M.X. Rodriques and A.A. Hohn. 2004. Pharmacokinetics of oxytetracycline in loggerhead sea turtles (*Caretta caretta*) after single intravenous and intramuscular injections. J. Zoo. Wildl. Med. 35(4):477-488.

Jacobson, E.R., R. Gronwall, L.K. Maxwell, K. Merrit and G.R. Harman. 2005. Plasma concentrations of enrofloxacin after single-dose oral administration in loggerhead sea turtles (*Caretta caretta*). J. Zoo. Wildl. Med. 36 (4):628-634.

Jacobson, E.R., G.R. Harman, L.K. Maxwell and E.J. Laille. 2006. Plasma concentrations of praziquantel after oral administration of single and multiple doses in loggerhead sea turtles (*Caretta caretta*). Am. J. Vet. Res. 64: 304-309.

Lai, O.R., P. Marín, P. Laricchiuta, G. Marzano, G. Crescenzo and E. Escudero. 2009. Pharmacokinetics of marbofloxacin in loggerhead sea turtles (*Caretta caretta*) after single intravenous and intramuscular doses. J. Zoo. Wildl. Med. 40(3):501-507.

Mallo, K.M., C.A. Harms, G.A. Lewbart and M.G. Papich. 2002. Pharmacokinetics of fluconazole in loggerhead sea turtles (*Caretta caretta*) after single intravenous and subcutaneous injections, and multiple subcutaneous injections. J. Zoo. Wildl. Med. 33(1):29-35.

Manire, C.A., R.P Hunter, D.E. Koch, L. Byrd and H.L. Rhinehart. 2005. Pharmacokinetics of ticarcillin in the loggerhead sea turtle (*Caretta caretta*) after single intravenous and intramuscular injections. J. Zoo. Wildl. Med. 36 (1):44-53.

Manire, C.A., H.L. Rhinehart, G.J. Pennick, D.A. Suttun, R.P. Hunter and M.G. Rinaldi. 2003. Steady-state plasma concentrations of itraconazole after oral administration in Kemp's ridley sea turtles, *Lepidochelys kempi*. J. Zoo. Wildl. Med. 34(2):171-178.

Marín, P., A. Bayón, E. Fernández-Varón, E. Escudero, C. Clavel, R. Almela and C.M. Carceles. 2008. Pharmacokinetics of danofloxacin after single dose intravenous, intramuscular and subcutaneous administration to loggerhead turtles *Caretta caretta*. Dis. Aquat. Org. 82:231-236.

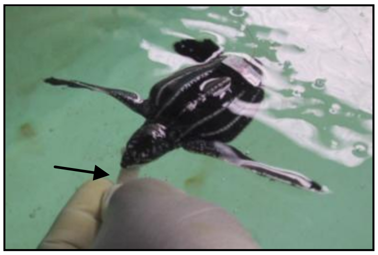
Rhinehart, H.L., C.A. Manire, L. Byrd and N.M. Garner. 2003. Use of human granulocyte colony-stimulating factor in a green sea turtle, *Chelonia mydas*. J. Herp. Med. Surg. 13(3):10-14.

Stamper, M.A., M.G. Papich, G.A. Lewbart, S.B. May, D.D. Plummer and M.K. Stoskopf. 1999. Pharmacokinetics of ceftazidime in loggerhead sea turtles (*Caretta caretta*) after single intravenous and intramuscular injections. J. Zoo. Wildl. Med. 30(1):32-35.

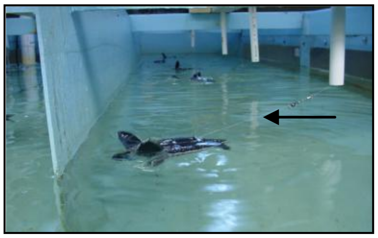
Stamper, M.A., M.G. Papich, G.A. Lewbart, S.B. May, D.D. Plummer and M.K. Stoskopf. 2003. Pharmacokinetics of florfenicol in loggerhead sea turtles (*Caretta caretta*) after single intravenous and intramuscular injections. J. Zoo. Wildl. Med. 34(1):3-8.

A Note about Leatherback Turtles

As a general rule, adult leatherback sea turtles (*Dermochelys coriacea*) should not be confined. Their enormous size (adult females encountered in the Caribbean region average 250-500 kg: Leslie et al., 1996; Boulon et al., 1996; Georges and Fossette, 2006), unique ecological requirements (e.g., deep diving and long-distance oceanic migrations: Eckert, 2006; Eckert et al., 2006; James et al., 2006; Fossette et al., 2008), and a diet based on jellyfish and other gelatinous zooplankton (Bleakney, 1965; Duron et al., 1983; Bjorndal, 1997) cannot be accommodated without specialized facilities and a highly trained and experienced staff.



A post-hatchling is hand-fed a strip of gelatin diet © M. Hastings



Post-hatchlings tethered (see arrow) in their holding tank (Hastings, 2006)

Similarly, Jones et al. (2000) emphasized that several issues had to be resolved before leatherback hatchlings could be maintained under captive conditions. In addition to a jellyfish-based diet, hatchlings suffer from bacterial and fungal infections when water quality is poor (Frayr, 1970; Birkenmeier, 1971; Foster and Chapman, 1975; Bels et al., 1988) and they fail to recognize physical barriers (Birkenmeier, 1972; Phillips, 1976; Witham, 1977; Davenport, 1987), leading to skin abrasions and infection from swimming into tank walls. A recent attempt to hone husbandry techniques for the benefit of both rehabilitation and research objectives, occurred at the University of British Columbia (Jones, 2009), where hatchlings were hand-fed at regular intervals, day and night, on an enriched gelatin-based diet. Temperature was held at 24º±1ºC, water quality was maintained by triple filtration systems (biological filter, ultraviolet filter, and protein skimmer), and water quality limits were monitored daily. Hastings (2006) describes elaborate efforts to minimize potentially fatal abrasions using a tether-and-swivel system that confined each turtle to a proscribed section of the tank. Sores and bacterial and fungal infections were treated with povidone-iodine solution; if the infection persisted, antibiotics were administered daily until the infections resolved. Notwithstanding, few hatchlings survived and necropsies revealed that most died from a "variety of systemic fungal and bacterial infections" (Jones et al., 2000).

Adults present even more significant challenges due to their great bulk and strength, and their habit of swimming repeatedly – to their serious harm – into tank walls. **Our recommendation** is that rescuers provide whatever care they can *in situ* (e.g., detangling, dehooking, cleansing, applying topical antibiotics), always with the safety of the turtle and the rescuers firmly in mind, and the turtle be released.

After a swimmer gently guides an adult tangled in a fishing line to the sloped entry of a fishing port in Roseau, Dominica, officers carefully untangle and release the turtle (photos by WIDECAST). At right, a biologist and a veterinarian enter the sea in French Guiana to cut an entangled leatherback free from the fishing net that has disabled it (photo by KWATA).

V. HOLDING ENVIRONMENT

The most important thing to consider about the holding environment is to encourage a **safe** and comfortable setting that is **simple** to care for and that is **organized** in such a way as to allow **easy** handling. This section describes all aspects of the holding environment, including tanks, temperature and lighting, life support systems, water quality, and sanitization.

Outdoor, sheltered facility,
© R. Romanowsi, Mote Marine Lab

Facility

The location of a rehabilitation facility is important and should provide security for people and animals, including adequate protection from intrusions by other domestic or wild animals.

The facility should be sited on or near a source of clean water with minimal threat to the water supply from waste generated either by the facility or by other users. Natural salt water is preferred, but artificial seawater is also a viable option. The facility should have access to medical or veterinary services and local water testing centers (if these are not included in facility design). Indoor and outdoor rehabilitation facilities are both acceptable, but in either case the design should allow for a controlled environment with proper space, lighting, and temperature; predator protection; and access to roads, parking, electricity, and water.

Indoor facility, note windows built into the tanks for viewing,
© B. Bergwerf, SCA

Maintaining Turtles in Water

Holding tanks should have unfurnished interiors, smooth interior surfaces, and be large enough to allow for unimpeded and complete submersion (Higgins, 2003). Tank diameter can range between 3-12 feet (ca. 1.0-3.7 m). Generally a water depth of 2-4 feet (0.6-1.2 m) allows the turtle to fully submerge and to reach the surface again with minimal effort, and facilitates relatively easy handling. Tanks should provide safe hiding places to reduce turtle stress. There is no "correct" number of tanks, but there should be enough tanks available to support an expected number and variety of sea turtle sizes and conditions.

Viewing window, © SCA

Considerations

- Larger tanks mean more water and more cleaning effort. On the other hand, the greater water volume promotes stable temperature and can improve water quality. Larger tanks also promote improved fitness for turtles that are able to get more exercise.
- Smaller tanks require less space and water. On the other hand, low water volume can make the system more susceptible to water quality issues such as bacteria load, temperature change, and pH fluctuations. Also, small tanks holding large turtles can lead to muscle atrophy over extended periods unless special attention is paid to exercise and/or physical therapy.
- Deeper tanks allow turtles to dive to the bottom, and this can identify buoyancy problems that may not be apparent with a large turtle in a shallow pool. On the other hand, shallow tanks offer easier access for dry docking (see *Section V: Holding Environment – Maintaining Turtles out of Water*), showering a weak turtle, and securing a large turtle to a "slant board" for tube feedings or injections instead of having to pull the turtle out of the tank.

- Tanks should be made with materials that cannot entangle the turtles, and they should be free of toxic substances and non-food items which can be ingested. Tank material should be non-corrosive, durable enough to withstand impact and rubbing from the turtle's carapace, head and flippers, smooth enough to prevent skin damage and calluses, and easily cleaned.

Materials

- <u>Glass tanks</u> can be expensive, heavy, and generally impractical for medium to large turtles; however, an advantage is that they are more resistant to scratching and etching from the turtles' beaks, shells, and claws. Glass may have to be re-siliconed periodically. When the silicone – or other sealant – peels it can be ingested, posing a risk to the turtle.
- <u>Acrylic plastic tanks</u> weigh less than glass and are easier to drill and mold into the desired shape, but acrylic may not be practical for medium-large turtles because of construction costs.
- <u>Fiberglass tanks</u> can also be molded into a variety of shapes and sizes. They are long-lasting, and a popular choice in the aquarium industry for a variety of animals. Disadvantages are that they can be relatively expensive and heavy to transport. Gel coatings can crack and peel.
- <u>Concrete tanks</u> should be constructed of appropriate grade cement material and sealed to prevent degradation when exposed to seawater. Quality sealants and treatments protect the concrete and provide smooth, cleanable surfaces. Poorly constructed cement tanks are more likely to be rough, and this can cause skin irritations, harbor bacteria, and be difficult to clean.
- <u>Polyethylene tanks</u>, like polyvinyl chloride (PVC) tanks, are easy to work with, inexpensive, lightweight, and easily molded into any shape and size. They are made of a flexible plastic and are reinforced with additional plastic, which is called the flange. If polyethylene tanks are over-filled, the flange can break and cause the tank to bow and fittings to leak.

Separation

Turtles housed together must be prevented from injuring each other. Ideally, there should be one turtle per tank (or per complete system) to avoid aggression, reduce contamination, and simplify feed monitoring. However, it is sometimes unavoidable to accommodate multiple turtles together in a single tank. If this occurs, house turtles with similar ailments/trauma in the same tank to reduce the risk of disease transfer and health complications.

Plastic fence tank separators, © VAF

Tank barriers constructed of plastic mesh or plastic fencing attached to PVC pipe, can be created to limit physical contact between turtles. Plastic mesh can be good for smaller turtles, but, if not sturdily constructed, turtles can become entangled and drown or ingest the building materials. Larger turtles can also break through the mesh, so plastic fencing is recommended for them. Tank barriers should always be constructed so that they do not inhibit proper water flow or drainage. For more detail on how to create tank dividers, see *Appendix D: Tank Dividers*.

Concerns and Warnings

Do not house a turtle with a **transmittable disease** in the same tank, or within the same system of tanks, with other turtles. See *Appendix H: Quarantine*.

If a tank needs to be **fitted with separators** because of space constraints, make sure that the tank is large enough to create divided sections with enough room for turtles to freely move.

SUMMARY OF HOLDING TANK REQUIREMENTS[7]

Size of Sea Turtle Holding Tanks

Holding tank size should be based on the size of the largest turtle in the tank, with turtle "size" measured as straight carapace length (SCL):

- Hatchlings and post-hatchlings (up to 10 cm SCL) – for one hatchling, a tank with a surface area of at least 5 times the carapace [shell] length multiplied by 2 times the carapace width plus a minimum water depth of 1 foot. For each additional turtle, increase the original surface area by 25%.
- Turtles 10-50 cm SCL – for one turtle, a tank with a surface area of at least 7 times the carapace length multiplied by 2 times the carapace width plus a minimum water depth of 2.5 feet. For each additional turtle, increase the original surface area by 50%.
- Turtles 50-65 cm SCL – for one turtle, a tank with a surface area of at least 7 times the carapace length multiplied by 2 times the carapace width, plus a minimum water depth of 3 feet. For each additional turtle, increase the original surface area by 50%.
- Turtles larger than 65 cm SCL – for one turtle, a tank with a surface area of at least 9 times the carapace length multiplied by 2 times the carapace width plus a minimum water depth of 4 feet. For each additional turtle, increase the original surface area by 100%.

Helpful calculations: 10 cm SCL turtle needs a tank with ≥ 1 square foot of surface area
45 cm SCL turtle needs a tank with ≥ 25 square feet of surface area
50 cm SCL turtle needs a tank with ≥ 31 square feet of surface area
65 cm SCL turtle needs a tank with ≥ 51 square feet of surface area
90 cm SCL turtle needs a tank with ≥ 123 square feet of surface area

3 foot diameter tank = 7 square feet of surface area
6 foot diameter tank = 28 square feet of surface area
9 foot diameter tank = 64 square feet of surface area
12 foot diameter tank = 113 square feet of surface area

EXAMPLE: **45 cm (ca. 18 in) SCL turtle should be placed in a 6 foot diameter tank**

Exceptions

- Sick or injured turtles may be held in smaller isolation tanks for medical treatment – they should be protected from desiccation and moved to an appropriate tank as soon as their health allows.
- Tanks holding mobility-impaired turtles shall meet the standard size requirements, unless it can be demonstrated that the tank is detrimental to the health or welfare of the animal.

Tank Condition

- The inside surfaces of holding tanks must be free of toxic substances, such as lead or copper paints.
- Holding tanks should not contain any non-food items that could be ingested by a turtle. Turtles will attempt to eat just about anything. Be sure that nothing except intended food is put into or falls into a tank; this includes material that could be either ingested immediately or broken apart and ingested.
- Holding tanks must be free of entangling materials. Position rocks, ledges, and other structures in the tank so that a turtle cannot become wedged or otherwise trapped underwater.
- The drains and intake pipes of holding tanks should be constructed or securely shielded such that a turtle cannot become trapped and be held underwater by them.
- Each holding tank must have enough lighting (sunlight and/or artificial lighting) to allow for easy viewing of the animal(s) in all areas of the tank. Photoperiod must be similar to natural day length. Tanks should never be artificially illuminated for more than 16 of every 24 hours.

[7] Adapted from FFWCC (2007c): "Marine Turtle Conservation Guidelines: Holding Marine Turtles in Captivity."

Maintaining Turtles out of Water

If a turtle is found to be weak and debilitated upon arrival, it may need to be maintained out of water – a scenario referred to as "dry-docking" – for a period of time. In most cases this need be only for one night in order to give the turtle time to rest and absorb any fluids which may need to be administered. Very occasionally turtles come into a facility with minimal eye response, fluid in the lungs, lockjaw, inability to swim, or too weak to lift their heads to breathe and may need to be maintained out of water for longer periods of time. In any case, dry-docking is used to allow weak turtles to rest on a padded surface, either in shallow water or not in water at all (Norton, 2005b), *while still being kept moist*.

Once the turtle can move on its own, including lifting its head to breathe, it can be placed in deeper water and be given more space for movement. When this happens, be certain that the turtle is closely monitored to ensure it does not weaken and require a return to dry-dock. *Note*: Most dry-docked turtles are initially placed in freshwater (24 hours; 48 hours maximum) for hydration and epibiota control (Choy et al., 1989). Once they regain strength and mobility, saltwater aids in buoyancy control, especially after being placed in a deeper tank. Saltwater also helps with external fungus and bacteria control, which may be exacerbated by hospital admittance or result from dry-dock rubbing.

Basic Set-Up

Small empty tanks, such as any commercially available "kiddie pool", permit easy access for care and monitoring, but consideration must be taken to make sure that the turtle cannot climb out of the pool. Regular holding tanks can also be emptied and used. In either case, turtles should be placed on a padded or soft surface to allow the turtle to expand when breathing. Lacking water, turtles must be kept misted, covered in Vaseline® or a water-based lubricant, or covered with damp towels to prevent desiccation. Severely dehydrated turtles may also need to be internally hydrated with veterinary supervision. Findings indicative of physical dehydration include sunken eyes, thick oral secretions, behavioral depression, slow and difficult-to-find heart beat, and minimal to no urination (Norton, 2005a). Air temperature should be closely monitored to prevent over-heating or dangerous chilling.

"Kiddie pool" dry-dock,
© M. Bauer, VCMSC

Shower boxes may also be constructed to hold debilitated turtles. Shower boxes are pools with foam padding lining the bottom and drains or containers underneath that allow continuous water spray over the turtle without water accumulating in the box – keeping the turtle wet and preventing it from drowning (Campbell, 1996; RAC/SPAW, 2004).

Dry-dock in shallow water,
© R. Romanowski, Mote Marine Lab

Advanced Set-Up

For a more advanced set-up, regular housing tanks can be used and filled with a small amount of filtered water, enough to suspend the turtle off the bottom. Misting units may also be attached overhead. In this case, make sure to secure the turtle on a padded surface, wrap a dive belt around its center, place it on a slight angle (such as on snorkeling fins), position a towel under the head for added support (and to aid in breathing), and keep the pad with the animal attached in place with cinder blocks (see photo) or something sturdy. To prevent abrasion, position the blocks so that the animal does not come into contact with them. This technique must be carefully constructed and monitored, or the turtle can be injured or drown. See *Appendix E: Advanced Dry-Dock Set-up*.

Concerns and Warnings

Dry-docking may last one to several days, or more, depending on the turtle's condition. During this time, the **most important variables to monitor are hydration and air temperature**. If the turtle is misted with (or partially submerged in) water, air and water temperatures should be maintained as warm, stable, and free of cool drafts. After a month of dry-docking, turtles may form bed sores on the plastron and on the chin or lower jaw areas. To decrease the chance of developing these bed sores, turtles may need to be rested on inner tubes and other soft materials *before sores develop*. The placement of these materials should be rotated to change pressure points.

Lighting and Photoperiod

Lighting is an important element for sea turtle health. For example, ultraviolet (UV) light is beneficial for the synthesis of Vitamin D, which is required for proper metabolism, allowing for calcium uptake in the intestines (George, 1997). A natural photoperiod can be reproduced by turning lights on and off when staff arrive and leave the facility, or by setting a timer to mimic daylight hours. Photoperiod should not exceed actual daylight, which is about 12-14 hours in Caribbean latitudes.

Outdoor Facilities

Outdoor facilities must limit the amount of direct sunlight to protect turtles from sunburn, inhibit algae growth in the tanks, and prevent water temperatures from getting too high. To limit direct light, fine-mesh (black) screening can be used to cover tanks. Sheltered (hiding) areas can also be created inside the holding tanks (see *Section VII: Enrichment*) to provide cover and to limit sun exposure.

Indoor Facilities

Indoor facilities can rely on windows for light, or incorporate clear fiberglass panels in the ceiling. When relying on artificial light, both type of lighting and photoperiod must be considered. We recommend a full-spectrum metal halide light because it is the closest to natural light (providing UVA and UVB), and it turns on slowly, resembling a sunrise. Care should be taken to keep the bulb 3-4 ft above the water surface, as any splashed water hitting the bulb will cause it to shatter. Newer bulbs are available that emit UV at 280-320 nm at greater distances, but these should *not be used* for routine lighting due to the potential for sunburn. A UV-meter can monitor the strength and diameter of UV output. Surface readings should not exceed natural sunlight (200-450 mw/cm^2 is a good target).

Fluorescent lights are generally inexpensive and readily available, but not all brands provide adequate UV (see Gehrmann, 2006, for photometric characteristics of selected lamps) and, in any case, fluorescent bulbs only emit UVA and UVB at distances (18 in) too limiting to be useful to sea turtles because of water splashing. See Gehrmann et al. (2004), Gehrmann (2006), and Burger et al. (2007) for a detailed discussion of artificial lighting as it relates to reptile husbandry.

To encourage proper light exposure for animals held indoors without windows or skylights, turtles can be taken outside on a regular basis: juveniles once per week (or daily if the animal is not stressed) and older turtles anywhere from once per week to once per month. Time outside should be limited to 15-30 minutes. When outdoors, keep the turtles properly moistened to prevent over-heating or excessive drying. If the animals are placed in water, the water should be fresh, clean, and not allowed to over-heat. Turtles taken outdoors for sunlight must be in stable condition (since movement can cause additional stress), and supervised when outside. If access to direct sunlight is insufficient, a veterinarian may recommend dietary supplements of calcium and vitamin D (see *Section VI: Diet*).

Temperature Control

Surface Area and Volume

Surface area and volume are directly related to tank size, and the relationship between surface area and volume is important for temperature regulation. Increased surface area allows for more exchange between water and air; increased volume means it will take much more energy and time to change the water temperature of a system. The effects of surface area and volume on water temperature regulation depend on how the system is designed. If ambient air temperature is expected to control water temperature, then low volume systems will be much more susceptible to temperature fluctuations than high volume systems. If heaters and/or chillers are used to control water temperatures, then surface area and volume of the system will be important factors in determining the energy requirements of the equipment. *Note*: Make sure the turtles do not have direct access to heaters.

Water Temperature

Water temperature is one of the most important variables to control for proper health. Like all reptiles, sea turtles rely primarily on the surrounding ("ambient") temperature to promote physiological norms that enable full range of movement, normal body functions, etc. The optimal temperature range for stable health, rehabilitation, and bodily function varies slightly depending on the turtle's condition and size, but is generally 25º-30ºC (77º-86ºF) (Higgins, 2003; Campbell, 1996).

Temperatures kept too high, especially in closed systems, can promote rapid bacterial growth, behavioral lethargy, and hyperthermic stress. Temperatures kept too low can make sea turtles susceptible to pathogens. To compensate for temperatures that fluctuate in response to air conditioning, heat, sunlight, and/or natural ambient temperature affecting the rehabilitation environment, several options are available. These include the use or adjustment of ambient air temperature, spray bars, and/or chillers and heaters. Tank and pipe insulation (closed cell neoprene) will help tanks hold their temperature. *Note*: The operation of water pumps can significantly increase holding tank temperature.

Air Temperature

Air temperature can have a strong effect on water temperature, depending on how a holding system is designed. If ambient air temperature is expected to control water temperature, then interior holding rooms should be well-ventilated and temperature-controlled. Depending on the need, sea turtle holding rooms should have circulating fans, air conditioning, and/or heaters.

Spray Bars

Spray bars are modified pipe extensions that can be added to a tank's return line (or fill line). Made of PVC, these pipes have a series of slits cut into them so that water will spray out and splash the water's surface in the tank. A spray bar is most efficient if it is spraying *across* the water's surface in the tank, rather than down into the water (as shown here). The spray and splash action facilitates temperature exchange between air and water, which can promote heat loss (cooling) in systems where water temperature varies from the ambient air temperature. *Note*: Be careful not to create misting – this can lead to bacteria inhalation.

Spray bar
Note: Increase the effect by spraying *across* the water.

Chillers and Heaters

Chillers are mechanical devices that can be added to the water circulation system to lower water temperatures. These include in-line internal chiller coils, as well as drop-in coils that can be placed into the sump or tank. Although effective at controlling and maintaining cool temperatures, they require electricity, maintenance, and expense, and can have devastating effects if the thermostats fail, causing the water temperature to become dangerously cold.

In air-conditioned facilities, tanks may need to be heated. Heaters can be plumbed in-line or added directly into the tank or sump. Heaters, like chillers, can have ruinous effects if the thermostat fails, causing water temperature to rise to dangerous, even fatal, levels. To determine the size of heater needed, the maximum temperature without a controller can be tested before a turtle is put in the system. If the temperature rises above optimal, the heater should be down-sized as a precaution.

Concerns and Warnings

Whenever adding fixtures to a tank, keep in mind that sea turtles may chew on them! **Reduce this risk** by placing fixtures in inaccessible locations, such as a sump or skimmer box. Whenever chillers or heaters are in use, there should be some **redundancy in design** to include warning alarms or fail-safe systems to disable the chiller (or heater) in the event of failure.

Life Support Systems

Pumps and Basic Plumbing

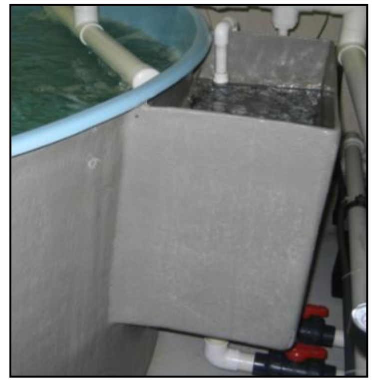
Centrifugal pump,
© S. May, NCA-PKS

Pump: A pump is a basic requirement in a tank where water movement is desired (see *Appendix F: Water System Diagrams*). Filters and other tools can be combined with the pump to provide other essential functions, such as cleaning. *Centrifugal pumps* are commonly used with saltwater tanks because they require little maintenance and can move high volumes of water with less energy. One pump can run several life support components, or several pumps can be used to run components individually. Tank volume, life support components, system head pressure, and biomass (number of turtles housed in the system) all need to be considered in pump size selection. Pump manufacturers often provide a pump curve to help you make your selection. Pumps can be expensive, but are necessary for many applications whether the system is closed, flow-through, or features static water that needs to be moved in and out of a tank quickly. *Note*: Pump vibration may be a source of stress. Consider mounting pumps and plumbing on rubber bushings or neoprene in an attempt to reduce the noise transfer.

Plumbing: Polyvinyl chloride (PVC) pipe is one of the most commonly used hard plastic pipes in the aquarium industry. PVC is known for its durability, light weight, low cost, versatility, and ease of use. PVC may become brittle and crack after long-term UV exposure, so when selecting the pipe needed for a system, consider carefully the amount of direct sunlight and the amount of pressure in the lines. PVC can be painted, covered or insulated, as needed, to reduce heat loss or gain and to provide UV protection. PVC pipe can be sized (using PVC cutters or a hand saw), plumbed together through the use of various fittings and PVC glue or cement, and crafted into almost any configuration.

Sump: Sumps are containers, often made from plastic, cement or fiberglass, into which water is gravity-fed. Sumps are generally placed under a tank in order to facilitate the gravity-feed, but they can be placed anywhere and will function as long as the water level in the tank is higher than the water level in the sump. Adding a sump to the system will increase water volume, as well as provide a place for gravity driven filtration (e.g., bag filters) to occur and life support components to originate. After water is gravity-fed from a tank to a sump, a pump can pull water from the sump, send it through filtration, and return it to the tank and/or back to the sump, depending on the filters used. Individual tanks may have their own sumps, or several tanks can share one main sump, thereby sharing life support systems and tank water. Large sumps can also function as water storage basins for an incoming water supply or a place to mix synthetic salt water; the water can be pumped from the basin to the systems, as needed. Finally, surface skimming (to reduce floating waste) can be achieved through tank overflows in a gravity-driven system that utilizes a sump, or through pump suction in a pressurized system.

Skimmer Box: Skimmer boxes are sometimes similar to sumps, but they are not always gravity-driven. Skimmer boxes are smaller than sumps, and are physically attached to a tank. Surface skimming is effective at filtering waste materials that collect at, or very near, the surface. Skimmer boxes also divide the intake pressure, reducing the chance that a weak or small turtle will become stuck to an intake on the tank bottom and drown. Ideally, each system should have multiple bottom intakes *and* a skimmer box.



Skimmer box

Saltwater: Saltwater can originate from a natural source or, if clean seawater is unavailable, can be made from freshwater mixed with a commercially available synthetic salt. Each company provides directions on how much salt mix to use per volume of water. Freshwater can be mixed with synthetic salt in a variety of water storage containers (e.g., sump, basin) and can be mixed manually or by using a submersible or external pump. Depending on the cleanliness of the salt mix, the mixed water can then be run through mechanical filtration before it is sent to the tanks. *Note:* Synthetic salts can be costly and shipments often arrive in large (28-62 lb / 13-23 kg) bags or boxes that, in bulk, require large pallets that may be difficult for some facilities to maneuver or afford.

Filters

If turtles are kept in tanks with static saltwater (meaning that there is no filtration), tank water should be changed daily. This can be very labor intensive. Adding filtration to a tank reduces labor, saves maintenance time, and provides water conditions more suitable for healing and recovery. There are three main filter types – biological, mechanical, and chemical – and all of them function when a pump or gravity-fed system moves water through them. Some filters fall into more than one category, and some serve more than one function. For the cleanest water, combine different types of filters. The possible combinations are limitless, and depend on the needs of the animals and of the facility.

“Bio-tower” with bio-ball media; a biological filter, © S. May, NCA-PKS

<u>Biological Filters</u>

Note: Biological filtration (which can include fluidized beds, low space bioreactors, bio-filter tanks, or media in a mesh bag placed in a sump or skimmer box) can be useful for sea turtles, but it is definitely less important than mechanical and chemical filtration (descriptions follow). For sea turtles, biological filtration is not necessary for flow-through set-ups and its use limits the use of some chemical sterilization. Remember that bleaching the system between sea turtles will most likely kill the bacterial bed in the biological filter, which must then be re-established.

Biological filtration uses living bacteria to remove toxic compounds from the water and can also improve gas exchange. Biological filters rely on a process called "nitrification", which can take place on a variety of substrates (*in-tank substrate is not recommended for sea turtles because it can be ingested*) and in a variety of structures, and removes harmful wastes by converting them from ammonia to nitrite, and nitrite to a less toxic nitrate. With a filter of the correct size and the proper amount of media (e.g., bio-balls, bio-wheels, bio-rings, bio-stars), the system will remain properly cycled and nitrogen balanced, assuming that the waste carrying capacity has not been reached or disabled (e.g., become clogged or anoxic).

Mechanical filtration should be plumbed prior to the biological filter to allow the cleanest water to move through the system and to help keep the bacteria free from excess debris. Only the nitrate levels will increase once the filter is established. It is possible to use a mechanical filter as a biological filter, but the system must be run at a reduced rate and cleaning the filter may kill the "good" bacteria, requiring that the system be recycled more often than would otherwise be necessary.

<u>Mechanical Filters</u>

Mechanical filters collect particulate matter, and the particle sizes are determined by the filter media. The flow rates and expected biological loads of the system will determine the optimal pump and mechanical filter selections for a holding system.

Sand Filters: Sand filters are one of the most common forms of mechanical filtration and are generally used for larger volume tanks. A pump pushes water through the top of the filter and through the sand, and the waste is captured in the top layers of sand. The filter can then be rinsed or backwashed, the latter reverses the flow of water through the filter to suspend the waste and dumps the water out of the system. A multi-port valve (see insert) on the filter controls the water direction and stays in the "filter" position during periods of normal operation.

Sand filter, © J. Bluvias
Insert: Multi-port valve,
© S. May, NCA-PKS

Check with the filter manufacturer for the type and amount of sand or gravel needed, recommended backwash frequency, and pump size for proper efficiency. *Note*: Excessive waste load in the filter reduces flow. A pressure gauge on the filter can help determine when the filter needs to be rinsed or backwashed. Over time the sand will "channel", which reduces filtration capacity. The frequency of sand replacement can be reduced by regular stirring of the sand, which prevents channeling.

Canister Filters: With the use of a pump, canister filters function under pressure by forcing water over a pleated cartridge or some other media that can be cleaned and/or replaced when needed. As the media becomes clogged, the system flow may be reduced. A pressure gauge can be used to monitor the pressure in the filter, which increases when the filter is clogged and needs to be cleaned or replaced. Usually the flow rate in this filter is too high for it to act as a biological filter; thus, when a canister filter is used in a closed system, we recommend that there be another source of biological filtration.

Bag filters, © S. May, NCA-PKS

Bag Filters: Bag filters are relatively inexpensive solid waste removers. They are available in a variety of materials that remove an array of micron-sized materials. Bag filters can be cleaned and reused, but eventually must be replaced. *Note*: If the bags are not maintained properly, they can overflow and back up a system. Also, be aware that the bag filter can fall off and block the pump suction, causing the tank to overflow and possibly burn out the pump. The smaller the filtration pores in the bag the better the filtration, but the faster the bag fills up and the more often it has to be cleaned. Bag filters can be directly connected to a water pump for in-line filtering, or used in conjunction with a skimmer box, skimmer drain, or sump for gravity-induced flow through the bag.

Chemical Filters

Activated Carbon Filters: Carbon filters can be added to a system or carbon bags can be inserted into other (sand, cartridge) filtration media, or put in the sump. Granular activated carbon can remove a variety of substances from tank water, including metals, antibiotics, organic wastes, and other foreign chemicals. Many of these substances can contribute to discoloration of the water, so use of activated carbon in filters or sumps can greatly improve water quality and appearance.

Protein Skimmer: A protein skimmer is a pump-driven filter that utilizes small air bubbles to “strip” dissolved organics from the water. Typically, air is injected at or near the bottom of a column of water. As the bubbles rise through the water, the air-stripping process creates a thick, dirty foam on the surface that can be collected and removed. This process can also remove some suspended particles, thus serving as a mechanical filter, as well. Efficiency of the protein skimmer is based on its size, pump selection, contact time, and bubble size. Protein skimmers can be very useful in maintaining clean water systems, but installation and operation requires technical knowledge, planning and skill.

Protein skimmer,
© S. May, NCA-PKS

Sterilizers

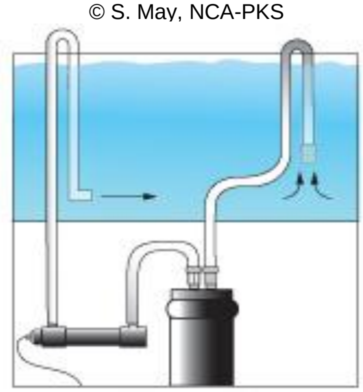
Sterilization filtration can greatly help in disease control and in removing harmful bacteria, viruses, and fungi from a system, but it must not be so powerful that it removes beneficial bacteria when biological filters are used (Moe, 1992).

UV sterilizer,
© S. May, NCA-PKS

Ultraviolet (UV) Light Sterilizer

Ultraviolet light is a spectrum of light just below the range visible to the human eye. UV-C (200-280 nm) is the most lethal range as a germicidal disinfectant and is capable of altering a living microorganism's DNA, keeping it from reproducing. The installation of pump-driven UV sterilizers in a water system can be effective in killing free-floating bacteria, viruses, and other microbes.

Insuring optimum flow rates through UV sterilizers is important in determining their effectiveness. In simplest terms, water is exposed to a UV bulb and the efficiency of the sterilizer depends on the age and wattage of the bulb, exposure time though the unit (pump size), and deposits on the quartz sleeve. The bulb must be periodically replaced (at least every six months) and the sleeve cleaned often. If water is not moving through the unit, the UV bulb should be turned off in order to not burn out the bulb and damage the sleeve. *Note*: Solid waste should be removed from the water before it enters the UV sterilizer.



UV sterilizer diagram. Source: http://www.emperoraquatics-aquarium.com provides user-friendly background on a variety of aquarium filters and UV sterilizers.

Ozone

Ozone (O_3) can be created by an ozone generator, and the oxidation ability of ozone can be exploited to kill many harmful organisms, including bacteria and viruses. There is debate about the relative safety of using ozone *versus* chlorine for disinfection and each technique has its advantages and disadvantages.

Ozone tower, © S. May, NCA-PKS

When using ozone, proper monitoring of the water using ORP probes (ORP, or "oxidation-reduction potential", is a measure of the water's ability to break down contaminants) is essential for determining proper dosing levels and for early detection of problems. Dosing levels and appropriate ORP monitoring ranges are available in the literature, but should be carefully designed with the life support system and require professional consultation.

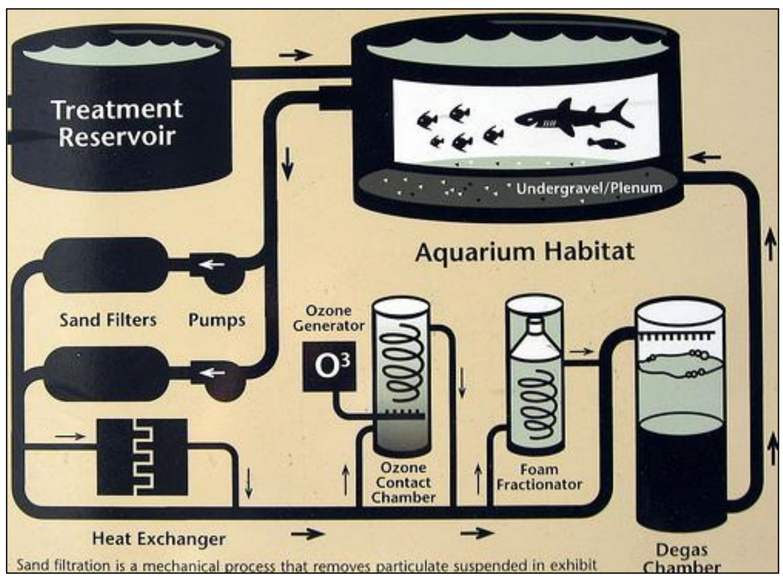
Depending on the ozone delivery method (e.g., contact chambers, protein skimmers) and system design, ambient air ozone monitors may be necessary. These monitors will alarm if atmospheric ozone is present in the facility and poses a hazard to human health. Both ozone generation systems and ozone monitors can be expensive and require regular professional maintenance to perform effectively.

Chlorine

Chlorine is a common disinfectant in water purification systems, swimming pools, and even aquatic systems housing marine mammals and sea turtles. Nevertheless, chlorine can be a very dangerous chemical to handle.

Always seek qualified help and consultation prior to using chlorine for sterilization, and remember that chlorine storage, application and monitoring must be carefully controlled.

Campbell (1996) and Wyneken et al. (2006) caution against free chlorine levels greater than 1.0 ppm, and Florida "Sea Turtle Conservation Guidelines" state that "free chlorine levels should be maintained no higher than 1.0 ppm and no lower than 0.5 ppm" in sea turtle tanks (FFWCC, 2007c).



In this diagram multiple filter types are utilized, including ozone.
Source: http://www.reefbuilders.com/

Chlorine should be introduced in an area where it can be mixed and evenly distributed to the filtration system at a point just before the water is returned to the main tank (such as in a sump or skimmer box). A chemical injector such as a diaphragm pump or peristaltic pump may be used for injection, but the chlorine may also be added by hand.

Concerns and Warnings

Designing a life support system requires knowledge, experience, and planning. These factors, combined with location and budget, will determine the best water holding system for a particular place and its expected needs. Keep in mind that, just because a particular piece of equipment was presented and explained in a previous section, *every* piece of equipment does *not* need to be used to maintain a stable environment. Keep it simple! More equipment costs more money, is more difficult to monitor and service, and can cause unnecessary complexity. Make informed decisions. For example, sea turtles have high waste production, so adding mechanical filtration to a tank may have more overall benefits than adding a biological or chemical filter. UV sterilization, ozone, and chlorine all pose significant dangers and should not be incorporated into your design without expert consultation. **In every case**, *proper disposal protocols for spent filters, waste water, etc. must be followed*.

In general, the following should be kept in mind:

Biological Filters: If the media (i.e., bio-balls, bio-wheels, bio-rings, bio-stars) find their way into the tank, they can be ingested and cause intestinal impaction (and potentially death) to captive turtles.

Mechanical Filters: Filters such as canister filters and sand filters operate under high pressures and extreme caution should be used when maintaining these filters. Pumps should always be turned off and air vents should be opened before the filters are opened for routine maintenance.

UV Sterilizers: Staring directly into a UV bulb can be damaging to the human eye. During maintenance procedures, the pump should be turned off and the bulb unplugged. Sterilization by UV irradiation may not be as efficient as sterilization by ozone, but it is considered safer and may be a more practical choice for smaller volume systems.

Ozone: Ozone released in a confined space can be fatal, and at the very least may cause headaches, eye irritations, and breathing trouble (Hall et al., 1992). Watch for leaks and do not use ozone in excess. Sometimes alarms fail! Extreme caution should always be used, especially if the very distinct odor of ozone becomes apparent in the facility.

Chlorine: Extreme caution is warranted when using chlorine in a poorly ventilated area where the toxic gas can irritate the respiratory system and eyes, as well as the skin if direct contact is made (Winder, 2001). Proper eye wear, gloves, and masks should be worn as a precaution. Store chlorine in a cool, shaded area; the potency of this chemical is reduced over time with heat exposure. Chlorine is pH sensitive; therefore, the lower the pH, the more effective the sterilization.

Water System Set-up

Successful rehabilitation of marine animals requires a consistent supply of clean seawater. This can be provided through a variety of water system designs. The designs are generally described based on the source of saltwater and how it circulates: open, or flow-through system; semi-open system; or closed system. See *Appendix F: Water System Diagrams*. *Note*: If the facility is not located on the coast, it may be necessary to transport water to storage tanks (e.g., Bentivegna, 2004).

Open, or Flow-through System

Flow-through systems generally use a pump to pull water from a natural water source and make use of valves to distribute the water where it is needed. The water is then returned to a common line before being discharged back to the source (e.g., open water, saltwater well). Because water passes through each tank only once before it is returned to its natural source, an open system may not need any type of filtration or wastewater treatment. However, turnover rate is still important to system design. Turnover rate is defined as the rate at which the water in the system is completely changed, and it is directly related to the flow rate provided by the system's pump(s).

If filtration is desired and/or mandated by law (to protect source waters), it should be added between the pump and the holding tanks or at the water inlet point. Water systems that rely on natural sources should be prepared for problems associated with intake lines. These are most often the result of biofouling (e.g., barnacles), but it is also possible for marine debris and even fish to clog the pipes. To minimize this risk, there are some basic design criteria that should be consulted for construction and installation of intake lines. These include removable intake screens to prevent large items from entering the pipe, piping designs that promote cleaning and flushing of lines, and/or redundant piping (at least two sets of intake lines) to facilitate routine maintenance procedures as well as emergency protocols. In addition, there should be an emergency plan in place to handle the possibility of contamination of the natural water source, such that it would be unusable for a period of time.

Semi-open System

Semi-open systems, sometimes called semi-closed systems, also rely on continuous replacement of water, but at a lower rate than in open systems. Semi-open systems usually have a natural water source that is brought into a basin or large tank, filtered with mechanical and/or chemical filtration, and then moved into the system as needed. When water is moved back out of the system, such as during a water change or backwash, the water is either recycled in a recovery basin or returned (drained, pumped) to its natural source. Semi-open systems are basically open systems that do not run on flow-through 100% of the time. Semi-open systems are generally more costly than open systems due to the need for more circulation pumps and filtration. However, the semi-open design has advantages for water management, including more opportunity to control water quality parameters (e.g., temperature, salinity, pH), and is better able to handle short-term interruptions of natural water sources.

Closed System

Closed systems are designed to re-circulate and filter seawater to maintain optimal water quality conditions. System water does not flow-through, but instead is continually filtered and cleaned. New water is only needed when water is drained from the system during tank maintenance or when evaporation causes water levels to drop. It is normally advisable not to send filter backwash or drained water from a closed system directly to a natural water source and local regulations often prevent this practice. If local sewer and/or water treatment is available, these may be good options for the waste water. Alternatively, waste water can be sent to a recovery basin to be filtered, sterilized, and reused. *Note*: Be aware of all regulatory requirements concerning treatment and/or discharge of water.

Closed systems are generally more expensive to construct and maintain, but they use less water and provide more control over water parameters than other designs. These systems may require emergency electrical power or supplemental water sources to maintain animals during catastrophic events.

Closed systems are ideal for facilities with limited water access and provide advantages in reducing disease transmission. A closed system can be comprised of several tanks plumbed to a single life support system, or a single tank with its own life support.

<u>In all cases</u>, drains and pipes must be securely shielded to prevent a turtle from becoming trapped or held underwater.

Water Quality Testing

Water quality directly affects the degree to which rehabilitation can be successful. All parameters that may affect the health and well-being of sea turtles housed in the facility should be tested and monitored as often as necessary. Temperature, salinity, pH, ammonia, nitrite, and nitrate are easy to monitor and should be tested and recorded daily so that trends can be observed (once the tanks are stable, monitoring once every 1-2 weeks is sufficient). Other water quality parameters, such as ORP, chlorine, or fecal coliforms, should be monitored as needed and as appropriate to the particular type of water holding system and filtration. For flow-through and semi-open systems, the water source should be tested at least once every 1-2 weeks. Tank water for semi-open and closed systems should be monitored daily or weekly depending on the equipment and sterilization methods used.

Water Temperature

There are a variety of ways to measure water temperature including, but not limited to, digital thermometers and controllers with submersible probes, temperature pens, infrared temperature scanners, and hand-held (portable) YSI meters. Portable meters can be costly, but, when properly calibrated and maintained, offer the advantage of also measuring other parameters, including ORP, salinity, conductivity, and/or pH. One disadvantage of portable meters that are moved between tanks is that they can compromise quarantine protocols. If turtles are isolated from others due to disease or other reasons requiring precautions (see *Appendix H: Quarantine*), moving portable meters among tanks must be done carefully. Water temperature can be manipulated with water heaters, air heaters, chillers, air conditioners, spray bars, and/or ventilation fans to maintain an optimal temperature of 25º-30ºC (77º-86ºF) (Campbell, 1996; Higgins, 2003; Wyneken et al., 2006). *Note*: Turtles bite at everything! Skimmer boxes provide a safe place for thermometers that are kept continuously in the tank.

Salinity

Salinity can be measured using a handheld YSI meter or a less expensive refractometer, hydrometer, or pinpoint salinity meter. Brackish to full strength saltwater (14-35 ppt) may be used (Higgins, 2003), but optimal values range from 20-35 ppt (FFWCC, 2007c), except during a veterinarian-guided and temporary freshwater submersion. If salinity gets too high, add freshwater for adjustment.

pH

pH can be measured with a handheld YSI meter or with a less expensive pH pen, pH pinpoint meter, or pH strip (litmus paper). The pH of natural saltwater, varying with location and water conditions, is typically 7.8 to 8.3. For sea turtles, the pH should be between 7.5 and 8.5 (FFWCC, 2007c). pH decline is often taken as an indicator of declining water quality due to increased bio-load.

Chlorine

For health and safety, regular testing is needed to ensure proper levels are maintained, which can be up to twice a day, every day. A DPD type test may be used to measure both free and total chlorine (total chlorine = free chlorine + combined chlorine). The DPD test is the most common type of chlorine test and utilizes two reagents (test chemicals). The test solution turns reddish in the presence of chlorinated water; the darker it turns, the more chlorine is in the water. Free chlorine should be maintained at a level between 0.5-1.0 ppm (FFWCC, 2007c) – higher levels can irritate a sea turtle's eyes (Campbell, 1996).

Chlorine and sat water testing equipment

Sanitization

Most sea turtles produce solid waste at least once each day, which accumulates on the tank bottom along with excess food debris. Dirty water can compromise health, inhibit wound healing, cause eye inflammation, and exacerbate mycotic and bacterial infection (RAC-SPA, 1999). It is important that the flow dynamics of the life support system be designed to properly remove debris and contaminants from the tank(s). Frequency of cleaning will vary with each type of system (e.g., a tank with filtration will require fewer water changes than a tank with static water). In tanks with static water, waste products must be removed manually, generally by netting or by using a hose to siphon waste from the tank. A pump suction line that pulls from the bottom of the tank can be useful in the removal of debris. In this case a screen should be designed to prevent large material from being entrained in the pump suction line, and to prevent blockage of flow by (and possible entrapment of) a turtle.

Tank cleaning using a scrubber brush

Water Changes

Tank water should always be clear. Water changes can be based on many factors, but often a decline in pH and an increase in nitrates will indicate the need for a water change. In non-biologically filtered tanks, ammonia can be used as an indicator.

The condition of incoming water, including temperature variance, must be considered carefully *before* it is added to the tank. Environmental fluctuations (e.g., water temperature, clarity) may cause serious stress to recovering turtles. Moreover, poor quality water means more frequent tank cleaning, which is also a source of stress to the turtle. Depending on the condition of the turtle and the nature of the cleansing, the turtle can either remain in or be removed from the tank during cleaning. If the former, always take precautions not to startle the turtle; if the latter, the turtle should be comfortable and not allowed to dry out.

Sanitization equipment should be properly cleaned and stored

Cleaning Utensils

Always sanitize hands and utensils between tanks to minimize the risk of cross-contamination. Utensils can be soaked in a diluted bleach solution and rinsed as necessary. Because the extent of a turtle's injury or illness is sometimes not completely known, always take strong precautions regarding sanitation. *Note*: Rotate disinfectants every several months to prevent resistance.

Discharging Waste Water

Waste water disposal is an issue that should be addressed during the water system planning and design. Any concentrated waste water, such as that from filter backwash, poses a potential threat to natural waters. In general, it is preferable to discharge to a sanitary sewer system or to treat the waste water (e.g., using ozone, chlorination and de-chlorination, or carbon filtration) prior to release.

When a turtle is released (or dies), the tank must be properly sterilized prior to it being re-used. Chlorine bleach (sodium hypochlorite) may be used to clean/soak tanks, aquaria, and any related equipment for 15-20 minutes in a 3% solution (1 oz [30 ml] beach per one quart of water) (J. Wyneken, FAU, in litt. 2008). Rinse the tank thoroughly with clean fresh or salt water.

Concerns and Warnings

Sodium thiosulfate should be kept on hand if you use chlorine or ozone for disinfection. This product is relatively safe to handle and poses little risk to aquatic animals. If there is an **accidental overdose** of chlorine or ozone in the water system, sodium thiosulfate quickly neutralizes chlorine residuals and reduces aquatic ozone levels. De-chlorination protocols should include dosing levels for thiosulfate.

Safeguard your source water! Waste water poses a potential threat to natural waters. Chlorinated waste water is of most concern, and its discharge into natural waters is likely to be illegal. In general, it is preferable to discharge to a sanitary sewer system or somehow treat or clean the waste water (e.g., using ozone, chlorination and de-chlorination, or carbon filtration) prior to release.

For more information on holding environments, see:

Florida Fish and Wildlife Conservation Commission "Marine Turtle Conservation Guidelines" (FFWCC, 2007a): http://myfwc.com/wildlifehabitats/managed/sea-turtles/conservation-guidelines/

UNEP Mediterranean Action Plan "Guidelines to Improve the Involvement of Marine Rescue Centers for Marine Turtles, Section VI: Maintenance of Sea Turtles in a Convalescent Pool" (RAC/SPA, 2004): http://www.rac-spa.org/sites/default/files/doc_turtles/glrs.pdf

Biology of Sea Turtles Volume II, "Chapter 16: Sea Turtle Husbandry" (Higgins, 2003)

SUMMARY OF WATER QUALITY STANDARDS[8]

Water Quality Standards for Sea Turtle Holding Tanks

- Salinity should be maintained between 20-35 ppt. Turtles undergoing medical treatment may be kept at salinity levels above or below this range as prescribed by the attending veterinarian.
- Water pH should be maintained between 7.5 and 8.5.
- Water temperatures should be maintained between 25º-30ºC (77º-86ºF). The use of shades on out-door tanks can help prevent tank water temperatures from becoming too warm. At facilities where tank water temperatures drop below 20ºC (68ºF), heating units should be used to maintain accept-able temperatures.
- If chlorine is used to treat the water, free chlorine levels should be maintained no higher than 1.0 ppm and no lower than 0.5 ppm (depending on the species and its sensitivity to chlorine).
- Coliform bacteria (MPN) must not exceed 1000/100ml of water [admittedly a difficult task in small systems]. Steps should be taken (e.g., adequate filtration, removing suspended material/ feces/ left-over food, use of an appropriate sanitizing chemicals such as chlorine, high turnover rate with fresh, uncontaminated seawater) to prevent the conditions in which coliform bacteria proliferate.
- Unless a turtle is being treated with a substance that inadvertently reduces clarity (e.g., the use of mineral oil as part of medical treatment), tank water should always be clear.
- No chemical may be used to treat water in a tank housing sea turtles if the chemical is not safely in-gestible by the animals at the dilution required for effective treatment.
- Any facility housing sea turtles must be able to provide adequate water quantity under normal and emergency conditions. Dry-docking should occur only if determined by a veterinarian. If a turtle is removed from its tank, it must be protected from drying out and other damage, and kept in a temper-ature controlled environment to ensure that its core temperature is not chilled or over-heated.
- Water disposal shall be in accordance with all applicable laws and regulations.

[8] Adapted from FFWCC (2007c): "Marine Turtle Conservation Guidelines: Holding Marine Turtles in Captivity."

VI. DIET

Food Selection

Significant gaps remain in our understanding of the foraging ecology of wild sea turtles, as well as of the development and duration of diet preferences. Similarly, there are gaps in our understanding of proper nutrition regimes for sea turtles in captivity (Goldman et al., 1998). In general, Caribbean sea turtles are either herbivorous (green turtle), specializing on seagrass; broadly omnivorous (loggerhead, ridley turtles); or more narrowly omnivorous, specializing on sponges (hawksbill) or gelatinous prey including jellyfish, ctenophores and tunicates (leatherback) (Bjorndal, 1997). When first presented to a rehabilitation facility, turtles are often malnourished and/or emaciated. Stabilizing a sea turtle's electrolytes is the first concern. Food intake by volume and caloric intake should rise over weeks. An atrophied liver may not have the necessary enzymes to deal with digestion and a rapid fat/protein intake in a debilitated animal can do more damage than good. Most reptiles are adapted to long periods of fasting. When weight gain becomes a priority, food should be selected based on calories, fat and protein, as well as on vitamin and mineral ratios. Because turtles started on one diet often resist changing to other items, <u>it is essential to offer a healthy, balanced, and varied diet from the start</u>, and then change only the proportions of each component of the diet over time, as necessary.

Sea turtles are generally not discriminating in the foods they eat, and captive individuals are often fed a selection of locally available vegetables mixed with fish and invertebrates. Commercial pelleted turtle feed, modified trout chow, and gelatin-based diets have all been used with varied success. Squid is often used because it is widely available, sea turtles readily accept it, and it is relatively inexpensive compared to shrimp, crabs and other natural foods. Squid can be effectively used to coax turtles to eat or to deliver medication; **however**, *squid is high in phosphorous (P) and low in calcium (Ca) and should only be used for these purposes* and never as the only protein source in a long-term diet. Studies documenting Ca:P plasma ratios in wild and captive sea turtles demonstrate that imbalances in these ratios can cause metabolic bone disease (Fowler, 1986; Goldman et al., 1998; Norton, 2005a). The optimum Ca:P ratios for most sea turtle species have yet to be determined, but foods known to have ratios between 1:1 and 1:2 are preferred (George, 1997). Ca:P ratios in sea turtle plasma can be used to monitor health in captive turtles, but this is more of a concern for sea turtles in long-term care (e.g., aquarium residents). Still, the better the diet reflects a species' natural foods, the more effective it is in maintaining the animal's "fitness" for release.

It is strongly recommended that sea turtles be offered an assortment of foods. This not only promotes proper nutrition, but more closely resembles the variety of foods and prey items that they would encounter and consume in the wild (Pough, 1992). For more detail on specialized diets and recipes, see *Appendix G: Food Guide*.

Note: Defecation and especially urination can be difficult to observe. Nevertheless, during periods of active feeding caregivers should always confirm that turtles are successfully defecating.

Food Quantity

The amount of food provided per meal is dependent upon factors such as physical condition, blood values, size (length, weight), species, and daily frequency of feedings. "Proper" feeding of a particular turtle is based, in part, on experience and on observation of an individual animal's behavior and condition. Because each sea turtle will arrive with a different weight, body condition, illness(es), and nutritional needs, staff and veterinarians should consult on the desired daily ration and feeding frequency. As a general guide, sea turtles should be fed 1-5% of their body weight on a daily basis, tending to the lower percentage for maintenance and the higher percentage for sick, emaciated and/or younger turtles. A diet of 5% body weight may be difficult for an emaciated turtle to handle at first, so meals should *start small* and gradually be raised to the prescribed amount. For turtles gaining weight and in transition to a maintenance diet, meals should be slowly reduced to 1-1.5% of body weight.

As a general guide, turtles are fed 1 to 3 times per day. The number of meals is dependent upon the amount of food desirable for the turtle to consume, as well as the frequency that any medication(s) need to be given. Meals can be scheduled to correspond with oral medications that need to be given more than once each day, or for medications that need to be administered at separate times. Additional feedings may be necessary for turtles that require more food, or to encourage reluctant eaters. For these and other reasons, several smaller meals are generally preferred over fewer larger meals. Larger food items should be cut into smaller pieces to minimize the risk of intestinal blockage.

Weighing food

Each meal should be properly weighed and recorded for each turtle prior to feeding, and all uneaten food should be collected and discarded. The amounts and types of foods that are offered should also be recorded for each turtle, in addition to how much and what was eaten, and any relevant behavioral notes. See *Appendix B: Sample Documentation Forms*.

Food Storage and Preparation

Preparing food

Every facility should have a designated food storage and preparation area with a functional freezer and refrigerator. Vegetables and certain medications may also need to be stored in a refrigerated environment. Bernard and Allen (2002) note that, "Nutrient losses may result, and fish may serve as a medium for bacterial growth if improperly thawed. The nutritional integrity of the fish is best maintained during thawing when they are placed loosely covered in a refrigerated area and thawed as close in time to feeding as possible. Fish may be safely thawed under refrigeration at 2.0º-3.5°C. Other thawing methods (microwave, running water) should be used in emergency situations only. Thawing at room temperature is not advised and will hasten microbial growth and oxidative tissue damage, adversely affecting quality and palatability." They also provide tabulated summaries of energy, major mineral, and trace mineral content of whole fish and marine invertebrates.

Prepared food for the day, stored in walk-in refrigerator

Frozen food should be thawed in a refrigerator. On the day of feeding, thawed food is taken out of the refrigerator, weighed, cut, allocated to designated storage bins for individual turtles, and then placed back into the refrigerator until the scheduled feeding time. Transporting food on ice is one way to ensure that it remains at an optimal temperature.

If seafood items are not used immediately upon catch or purchase, they can be frozen for later use. Some experts recommend that seafood, including fresh catches, be kept frozen prior to use to slow the growth of potentially harmful bacteria and kill intermediate stages of parasites. Others contend that some use of fresh seafood is acceptable in diets; e.g., live crabs are useful for maintaining natural diets and conditioning turtles for release. Never re-freeze food that has been prepared but not eaten.

Concerns and Warnings

To **reduce bacteria** growth, feed immediately once food is prepared and avoid prolonged exposure to ambient temperatures. **Tools** – including strainers, knives, food containers, cutting boards – should be washed with soap and water and disinfected after every use, and then stored properly.

SUMMARY OF FOOD AND FEEDING[9]

Food and Feeding

- Food must be provided in an unspoiled and uncontaminated condition. Food should either be fresh, flash frozen and glazed, or frozen in some other manner that ensures the quality of the food. Any frozen food should be completely thawed under refrigeration prior to feeding and used entirely or discarded. *Note*: Fish can become mushy when completely thawed and should be cut when still slightly frozen.
- Frozen food that has been thawed must be used within 24 hours after thawing. Under no circumstances may food be refrozen. If the quality of the food is questionable, it should not be used.
- Food shall be of a type and quantity that meets the nutritional requirements for the particular turtle species. Reasonable efforts should be made by the holding facility to develop proper diets, and it is the responsibility of the holding facility to ensure and justify the adequacy of its feeding regimen.
- A varied diet is best. A “typical” mixed diet consists of a leafy, dark green vegetable fed with whole fish, crabs, shrimp and/or squid. Multi-vitamin supplements (see *Appendix G*) are recommended.
- As a general rule, sea turtles are fed 1-3 times per day (for a total of 1%-5% of their body weight on a daily basis), tending to the lower percentage for maintenance and the higher percentage for sick, emaciated and/or younger turtles.
- Hand-feeding of turtles that will eventually be released should be prohibited except when absolutely necessary for rehabilitation. In the latter case, the turtle should be allowed to feed on its own as soon as possible.

Feeding Techniques and Tips

Free Feeding

The most basic feeding method is to hand-toss prepared food into the tank. To promote “foraging”, food items should be dispersed and not concentrated in one area. Walk away once the food has been given so that the turtle is less likely to associate human presence with food. Dispose of any seafood not eaten after 20 minutes. Vegetables can be removed for disposal prior to the next meal. Anything not eaten should be weighed and recorded. Never save or re-use food items.

Assisted feeding with a wooden pole

Assisted Feeding

Turtles occasionally need coaxing before they will eat. Tongs (available for purchase in many lengths) or a sharpened pole (wood, metal) are simple tools that can be used to hold food securely while waving it in front of a turtle’s mouth. Once the turtle takes the food, immediately remove the tongs (or pole) from the water. If the turtle does not eat after attempting for several minutes, try again later. Patience is the key – vary the time of day and the food item(s) offered. Try live food!

[9] Adapted from FFWCC (2007c): “Marine Turtle Conservation Guidelines: Holding Marine Turtles in Captivity.”

Always properly sanitize the tongs (or pole) between feedings, and between turtles. Generally, short tongs work better for turtles that tend to feed at or near the surface, while long tongs or poles work best for turtles that prefer to remain on the bottom of the tank.

Concerns and Warnings

Feeding poles can be very sharp – keep them away from a turtle's eyes and wounds. Keep your **hands safely out of bite range** when feeding, and be aware that sea turtles can both lunge forward and turn their heads quickly. **Do not attempt** to hand-feed a sea turtle. To **prevent contamination** and over-feeding, never share uneaten food among turtles.

Tube Feeding

Tube feeding a loggerhead, © SCA

Sea turtles can survive several weeks, even months, without food, but if a turtle will not eat or is unable to eat on its own, tube feeding may be the only option. Because severely dehydrated and debilitated sea turtles have a tendency to regurgitate food, confirm that the turtle is in stable condition and has received initial IV/SubQ fluids, radiographs (to rule out intestinal blockages), and antibiotics prior to attempting tube feeding.

Liquids used for tube feeding vary depending on the turtle's physical condition. Some experts advise less viscous mixtures for extremely emaciated turtles, and more viscous (thicker) mixtures for turtles in better physical condition. Others advocate for thicker mixtures for very weak turtles so they do not regurgitate and aspirate the liquid into their lungs, then thinner mixtures as the animal gets stronger. Follow the attending veterinarian's advice on this subject.

The number of meals and amount of food offered should be determined by a veterinarian based on measured blood values, turtle size/weight, and any medications to be administered (see *Appendix G: Food Guide* for gruel recipes for tube feeding). Pieces of whole food should be offered between tube feedings. Watch for and confirm that the turtle is defecating. When the turtle is able to eat on its own, tube feeding should be stopped. The following are additional helpful notes on supplies and methods provided by caregivers at the Volusia County Marine Science Center in Florida.

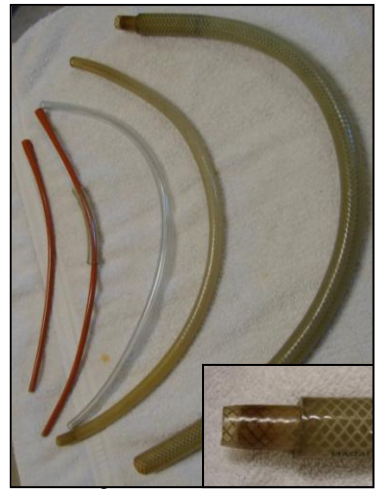
Position the turtle: Place the turtle on a padded board with an incline of 30º to 90º to assist with feeding and help prevent regurgitation. The board can be attached to or positioned inside a holding tank.

Bite blocks and rope to open mouth, © M. Bauer, VCMSC

Open the mouth: Tap the nose and the turtle is likely to open its mouth. For smaller turtles, malleable metal teaspoons can be used to pry open the mouth. To reduce the risk of injury, take heed to tilt and prop the spoon at different positions around the beak during each use. Rope threaded through heavy gauge flexible tubing can also be used, especially for large turtles. The key to this technique is the smooth edge of the tubing, which should be strong enough to open the mouth and gentle enough not to harm the beak.

Keep the mouth open: A bite block is necessary to prevent the turtle from crushing the feeding tube and to protect the handler. Bite blocks can be made from a piece of PVC pipe or by using flexible, reinforced nylon tubing. If using tubing, strength is gained by layering smaller diameter tubes inside larger diameter tubes.

Select a feeding tube: The best material for a feeding tube is flexible, reinforced nylon. The size of the feeding tube is related to the size of the turtle, but is typically 1.0-2.5 feet (30-76 cm) long and displays a diameter somewhere between a butterfly catheter tube and a garden hose. One end of the tube should be small enough for a catheter tip syringe to fit inside, so smaller tubes can be fit into larger tubes. *Note*: Various sizes of equine stomach tubes work well for all but very small sea turtles.



insert, © M. Bauer, VCMSC

Lubrication: Prior to use, lubricate the outside of the tube with KY® jelly, vegetable or fish oil, or other non-toxic, water soluble lubricant.

Catheter tip syringe: A catheter tip syringe, up to 100 cc, is useful for injecting medication, food, and water into the tube. The size of the syringe should correspond to the size of the tube; i.e., small enough to fit inside the tube but large enough to fit snugly (to prevent leakage).

CHECKLIST: PROCEDURES FOR TUBE-FEEDING A SEA TURTLE

☐ Select an appropriately sized tube (length, diameter), depending on the size of the turtle.

☐ Prepare your gruel and have all feeding equipment at hand for the procedure.

☐ Prior to feeding and *with the turtle's neck extended*, align one end of the tube with the turtle's nose, then measure and mark the point on the tube that corresponds with the second vertebral scute (refer to the "Sea Turtle Anatomy Guide" in *Section II: The Essentials*). This provides a reference point for the anterior portion of the stomach and, therefore, a guide for how deep to insert the tube. Sea turtles have supreme control of their esophageal sphinctors and successfully reaching the stomach is rare, but the mark indicates the ideal insertion point.

☐ Position and secure the turtle against the padded board.

☐ Tap the nose or gently pry the mouth open with a rope or malleable spoon.

☐ Insert a bite block.

☐ Extend and straighten the head and neck, then insert the lubricated tube gently into the mouth and slide to it down to your mark (tube needs to enter the stomach, not just distal esophagus).

☐ Hold the tube vertically. Using the catheter tip syringe, inject any medications first, and follow with a syringe filled with water. Follow with appropriate injections of liquid food. Remember that liquid food is easily regurgitated – to minimize regurgitation, maintain the turtle in a head-up angle during and for a period of time (3-5 minutes) after tube-feeding.

☐ Constantly smell the animal's breath for signs of halitosis, which can indicate regurgitation and aspiration. If foul smell is present and/or food is regurgitated, immediately stop tube feeding, tilt the turtle with head down to allow the food to run out, and return the turtle to the water.

☐ When feeding is done, gently remove the tube (pinch the tube before removal to prevent remaining tube contents from leaking onto the glottis at the base of the tongue), remove the bite block, and return the turtle to shallow water. Weak turtles should also be placed in water, even if only for 1-5 min. The water allows the turtle to clear its throat and safely expel excess material. Some material may expel from the nose, which is normal and does not indicate aspiration.

Concerns and Warnings

Tube feeding is a last option for a turtle that will not or is physically unable to eat on its own. Serious complications can occur, and the technique should only be done with expert guidance. Tube feeding should **not be attempted** more than once per day. Sea turtles with a decent body condition can go weeks without eating, and getting them to eat on their own is ideal.

For more information on tube feeding, see:
"Sea Turtle Rehabilitation" (Campbell, 1996) in *Reptile Medicine and Surgery* (Mader, 2006)
"Chelonian Emergency and Critical Care" (Norton, 2005a)
"Rehabilitation of Sea Turtles" (Walsh, 1999)

Oral Medications/Vitamins

For turtles that are eating on their own, oral medications and vitamins can be given with meals. Vitamin and mineral considerations include Vitamin E, B Complex, A, D3, calcium, and iron, and these should be administered as part of regimen prescribed by a veterinarian.

Stuffing medication in squid mantle

Pills and capsules can be stuffed inside the fish gills, cloaca, or muscle; inside a squid mantle; or inside a plain gelatin capsule prior to feeding. Stuff pills far enough inside the food item so that they do not fall out. Do not place multiple pills of different types in the same piece because it is important to know how much of each vitamin or drug was ingested. Green turtles fed primarily vegetables can also be given fish or squid for oral medications and vitamins.

Shrimp stuffed in squid mantle

Note: Watch closely to be sure the pill is ingested. To help ensure that medications and vitamins are taken, feed medicated food first (turtles with unstable appetites can be given a piece of non-medicated food first to confirm a readiness to eat). Medicated food is for immediate use, never store it. Keep track of and discard any uneaten pills.

Other Tips

- Offering a variety of food items can encourage reluctant eaters, and offer some creative feeding options. For example, if small food items (e.g., fish, shrimp) are not preferred but squid is, then stuff small food items inside the squid mantle (see photo insert).
- If a debilitated turtle does have not full gastrointestinal function, it is helpful to remove squid pens. Turtles do not digest them and they can clog pipes, drains, and skimmers.
- Add Vitamin E and thiamin when feeding frozen food: 100 IU/kg and 25 mg/kg, respectively, of frozen fish fed.
- Monitor growth and development! The turtle pictured here was kept as a family pet during the first years of its life. The malformation is attributed to malnourishment (causing the shell to be soft) and frequent manipulation by children prior to it arriving at the rescue center (Claire Cayol, in litt. 19 September 2008).

Sea turtle malformed by improper diet and handling,
© Réseau tortues marines Martinique - ONCFS

VII. ENRICHMENT

Captive sea turtles are often restricted to a sterile, single species environment that does not allow them to engage in many natural behaviors. Enrichment provides behavioral choices by allowing turtles to use the available space, reduces stereotypical swimming that can result in injury (such as calluses from rubbing the sides of the tank), and encourages species-specific activity related to exploration, foraging, and tactile stimulation (Cunningham-Smith et al., 2006; Therrien et al., 2007). Promoting natural behaviors aids in the rehabilitation process by stimulating appetite, building strength, and encouraging alertness.

Loggerhead turtle eats a live crab, © K. Martin, Mote Marine Lab

Food Items

Food-based enrichment stimulates appetite, curiosity, and movement. Each food item offered needs to be considered in the daily diet; enrichment should not result in over-feeding. To reduce the risk of cross-contamination, never re-use uneaten food items or share food (or other enrichment) items between tanks. Always remove uneaten remains.

Live Food

Turtle interacts with an ice block

Crabs and jellyfish are excellent food sources and part of many turtle's natural diets. Both offer excellent enrichment because they represent easy-to-catch live prey. Remove *tips* of crab pinchers to prevent injury to eyes or open wounds. Place the crab so the turtle has to chase it in order to catch it. Use only one live food item at a time to reduce waste. *Note*: Loggerheads and ridleys especially like crabs.

Ice Blocks

Fill a small container with water, several drops of food coloring (optional), and a few pieces of food (fish, shrimp, vegetables) and freeze the container overnight. Place the frozen block in the tank and let the turtle do the rest! Dispose of any uneaten food. *Note*: Good for all species.

Turtle feeding from a drilled pipe, © K. Martin, Mote Marine Lab

Drilled Pipes

Cut a 20-60 cm length of large PVC pipe and drill several holes (less than 2.5 cm in diameter) on opposite sides of the pipe. Smooth the cut ends of the pipe, or cover them with socket fittings. Insert leafy or sliced vegetables into holes, and sink to the bottom of tank. Remove the tube once the food is gone or before staff members leave the facility for the night. *Note*: Best for green sea turtles, but you can also put fish or fish pieces into the holes to encourage foraging behavior in other species.

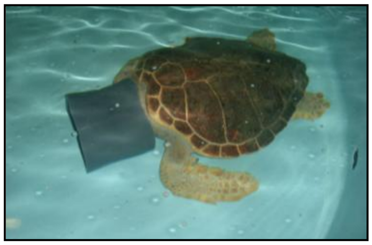
Constructing a feeding mat, © K. Martin, Mote Marine Lab

Feeding Mat

Secure (such as with nylon cable ties) a rubber mat to a plastic grate and insert leafy and sliced vegetables into the holes. Weights or rocks may be needed to sink the mat. Remove mat when the food is gone or before staff members leave for the night. *Note*: Best for green turtles.

Non-food Items

PVC pipe hiding place (above); asleep in a pipe cuff (below), © J. Miller, SCA



Non-food items are excellent for tactile stimulation and natural exploration. They can be left in tanks during hours of supervision. They should not be shared among tanks unless they are sterilized between uses.

Rocks

Large, smooth rocks can be placed on the bottom of any tank. Rocks too large to be ingested are one of the few items that can be left in the tank at all times. To prevent contamination, rocks should be cleaned every few weeks and when a new turtle is introduced into the tank.

Waterfalls

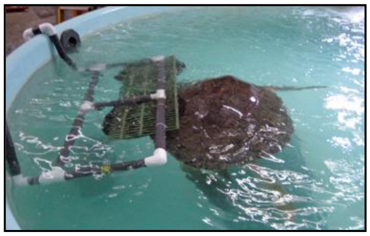
A simple trickle of water or a spray bar (see *Section V: Holding Environment – Temperature Control*) provides a welcome massage!

Refugia (Hiding Places)

Cement block and panel hiding place

Hiding places are essential for sea turtles. PVC pipes fashioned into various shapes with large diameters and smooth edges are great hiding places. Be mindful of the size of pipe used – turtles can become stuck in too-narrow pipes. PVC pipes can also be constructed into pyramid or rectangular shapes that allow turtles to swim in and out. Exploration areas can also be created using cement blocks and flat plastic, fiberglass, or non-corrosive metal panels (*hint*: layer blocks, add panels, and layer blocks again). The space should be wide enough for the turtle to swim through, and the structure should be sturdy enough to prevent collapse.

Back Scratcher



"Back scratcher", © VAF

Back scratchers are easily constructed of PVC pipes and socket fittings. During the design phase, make sure that the finished product fits snugly onto the side of the tank and that it is angled slightly up from the water. This allows the "scratcher" to stay in place, and the sea turtle to easily get underneath. Experiment with scrub brushes, heavy ship rope and other coarse materials that can be securely attached to tank walls.

Concerns and Warnings

Crabs should only be fed to turtles that have a stable digestive tract and in preparation for release.

Be mindful when designing **enrichment items**: keep the design simple and as natural as possible. Turtles may associate certain materials and objects (e.g., parking cones, buoys, tires) with objects they might naturally encounter in the wild – this association encourages exploration and alertness.

Enrichment items are generally meant for turtles that are in better health and **should not be used** for extremely debilitated turtles, unless live food is given to stimulate appetite.

VIII. Release

Final Assessment and Clearance

A recovered turtle should be prepared for release as soon as practicable. An assessment, conducted by a veterinarian, should meet the minimum requirements articulated in the check-list below.

Checklist: Final Assessment & Clearance for Release

To be a successful candidate for release, the turtle should be:

- ☐ Off all medications for a minimum of 14 days without complications
- ☐ Actively eating on its own – free feeding, diving to retrieve food
- ☐ Able to capture any live food given (in the case of a large juvenile or adult) or able to make a good attempt to capture live food (in the case of a young juvenile)
- ☐ At a stable and normal weight – not changing drastically, not emaciated, not overweight
- ☐ Disease free – no open wounds/sores, tumors, skin irritations, debilitating epibiota, parasites
- ☐ Defecating and urinating normally and regularly
- ☐ Actively moving, swimming, diving without assistance; resting comfortably on tank bottom
- ☐ Able to lift its head strongly when breathing
- ☐ Attempting to crawl when on solid ground
- ☐ Able to hold its limbs and head above the ventral surface of its body, and act as if swimming when lifted out of the water
- ☐ Displaying blood parameters within normal limits

Once a turtle is cleared for release and tagged (see *Section VIII: Release – Tagging*), return the animal to a safe and non-polluted area, ideally the site where it was found or in an area where others of its species and size are known to occur. The most common protocol is to allow the turtle to crawl on the beach, into the sea. If individuals of its species and size are not found in nearshore waters, release at sea from an appropriate vessel should be arranged (see *Section III: Handling and Transport*).

Release from a rocky cove,
© B. Bergwerf, SCA

Release from a sandy beach

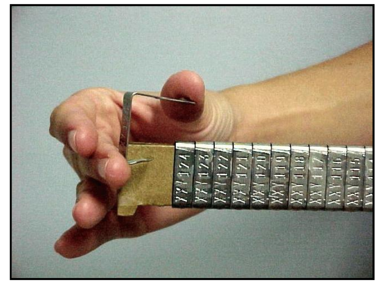
Release from a boat

Tagging

Upon release, tagging provides a way to identify sea turtles as individuals. Tag types most often used on sea turtles are externally placed flipper tags (generally metal or plastic) and internally placed PIT (Passive Integrated Transponder) tags (Eckert and Beggs, 2006). We recommend that both flipper-tagging and PIT-tagging be done one week prior to release, giving time to monitor for potential infection at the tag site. To reduce the risk of infection, tagging should be a clean and careful process.

Flipper Tags

Flipper tags are modified livestock tags that must be pierced through the flesh and clamped closed using tag applicators specially designed for each tag type. They are the most commonly used identification mark on sea turtles and can provide information on population trends, habitat residency, movement patterns (including international movement and migrations), individual growth rates, reproductive life history (e.g., remigration intervals, nesting frequency, clutch size, and/or hatchlings produced per female), and stranding patterns.



Metal flipper tags,
© National Band & Tag Company

Tag Size Considerations

Most flipper tag styles are unsuitable for use on turtles smaller than 25-30 cm straight carapace length (SCL). While very small metal tags are commercially available (e.g., National Band and Tag [NBT] #1005-1), there are few data to evaluate their retention rates or any effect they may have on the movement or survival of very small turtles. In general, sea turtles larger than 30 cm SCL should be tagged with NBT Inconel #1005-681 tags. A larger tag (NBT #1005-49) is better suited for the largest adult sea turtle species: green, loggerhead, and leatherback turtles. See http://www.nationalband.com/nbtear.htm for product details.

Flipper tag through the scale,
© B. Bergwerf, SCA

Where Should a Flipper Tag be Applied?

Two tags, one in the trailing edge of each front flipper, are applied to every turtle prior to release. “Double-tagging” increases the likelihood that a turtle retains its unique identification over several years. Flipper tags can be applied in one of two ways: either through or between the enlarged fleshy scales located at the trailing edge of the flipper. If *through* the scale, we recommend placement in the center of the first or second scale proximal to (closest to) the body of the turtle on each front flipper. If *between* the scales, we recommend placing the tag between the first and second scales. Each tag should be applied so that there is approximately 3-5 mm of open space between the trailing edge of the flipper and the inside curve of the tag.

Rear flipper tag,
© M. Godfrey, NCWRC

If injury or other circumstances significantly reduce the likelihood of successful tagging on a front flipper, a rear flipper tag is placed through (or adjacent to) the first large scale on a hard-shelled species. For leatherback turtles, the tag is placed in the “baggy pants area”; that is, in the fold of skin that connects the tail to the rear flipper.

Rear flipper tag,
© P. Dutton, NOAA

Concerns and Warnings

Regardless of whether your tag is placed through or between scales, it is important to remember that with increasing distance away from the body, **tag retention is compromised**. In other words, the further the tag is placed from the body, the more likely it is to be lost due to hydrodynamic forces, biting during courtship (or by predatory or curious fish), entanglement in a fishing net, etc.

In the case of rear flipper tagging, placing the tag too close to the tail can be **painful** for the turtle. Placement too far from the tail risks loss by predatory or curious fish, or loss to abrasion during nest excavation, in the case of a female.

Preparing for the Application of a Flipper Tag

Wash: During the manufacturing process the tags are covered in a lubricating oil comprised of an animal-based oil and mineral spirits, and therefore must be washed prior to being applied to a turtle. Unwashed tags can quickly cause infection at the point of application. One option is to wash the tags in hot soapy water; another option is to use a biodegradable solvent or cleaning solution, such as Simple Green® or BioChem SolSafe 245®. After cleaning, thoroughly dry the tags and store them in sealed plastic food storage boxes or Ziploc™ type bags.

Tagging pliers with metal flipper tag, © National Band & Tag Co.

Bend: If you consistently encounter problems with tags that do not fully cinch closed, give extra care to loading each tag correctly with the base plate flush against the pliers. You may also find it useful to adjust or bend the tag to help ensure that the point of the tag enters the hole during the application process. Bend the tag so that the pointed end meets up with the hole, but *be careful not to bend the tag too frequently* as this will affect the integrity of the metal (this is particularly true with the softer Monel tags). Once you have bent the tag to ensure a fit, re-open the tag so that it will be retained snugly in the tag applicator.

Positioning pliers to tag, © VAF

Examine: Before applying a tag, feel along the flipper edges and gently squeeze the first and second scales to identify any sores, lumps, or obvious sensitivity. Record the presence of potential tag scars (these may appear as rips in the flipper scales or skin, or lumps of scar tissue in the same location on both front flippers), and avoid placing new tags in these areas. Apply new tags as described below.

Flipper Tag Application Steps

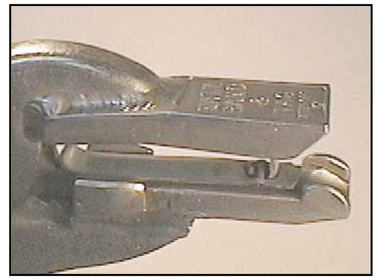
- Rinse the tip of the tagging pliers and the tags in alcohol. Clean hands with soap and water or hand sanitizer prior to tagging and between tagging turtles.

- Cleanse tagging site on the turtle with a broad-based topical microbicide, such as a povidine-iodine antiseptic solution (e.g., Betadine®) or rubbing alcohol before tag insertion.

- Pull the tag through the grooved guides in the jaws of the applicator (pliers) until it "snaps" into place. Make sure that the base plate of the tag is flat against the bottom jaw and the "bubble" is seated in the hole. Marking one jaw of the pliers with white paint can assist in loading the tags correctly at night. *Be sure to check that the tag is seated securely*.

- Position the tag and pliers so that the tag number is facing upwards, is at the proper location on the flipper, and will result in an appropriate gap between the trailing edge of the flipper and the inside curve of the tag.

- Squeeze the pliers with a firm, smooth action. Squeezing too lightly will not allow the tine to bend and lock into place, while squeezing too hard may cause the tag to flatten and pinch the flipper. *Either mistake will result in tag loss, and the latter (i.e., squeezing too tightly) can cause unnecessary and unacceptable discomfort to the turtle.*



Closed pliers; note the stirrup style, © National Band & Tag Co.

- Confirm that the tag is properly applied and cinched. For Inconel tags, turn the flipper over and examine the bottom of the tag to confirm that the tag has penetrated and that the tip (tine) is completely bent over and secure. An Inconel tag that is not secure can often be re-crimped with the tagging pliers. If this fails, remove the tag carefully and try again with a new tag, using the same puncture hole if possible. In the case of a stirrup-style Monel tag (see insert) where the bent tine is not visible, place your thumb and index finger on either side of the tag and gently attempt to wedge your fingers under the tag; if the tag pops open, it is not secure and must be replaced.

- RECORD THE TAG NUMBER. It is only after you have confirmed the proper and secure placement of the tag(s) that the tag numbers are recorded on the datasheet. Record the numbers carefully, and indicate the placement site (e.g., left front flipper) if required by the datasheet. Take **GREAT CARE** in reading and transcribing the numbers. Check and *double-check* that you have read and recorded the numbers correctly (it is helpful if a second person reads the numbers to the data recorder). Always record zeros.

Concerns and Warnings

Practice tagging technique on a sheet of corrugated cardboard. It is important to become comfortable and confident with the quick, decisive action needed to penetrate the flesh and cinch the tag correctly. Slow or imprecise movements can cause discomfort to the turtle. Moreover, if the animal moves (especially in a startle response) during tag placement, the application may be ruined.

Two people should be involved in each tagging – one person to hold the flipper and the turtle in case the turtle lurches, and one to do the actual tagging.

PIT Tags

Passive Integrated Transponder (PIT) tags are “small inert microprocessors sealed in glass that can transmit a unique identification number to a hand-held reader when the reader briefly activates the tag with a low frequency radio signal at close range” (Balazs, 1999). A PIT tag is cylindrical in shape, about the size of a grain of rice, and is injected under the skin or into the muscle. When a specialized reader is passed over the tag, a number, typically 9-15 digits arranged in a unique and unalterable alphanumeric code (i.e., a combination of numbers and letters), is displayed in the reader’s viewing window. The sea turtle feels nothing as the reader (or, scanner) is passed over it.

PIT tags, © LMLC

The use of PIT tags in adult sea turtles is well-tested and offers the advantage of superior tag retention when compared to metal flipper tags. Less information is available on the long-term effects of PIT-tagging juvenile turtles. We do not discourage the PIT tagging of small juveniles, but we encourage you to contact colleagues who are experienced with younger age classes.

Concerns and Warnings

Applying a PIT (Passive Integrated Transponder) tag is **more invasive than applying a flipper tag**, and should be done only under the guidance of workers experienced with the technique. PIT tagging is not a substitute for flipper tagging, but is best used together with flipper tagging so that at least one external tag is readily visible for the next encounter.

Tag Brand Considerations

There is little standardization among sea turtle scientists with regard to PIT tag brand, frequency, placement (tag site), or record-keeping. The challenge this presents for data collection is that when the reader is not "matched" to the frequency of the tag, the tag cannot be detected. Standardizing brand use across geographic regions would assist in ensuring that turtles PIT-tagged at one site could be detected as tagged at other project sites. In the absence of standardization, we recommend **un**encrypted PIT tags so that they can be read by other scanning technologies (other manufacturers) should your tagged turtle nest or be captured in another location, and we also recommend that you select a reader capable of detecting PIT tags made by different manufacturers.

Scanning for PIT tag,
© B. Bergwerf, SCA

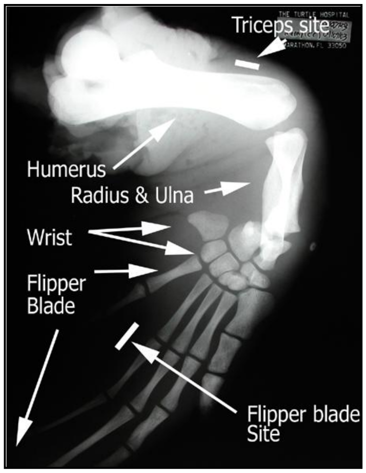
Where Should a PIT Tag be Inserted?

A PIT tag is injected under the skin, generally into muscle, using a sterile needle applicator available from the manufacturer. For sea turtles larger than 30 cm SCL, we suggest tag insertion into the triceps muscle complex on the anterior and dorsal aspect of the upper arm. This muscle mass, located on the humerus, can be pinched up so that the applicator easily enters the muscle. (*Note*: The major joint in the flipper is between the humerus bone and the radius and ulna bones.) The triceps muscle complex is active during part of the swimming stroke, but no lameness has been detected in animals receiving a PIT tag in this site (J. Wyneken, Florida Atlantic University, unpubl. data).

Triceps muscle complex
PIT tag injection,
© NOAA/NMFS/SEFSC

An alternative site is adjacent the radius and ulna atop the flipper blade. You can feel the edges of the radius and ulna adjacent to the three largest scales. If this site is used, insert the tag parallel to the radius and ulna on the flipper's trailing edge. In some cases, PIT tags placed at this site may not enter muscle and can migrate and cause irritation.

Whatever location you choose, remember that PIT tags are designed to become encapsulated with fibrous connective tissue in muscle. When the tag is encapsulated, it will not migrate away from the insertion point. Experience has shown that the tags do not encapsulate as reliably in skin, tendon, ligament, connective tissue or fat.



© The Turtle Hospital, annotated
by J. Wyneken

Preparing for the Application of a PIT Tag

Sterilize: Most PIT tags and applicators are pre-sterilized and packaged for field use, and we strongly recommend these. If the PIT tag style you select is not pre-sterilized, *each tag* must be soaked in non-toxic disinfectants (such as Betadine™, followed by alcohol) prior to use.

Scan: Verify that the sea turtle is not already PIT-tagged. As there is no consensus on PIT tag placement, examine foreflippers, shoulder muscles, rear flippers, and neck. Continue scanning even if a tag is found because some turtles may already have more than one PIT tag. To scan for an existing tag: turn the reader ON, place the reader directly on the skin of the turtle to decrease the "read distance", and then press and hold the READ button while moving over the area to be scanned in a circular motion. Use the entire reading surface of the scanner when trying to detect a tag.

Re-scan: After scanning an area, re-scan while tilting the scanner at various angles. PIT tags read best when the tag is pointing with the small end (picture the tip of a grain of rice) pointed directly toward the scanner, but the tag is not always oriented optimally under the skin. By tilting the reading surface at different angles during a sweep, the probability of tag detection is increased.

Record: If a PIT tag is found, enter the number (and any hyphens) on your data form exactly as it appears on the scanner display. The number is usually hexadecimal (digits 0-9 and letters A-F) and 10 (125, 128, or 400 kHz) or 15 (134.2 kHz) bytes long. Double-check to verify that the number is recorded without error, taking extra precaution concerning letters/numbers that can be confused; e.g., letter O and number 0 or Ø. If the display is inconsistent, displays a 16 byte alphanumeric code (0-9 and A-Z), or reads "AVID", you may have found an undecipherable, encrypted AVID tag.

PIT Tag Application Steps

- Scan and record the new tag before insertion to verify that the tag is functional.
- Clean the injection site with a swab saturated in an antiseptic solution, such as Betadine®.
- Insert the tagging needle under the skin and depress the syringe plunger to move the tag out of the applicator and into the muscle tissue. To inject using the triceps muscle complex, isolate by pinching the area next to the dorsal humerus, angle the applicator to ensure the tag is inserted into the muscle complex and not too deep into the flipper, and push the plunger to move the tag out of the applicator. If injecting into the flipper blade, identify the bones and inject adjacent to the radius and ulna.
- Watch for bleeding after injection. If blood flows from the wound, apply pressure with swab soaked in an antiseptic solution, such as Betadine®, until the flow stops. It may be necessary, especially in small juveniles, to apply a small amount of surgical glue to close the opening.

Concerns and Warnings

If the scanner has a low battery, or finds an unrecognized encrypted tag, the scanner may give **bogus or "ghost" numbers**; e.g., an excessively long alphanumeric code or nonsense symbols. Turn the scanner OFF, then ON, then re-scan. If bogus readings persist, replace the batteries or try another scanner – or, record the reading for later evaluation and make relevant notes on the data form. If the turtle is **resting on anything iron**, such as the bed of a truck, lift it up a few inches before scanning. Iron (and certain neon lighting and electrical motors nearby) render the scanner ineffective.

IX. HATCHLING HUSBANDRY

Hatchlings can be disoriented by beachfront lighting and wander inland, resulting in dehydration and/or injury (e.g., Witherington and Martin, 2003). Other threats typically associated with beachfront development near nesting grounds (e.g., high predator concentrations, beach driving, seawalls, litter and debris: see Choi and Eckert, 2009) can also result in hatchling injury. In addition, hatchlings are occasionally removed illegally from the nesting beach and kept as pets in home aquaria, where they are often housed in freshwater, fed inappropriately, and fail to thrive.

If healthy hatchlings are rescued after being disoriented inland by beachfront lighting, they should be released immediately. If rescued during the heat of the day, they should be kept until late afternoon or evening in a lightly covered plastic cooler or bucket. On rare occasions, hatchlings or very young sea turtles may require care for up to several weeks to recuperate from traumatic injuries and other health issues.

Temporary Holding of Healthy Hatchlings

Hatchlings kept for several hours or less may be kept in covered buckets or containers with a few inches of damp beach sand or a damp towel. According to Phelan and Eckert (2006):

1. Place a few inches of damp beach sand (*never water*) in a bucket or cooler. If the sand is too dry, the young turtles may desiccate (dry out); if too wet, energy will be wasted in swimming, and weaker hatchlings may be unable to hold their heads above the water to breathe.

2. Cover the bucket or cooler and place it in the shade until late afternoon or nightfall. Supervise the container to avoid the unwanted attention of predators (e.g., dogs) and onlookers.

3. At the time of release, keep potential predators (e.g., dogs, birds, crabs) away from the hatchlings as they cross the beach. Select an unlit stretch of beach (preferably the beach where the eggs were laid or the hatchlings found) to release the hatchlings; if the beach is well lit, request that the landowner/ hotelier to turn off the lights briefly as the hatchlings make their way to the sea. To encourage natural sea-finding, use minimum light and prohibit flash photography during hatchling releases.

Concerns and Warnings

Make sure that containers are secured during transport, such that they do not slide around or tip over.

Avoid excessive heat or cold during transport. Because hatchlings are so small, they are more vulnerable to temperature changes. Check moisture levels regularly; moisture can be added using a fine mist from a spray bottle.

During release, never toss newborn hatchlings directly into the sea, or “ferry” them into deeper water. It is important that the hatching process be as undisturbed as possible, so as not to interrupt the natural progression of the hatchling from the nest, across the beach, through the coastal zone, and into the open sea where it will spend the first several years of life.

Exception: Sometimes hatchlings successfully leave the nest, enter the sea, and wash ashore weeks later (e.g., by storms) as “post-hatchlings”. Depending on its size, the young animal may have to be ferried out to an oceanic convergence where fishermen would normally encounter that life stage.

It is **illegal to possess sea turtles** during the nesting/ hatching season in most Caribbean countries. Unless clearly sick or debilitated, newborn hatchlings should be released to the sea as soon as possible. They have limited internal yolk stores, which provide sufficient “fuel” for their swim frenzy into open ocean systems immediately after departing the nesting beach. Each day a hatchling is held captive, drawing on its internal food stores, makes it more likely that it will deplete its yolk and be forced to stop, prematurely, to feed in predator-rich coastal waters.

Holding Environment for Sick or Injured Hatchlings

Some hatchlings require more than an overnight stay and may or may not be able to swim. If the hatchlings are put into water and they show no effort to swim or float, they should be removed from the water immediately. If too weak to swim, the hatchling can be placed on an in-water stretcher and closely monitored for reactions to environmental stressors, such as temperature (see *Section V: Holding Environment – Maintaining Turtles out of Water*). Hatchlings that are alert and active may be able to swim on their own, but should be monitored closely when put in water more than 1 inch deep, to make sure that they can float and surface to breathe effortlessly.

Floating basket array

Tanks established for larger sea turtles (see *Section V: Holding Environment – Maintaining Turtles in Water*) can be used for hatchlings. However, floating perforated baskets (made of sturdy plastic) should be placed inside the larger tank to allow caregivers to closely monitor the small turtles, prevent them from getting trapped in drain or suction lines, and reduce the threat posed by biting. If additional flotation is necessary, small floats can be attached to baskets and/or the baskets can be tied to the side of the tank. If post-hatchlings are kept longer than overnight, consider providing amphipods or shrimp for them to peck at.

Close-up of individual float with mesh bottom and barrier

If the hatchlings are unable to swim well, “float beds” (floating stretchers made from mesh that can be cable-tied to a capped PVC pipe frame) can be created inside the tank or within the baskets. Float beds should be built so the hatchling has its nostrils out of water. Float beds allow hatchlings to thermoregulate and stay hydrated, and the thin water layer helps to support the body. Once the hatchling has enough energy to crawl around the mesh, introduce bouts of supervised swimming.

Concerns and Warnings

Because all the evidence suggests that the immune system of leatherback hatchlings is “fragile under captive conditions” (Jones et al., 2000), **we do not recommend** prolonged *ex situ* care for this species (see *Section IV: Admitting a Patient – A Note about Leatherback Turtles*).

Because hatchlings are small, **extra care** must be taken concerning the size and location of outflow valves, intake pipes, and holes to prevent injury or drowning. All **floating debris**, including system components, that is accessible to the hatchling(s) must be removed.

Cleaning protocols that involve **chlorine bleach** (sodium hypochlorite) require extra precautions in the presence of hatchlings. Keep bleach fumes away from hatchlings. Tanks, aquaria, baskets, floats, and bowls can be soaked for 15-20 min in a 3% solution (1 oz [30 ml] bleach per 1 quart water), then rinsed thoroughly with clean fresh or saltwater before reintroducing hatchlings (J. Wyneken, Florida Atlantic University, in litt. 2008).

Identification Marking

Because hatchlings are difficult to distinguish from one another, it is helpful to mark them – such as with children's nontoxic nail polish applied as a number or combination of dots to the dry carapace – for feeding and medication records. Nail polish is not a permanent mark and reapplication may be needed depending on the length of stay.

Nail polish identification marker,
© K. Martin, Mote Marine Lab

Another option is to keep hatchlings in separate, labeled, perforated baskets or other suitable floating containers in the holding environment.

Photographs (top view, side view) provide an important redundant system of identification because scale (and sometimes scute) patterns can be unique.

Diet

Hatchlings (with the exception of leatherbacks) can be fed a variety of crustaceans, mollusks, and fish carefully sized so that they are easy to swallow whole or soft enough to bite off small pieces. Bones and shells are essential, but alternative calcium supplementation may be necessary until the turtle is large enough to swallow bones and shells safely and without difficulty. Hatchlings can also be fed or supplemented with a gel or pellet food. Add additional foods or vitamins to meet nutritional needs and to make the gel food more palatable. For gel recipes, see *Appendix G: Food Guide*. The amount of food given depends on species and body weight. Hatchlings are often fed a high percentage body weight at first, between 8% and 15% (J. Wyneken, FAU, in litt. 2008), and may need to be fed several times each day to meet a target intake. Food preparation and storage should follow the same guidelines described in *Section VI: Diet*.

Hatchling food (mysis shrimp)

During the first several (5-8) days of life, hatchlings obtain most of their energy and nutrition from a residual yolk sac. For this reason, it is normal that newborns may not feed for several days. Once the yolk has been fully utilized, hatchlings should be eating within a few days (no more than 3). If the hatchling does not eat on its own, assistance may be needed. Gently open the mouth with the loop end of a small paper clip or a blunt toothpick. Cut solid food, such as small pieces of shrimp or fish, to a size less than one quarter of the mouth. Feed less than a healthy turtle would eat in a single feeding, with a target amount between 8% and 15% of body weight per day (Wyneken, FAU, in litt. 2008). Easy-to-swallow food can be placed in the mouth, or a liquid fish diet may be dropped in the mouth; watch to see if the turtle swallows it. *Note*: The turtle may need to be placed back in the water to facilitate swallowing.

Release

Hatchlings that remain hospitalized for several hours to a few days can be released on the beach where they were hatched (or found). Hatchlings can be placed near the water's edge to allow them easy access to the water without an excessive journey across the sand, but should never be placed directly in the water. The hatchling should orient natur-

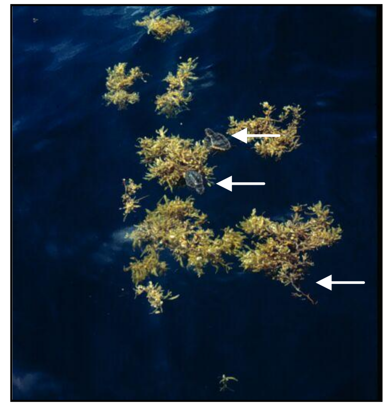
Hatchling release,
© A. Fallabrino, Karumbé

ally toward the sea. Release should take place in late afternoon or evening to reduce the threat of predation and heat stress. Observers should remain on site for 10-20 minutes to confirm that none of the turtles wash back to the shore.

"Post-hatchlings" that have been rehabilitated for several days or weeks should be able to easily swim and dive, display buoyancy control, have outgrown minor deformities, be eating on their own, and be free of serious wounds, lesions, and/or injuries prior to their release.

Although not strictly necessary, it is helpful if live, active food (e.g., jellyfish, small shrimp, small crabs) can be offered prior to release. Hatchlings are generally curious and will eat almost anything, and successful hunting skills can be assessed using live food.

Hatchlings that have been hospitalized for more than several weeks should be taken offshore, perhaps a mile or so (depending on your location), and released by boat into open water. Ideally, these turtles should be placed within naturally occurring mats of floating seaweed, which offer protection and prey for the young animals.



Hatchlings associated with floating seaweed, © Florida Fish & Wildlife Conservation Commission (FWC)

One of the least understood stages in the life cycle of a sea turtle is the pelagic phase, in which sea turtle hatchlings swim into the open sea and spend the first years of life growing and developing. Often referred to as the "lost years", this period most likely extends to a decade or more in some species (Carr, 1987; Musick and Limpus, 1997; Bolten, 2003). For this reason, it is admittedly difficult to know where to release young juveniles too small (less than 20 cm SCL) to regularly inhabit coastal marine habitats (e.g., seagrass, coral reefs).

Hatchlings associated with floating seaweed, © FWC

In preparation for release of very young sea turtles, caregivers should spend time talking to offshore fishers, ferry captains, and yachters to learn if sightings have been made of wild turtles in the size range of those ready for release.

Post-hatchling loggerhead sea turtles, *Caretta caretta*, released from a research vessel into South Carolina's (USA) offshore waters. Developmental habitat in this region features floating seaweed such as *Sargassum* (right), © South Carolina Aquarium

X. Emergency Preparations and Procedures

The Caribbean is susceptible to tropical storms, hurricanes, and other factors that can result in power loss, flooding, and other emergency situations. With this in mind, there are several precautions that can be taken prior to or in the event of an emergency.

Staff and volunteers should be fully aware of all emergency procedures. Practice drills should be implemented at regular (at least annual) intervals.

Under the most serious scenarios (e.g., a direct hit by a powerful hurricane), the immediate release of turtles diving and eating on their own should be considered.

Checklist: Equipment & Precautions for Emergency Situations

☐ Power Generator: Power outages can span days or weeks after a storm. During an emergency situation, the rescue center must have access to a functional generator of sufficient size and capacity to ensure minimum filtration, water intake, and refrigeration.

☐ Extra Water: If water cannot be accessed from the primary water source, a back-up source of water should be available. Store fresh- and salt-water reserves.

☐ Food: Extra food should be stored in a powered refrigerator or freezer. If there is no power, the facility must be able to obtain food for emergency purposes.

☐ Secure Shelter: If wind and storm conditions threaten the structure of (or access to) outdoor holding facilities, turtles should be transferred to alternative and more secure locations. Outdoor facilities should develop cooperative relations with suitably secure shelters able to host tanks and turtles during inclement weather.

☐ Prepare Building and Surrounding Area: Take normal precautions prior to a severe storm; e.g., trim tree branches, bring loose items inside, board-up windows, test generators and other alternative systems.

☐ Extra Tanks: "Kiddie pools" are useful to have on hand. They allow easy access and cleaning for temporary holding. *Note*: Active turtles are monitored more closely to prevent escape.

☐ Back-up Documentation: Documents are often lost due to flooding. Confirm that all original and/or photocopied or computer archived documentation (e.g., patient records, documentation of food and medicine prescribed and/or administered, water quality monitoring data) are safely storied, ideally off-site.

☐ Facility Design: The facility should be designed for easy management, cleaning, and drainage. See *Section V: Holding Environment* for more information.

XI. Mortality and Necropsy

Sickness and death are inevitable in any population. Sometimes a critically sick or injured sea turtle will die before it arrives at a rescue/rehabilitation facility or, despite your best efforts, it will die in your care. The incident provides an opportunity to improve your understanding of anatomy, to collect samples for more detailed assessments, to collect information that may inform and improve future treatment protocols, etc. If you are inexperienced in necropsy methodology, invite a more experienced veterinarian, fisheries or wildlife officer, or animal care colleague to participate in the exercise. It is always helpful to work in pairs, so that one person can properly document the procedure.

Euthanasia

On extremely rare occasions and in the worst of cases – such as when an interrupted poaching event has resulted in the amputation of all four flippers or a blunt trauma renders the turtle comatose and unresponsive – euthanasia may have to be considered. Based on the best available information and protocols (e.g., CCAC, 1993; AVMA, 2007; NYS/CCE, 2005), *Appendix I: Euthanasia in Sea Turtles* provides a guide to sea turtle euthanasia that ensures a death "without signs of panic, pain or distress; with minimum time to loss of consciousness; and under conditions that are safe for the personnel involved" (CCAC, 1993). Mader (2006b) and Phelan and Eckert (2006) also offer overviews of euthanasia, including recommended techniques and carcass disposal.

Necropsy

Whether a turtle succumbs to illness or injury, or is euthanized, a necropsy (the animal equivalent of an autopsy) is one of the basic tools used to determine the underlying cause(s) of death if an antemortem diagnosis was not obtained. A necropsy also yields general information useful to management, including diet and reproductive condition. A good necropsy involves the thorough examination of a carcass externally and internally, including careful observations of lesions or abnormalities and procurement, labeling, and storage of tissue samples (Work, 2000).

The external examination involves close inspection of the turtle and emphasizes the collection of standardized data, including measurements. The minimum measurements to be obtained are: body weight, head length and width, carapace length (straight line and curved, if possible) and width, plastron length and width, distance between plastron and vent, and distance between plastron and tip of tail. Look for any sign of injury, such as that caused by an encounter with a water craft (e.g., propeller cuts), line entanglement, rope burns, shark bites, etc. Severely emaciated turtles have sunken eyes and plastron and reduction of the muscle masses on the head and neck, creating a prominent appearance to the supraoccipital crest at the back of the head. Flippers should be examined for holes or scars from lost flipper tags. Scan for PIT tags. Any masses, swellings, discolorations, and scars should also be noted (Campbell, 1996).

This Husbandry Manual is not designed as a necropsy guide. The most user-friendly reference, in our view, is Work (2000). Presented in a full-color format and available in several languages, it was written for biologists who have "little or no background in necropsy techniques." The photographs and illustrations are very helpful in recognizing various organs, obtaining samples, etc. Work (2000) and Wyneken (2001) both provide information on how to take standard measurements; guidance on measuring sea turtles is also available in Bolten (1999). Additional detail on various aspects of sea turtle anatomy can be found in Wyneken (2003) and Bartol and Musick (2003). Garner (2006) offers a nicely illustrated overview of reptile necropsy in general, including sample procurement. Jacobson

(1999) is another excellent resource, as is a related Internet-based guide provided by the University of Florida's College of Veterinary Medicine entitled, "Sea Turtle Biopsy and Necropsy Techniques" (see boxed insert), featuring a comprehensive Necropsy Report Form that can be downloaded and printed.

Concerns and Warnings

Remember that **you may need a permit** to conduct a necropsy.

Dead turtles should **not be lifted by head or flippers**. Ideally they should be lifted by the carapace, with one person on each side of the turtle holding the carapace at the nuchal notch and suprapygals (i.e., one hand on the shell just behind the head, the other at the posterior tip). On land, there is never a reason to lift a turtle by its flippers (the bones in the flipper or shoulder may be fractured or dislocated this way). When hefting a turtle onto a boat, the flippers can be used to help lift the turtle out of the water as long as those lifting the turtle *hold the base of the flipper and not the tip*. Even in this situation, those lifting the turtle should work to avoid as much stress on a single flipper as possible.

Dead and decaying sea turtle **tissues harbor a variety of potentially harmful organisms**, some of which can infect humans. Potentially dangerous consequences that may result from exposure can be reduced by wearing appropriate clothing (protective overalls and rubber gloves), eye protection (safety glasses or sun glasses), and by being careful when handling tissue. Always protect open wounds with dressings, avoid contact with fluids or airborne droplets, and keep disinfectant solutions readily available (Geraci & Lounsbury, 1993).

Any cuts suffered by people while conducting a necropsy should be thoroughly cleaned and treated. Any wound, however minor, must be carefully monitored for signs of infection. Infection under these circumstances can occur, and can become dangerous very quickly. *Take special precautions* when conducting a necropsy on a **hawksbill turtle –** sponge spicules in the gastrointestinal tract can cut through and embed in the skin.

The **carcass must be properly disposed** after conducting a necropsy (see Phelan & Eckert, 2006).

SEA TURTLE NECROPSY MANUALS AND RELATED RESOURCES

IUCN/SSC Marine Turtle Specialist Group "Research and Management Techniques for the Conservation of Sea Turtles" (Eckert *et al.* 1999): http://iucn-mtsg.org/publications/techniques-manual-en/; see, in particular, "Tissue sampling and necropsy techniques" (Jacobson 1999)

University of Florida College of Veterinary Medicine "Sea Turtle Biopsy and Necropsy Techniques": http://www.vetmed.ufl.edu/college/departments/sacs/research/SeaTurtleBiopsyandNecropsyTechniques.html

US Geological Survey "Sea Turtle Necropsy Manual for Biologists in Remote Refuges" (Work 2000): http://www.nwhc.usgs.gov/publications/necropsy_manuals/Sea_Turtle_Necropsy_Manual-English.pdf

US NOAA National Marine Fisheries Service "The Anatomy of Sea Turtles" (Wyneken 2001): http://courses.science.fau.edu/~jwyneken/sta/; see, in particular, the section on dissection: http://courses.science.fau.edu/~jwyneken/sta/SeaTurtleAnatomy-Methods_of_Dissection.pdf

XII. LITERATURE CITED

AZA. 2008. Policies and recommended quarantine procedures, p.18-24. In: Accreditation Standards and Related Policies, 2008 Edition. Association of Zoos and Aquariums (AZA).

AVMA (American Veterinary Medical Association). 2007. AVMA Guidelines on Euthanasia. Publication of the American Veterinary Medical Association, Schaumburg, Illinois. 36 pp. http://www.avma.org/issues/animal_welfare/euthanasia.pdf

Balazs, G.H. 1999. Factors to consider in the tagging of sea turtles, p.101-109. In: K.L. Eckert, K.A. Bjorndal, F.A. Abreu G. 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. http://iucn-mtsg.org/publications/techniques-manual-en/

Bels, V., F. Rimblot-Baly and J. Lescure. 1988. Croissance et maintien en captivité de la Tortue Luth, *Dermochelys coriacea* (Vandelli, 1761). Revue fr. Aquariol. 15(2):59-64.

Bentivegna, F. 2004. Turtle Point: The first marine turtle rehabilitation center in Italy. Marine Turtle Newsletter 106:22-23.

Bernard, J.B. and M.E. Allen. 2002. Feeding captive piscivorous animals: nutritional aspects of fish as food. Nutrition Advisory Group Handbook. Association of Zoos and Aquariums (AZA). http://www.nagonline.net/Technical%20Papers/NAGFS00597Fish-JONIFEB24,2002MODIFIED.pdf

Birkenmeier, E. 1971. Juvenile leathery turtles, *Dermochelys coriacea* (Linnaeus), in captivity. Brunei Museum Journal 2(3):160-172.

Birkenmeier, E. 1972. Rearing a leathery turtle, *Dermochelys coriacea*. Intl Zoo Yearbook 12:204-207.

Bjorndal, K.A. 1985. Nutritional ecology of sea turtles. Copeia 1985(3):736-751.

Bjorndal, K.A. 1989. Flexibility of digestive responses in two generalist herbivores, the tortoises *Geochelone carbonaria* and *Geochelone denticulata*. Oecologia 78:317–321.

Bjorndal, K.A. 1991. Diet mixing: Non-additive interactions of diet items in an omnivorous freshwater turtle. Ecology 72:1234-1241.

Bjorndal, K.A. 1997. Foraging ecology and nutrition of sea turtles, p.199-231. In: P.L. Lutz and J.A. Musick (Editors), The Biology of Sea Turtles. CRC Press, Boca Raton, Florida.

Bjorndal, K.A., A.B. Bolten and J.E. Moore. 1990. Digestive fermentation in herbivores: Effect of food particle size. Physiological Zoology 63:710-721.

Bleakney, J.S. 1965. Reports of marine turtles from New England and eastern Canada. Canadian Field Naturalist 79(2):120-128.

Bolten, A.B. 1999. Techniques for measuring sea turtles, p.110-114. In: K.L. Eckert, K.A. Bjorndal, F.A. Abreu G. 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. http://iucn-mtsg.org/publications/techniques-manual-en/

Bolten, A.B. 2003. Variation in sea turtle life history patterns: neritic *vs*. oceanic developmental stages, p.243-257. In: P.L. Lutz, J.A. Musick and J. Wyneken (Editors), The Biology of Sea Turtles Volume II. CRC Press, Boca Raton, Florida.

Bolten, A.B. and K.A. Bjorndal. 1992. Blood profiles for a wild population of green turtles (*Chelonia mydas*) in the southern Bahamas: size-specific and sex-specific relationships. J. Wildlife Diseases 28 (3):407-413.

Boulon, R.H., P.H. Dutton and D.L. McDonald. 1996. Leatherback turtles (*Dermochelys coriacea*) on St. Croix, U.S. Virgin Islands: fifteen years of conservation. Chelonian Conserv. Biology 2(2):141-147.

Burger, R.M., W.H. Gehrmann and G.W. Ferguson. 2007. Evaluations of UVB reduction by material commonly used in reptile husbandry. Zoo Biology 26(5):417-424.
http://www3.interscience.wiley.com/journal/114294886/abstract\

Campbell, T.W. 1996. Sea turtle rehabilitation, Section VII Appendix (p.427-436), In: D.R. Mader (Editor), Reptile Medicine and Surgery. W.B. Saunders Company, Philadelphia, Pennsylvania.

Carpenter, J.W. 2005. Exotic Animal Formulary, Third Edition. Elsevier Saunders, St. Louis, Missouri. 564 pp.

Carr, A. 1987. New perspectives on the pelagic stage of sea turtle development. Conservation Biology 1(2):103-121.

CCAC. 1993. Guide to the Care and Use of Experimental Animals (Volume I, Second Edition). Chapter XII: Euthanasia. Canadian Council on Animal Care (CCAC).
http://www.ccac.ca/Documents/Standards/Guidelines/Experimental_Animals_Vol1.pdf

Choi, G.-Y. and K.L. Eckert. 2009. Manual of Best Practices for Safeguarding Sea Turtle Nesting Beaches. Wider Caribbean Sea Turtle Conservation Network (WIDECAST) Technical Report No. 9. Ballwin, Missouri. 86 pp. http://www.widecast.org/Resources/Pubs.html

Choy, B.K., G.H. Balazs and M. Dailey. 1989. A new therapy for marine turtles parasitized by the piscicolid leech, *Ozobranchus branchiatus*. Herpetological Review 20(4):89-90.

Chrisman, C.L., M. Walsh, J.C. Meeks, H. Zurawka, R. LaRock, L. Herbst, et al. 1997. Neurologic examination of sea turtles. J. Am. Vet. Med. Assoc. 211(8):1043-1047.

Cunningham-Smith, P., K. Martin and C.A. Manire. 2006. Implementation of a Behavioral Husbandry Program for Captive Sea Turtles. Mote Marine Laboratory, Sarasota, Florida. 14 pp. Unpublished.

Davenport, J. 1987. Locomotion in hatchling leatherback turtles, *Dermochelys coriacea*. J. Zoology London (1987)212:85-101.

Deem, S.L., E.S. Dierenfeld, G.P. Sounguet, A.R. Alleman, C. Cray, R.H. Poppenga, T.M. Norton and W.B. Karesh. 2006. Blood values in free-ranging nesting leatherback turtles (*Dermochelys coriacea*) on the coast of the Republic of Gabon. Journal of Zoo and Wildlife Medicine 37(4):464-471.

Duron, M., J.C. Quero and P. Duron. 1983. Présence dans les eaux cotières de France et de Guyane fréquentées par *Dermochelys coriacea* L., de *Remora remora* L., et de *Rhizostoma pulmo* L. Annal. Soc. Sci. Nat. Charente-Mar. 7:147-.

Eckert, K.L. and J. Beggs. 2006. Marine Turtle Tagging: A Manual of Recommended Practices, Revised Edition. WIDECAST Technical Report No. 2. Beaufort, North Carolina. 40 pp. http://www.widecast.org/What/Regional/Tagging.html

Eckert, K.L., K.A. Bjorndal, F.A. Abreu G. and M. Donnelly (Editors). 1999. Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publ. No. 4. Washington, D.C. http://iucn-mtsg.org/publications/techniques-manual-en/

Eckert, S.A. 2006. High-use oceanic areas for Atlantic leatherback sea turtles (*Dermochelys coriacea*) as identified using satellite telemetered location and dive information. Marine Biology 149:1257-1267.

Eckert, S.A. and D. Sammy. 2008. WIDECAST Regional Marine Turtle Database: User's Manual Version 4.1. Wider Caribbean Sea Turtle Conservation Network (WIDECAST) at Duke University Marine Laboratory. Beaufort, North Carolina. 55 pp. http://www.widecast.org/Resources/Docs/Eckert_and_Sammy_2008_WIDECAST_Database_User_Manual_ver4.1.pdf

Eckert, S.A., D. Bagley, S. Kubis, L. Ehrhart, C. Johnson, K. Stewart and D. DeFreese. 2006. Internesting and post-nesting movements and foraging habitats of leatherback sea turtles, *Dermochelys coriacea*, nesting in Florida. Chelonian Conservation and Biology 2(2): 239-248.

FFWCC. 2007a. Marine Turtle Conservation Guidelines. Florida Fish and Wildlife Conservation Commission, St. Petersburg, Florida. 107 pp. http://myfwc.com/wildlifehabitats/managed/sea-turtles/conservation-guidelines/

FFWCC. 2007b. Marine Turtle Conservation Guidelines. Section III: Stranding and Salvage Activities, p.3-1 – 3-6. In: Florida Fish and Wildlife Conservation Commission, St. Petersburg, Florida. http://myfwc.com/wildlifehabitats/managed/sea-turtles/conservation-guidelines/

FFWCC. 2007c. Marine Turtle Conservation Guidelines, Section IV: Holding Turtles in Captivity, p.4-1 – 4.13. In: Florida Fish and Wildlife Conservation Commission, St. Petersburg, Florida. http://myfwc.com/wildlifehabitats/managed/sea-turtles/conservation-guidelines/

Fossette, S., H. Corbel, P. Gaspar, Y. Le Maho and J.-Y. Georges. 2008. An alternative technique for the long-term satellite tracking of leatherback turtles. Endangered Species Research 4:33-41.

Foster, P. and C. Chapman. 1975. The care and maintenance of young leatherback turtles, *Dermochelys coriacea*, at the Miami Seaquarium. International Zoo Yearbook 15:170-171.

Fowler, M.E. 1986. Metabolic bone disease, p.69-90. In: M.E. Fowler (Editor), Zoo and Wild Animal Medicine, Second Edition. W.B. Saunders Company, Philadelphia, Pennsylvania.

Frayr, W. 1970. The world's largest living turtle. Salt Water Aquarium 5:235-241.

FWS. 2000. Draft Requirements for Care and Maintenance of Captive Sea Turtles. U.S. Fish and Wildlife Service, Jacksonville, Florida. 9 pp.

Garner, M.M. 2006. Overview of biopsy and necropsy techniques, chapter 34:569-580, In: D.R. Mader (Editor), Reptile Medicine and Surgery, Second Edition. W.B. Saunders Company, St. Louis, Missouri.

Gehrmann, W.H. 2006. Artificial lighting, chapter 84:1081-1084, In: D.R. Mader (Editor), Reptile Medicine and Surgery, Second Edition. W.B. Saunders Company, St. Louis, Missouri.

Gehrmann, W.H., J.D. Horner, G.W. Ferguson, T.C. Chen and M.F. Holick. 2004. A comparison of responses by three broadband radiometers to different ultraviolet-B sources. Zoo Biology 23(4):355-363. http://www3.interscience.wiley.com/journal/109580440/abstract

Gelli, D., M. Morgante, V. Ferrari, A. Mollo, D. Freggi, and S. Romagnoli. 2004. Hematologic, serum biochemical, and serum electrophoretic patterns in loggerhead sea turtles (*Caretta caretta*), p.149-152. In: Proceedings of 11th Annual Conference of the Association of Reptilian and Amphibian Veterinarians, Florida, 8-11 May 2004.

George, R.H. 1997. Health problems and diseases of sea turtles, p.363-385. In: P.L. Lutz and J.A. Musick (Editors), The Biology of Sea Turtles. CRC Press, Boca Raton, Florida.

Georges, J.-Y. and S. Fossette. 2006. Estimating body mass in leatherback turtles *Dermochelys coriacea*. Marine Ecology Progress Series 318:255-262.

Geraci, J.R. and V.J. Lounsbury. 1993. Marine Mammals Ashore: A Field Guide for Strandings. Texas A&M Sea Grant Publications, College Station, Texas. 305 pp.

Gicking, J.C., A. M. Foley, K.E. Harr, R. E. Raskin, and E. Jacobson. 2004. Plasma protein electrophoresis of Atlantic loggerhead sea turtle. J. Herpetological Medicine and Surgery 14(3):19-23.

Goldman, K.E, R.H. George and W.M. Swingle. 1998. Dietary regulation of blood calcium and phosphorous values in Virginia Marine Science Museum sea turtles, p.43-46. In: S.G. Barco (Compiler), Proceedings of the 1998 Northeast Region Stranding Conference, 27-29 March 1998. Virginia Marine Science Museum Scientific Report 1998-002.

HACC. 2004. Guidelines for the Use of Live Amphibians and Reptiles in Field and Laboratory Research, Second Edition. Herpetological Animal Care and Use Committee, American Society of Ichthyologists and Herpetologists. http://www.asih.org/files/hacc-final.pdf

Haines, H. and W.C. Kleese. 1977. Effect of water temperature on a herpesvirus infection of sea turtles. Infection and Immunity 15(3):756-759.

Hall, J.V., A.M. Winer, M.T. Kleinman, F.W. Lurmann, V. Brajer, and S.D. Colome. 1992. Valuing the health benefits of clean air. Science 255(5046):812-817.

Hastings, M.D. 2006. Growth and Metabolism of Leatherback Sea Turtles (*Dermochelys coriacea*) in Their First Year of Life. Master's Thesis. Department of Zoology, University of British Columbia. Vancouver, Canada. https://circle.ubc.ca/handle/2429/17970

Herbst, L.H. 1999. Infectious diseases of marine turtles, p.208-213. In: K.L. Eckert, K.A. Bjorndal, F.A. Abreu G. 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. http://iucn-mtsg.org/publications/techniques-manual-en/

Hernandez-Divers, S.J. 2006. Diagnostic techniques, chapter 30:490-532, In: D.R. Mader (Editor), Reptile Medicine and Surgery, Second Edition. W.B. Saunders Company, St. Louis, Missouri.

Higgins, B.M. 2003. Sea turtle husbandry, p.411-440. In: P.L. Lutz, J.A. Musick and J. Wyneken (Editors), The Biology of Sea Turtles Volume II. CRC Press. Boca Raton, Florida.

IATA-LAR. 2006. Live Animals Regulations, 33rd Edition, p.276-277. In: IATA Resolution 620, Attachment "A". Effective 1 October 2006. International Air Transport Association, Washington, D.C. http://www.iata.org/ps/publications/live-animals.htm

James, M.C., C.A. Ottensmeyer, S.A. Eckert and R.A. Myers. 2006. Changes in diel diving patterns accompany shifts between northern foraging and south-ward migration in leatherback turtles. Canadian Journal of Zoology 84:754-765.

Jones, T.T. 2009. Energetics of the Leatherback Turtle, *Dermochelys coriacea*. Ph.D. Dissertation. Dept. of Zoology, Univ. British Columbia. Vancouver, Canada. https://circle.ubc.ca/handle/2429/7454

Jones, T.T., M. Salmon, J. Wyneken and C. Johnson. 2000. Rearing leatherback hatchlings: protocols, growth and survival. Marine Turtle Newsletter 90:3-6

Kakizoe, Y., K. Sakaoka, F. Kakizoe, M. Yoshii, H. Nakamura, Y. Kanou, and I. Uchida. 2007. Successive changes of hematologic characteristics and plasma chemistry values of juvenile loggerhead turtles (*Caretta caretta*). Journal of Zoo and Wildlife Medicine 38(1):77-84.

Leslie, A.J., D.N. Penick, J.R. Spotila and F.V. Paladino. 1996. Leatherback turtle, *Dermochelys coriacea*, nesting and nest success at Tortuguero, Costa Rica, 1990-1991. Chel. Conserv. Biol. 2:159-168.

Mader, D.R. (Editor) 2006a. Reptile Medicine and Surgery, Second Edition. W.B. Saunders Company, St. Louis, Missouri. 1,242 pp.

Mader, D.R. 2006b. Euthanasia, chapter 33:564-568, In: D.R. Mader (Editor), Reptile Medicine and Surgery, Second Edition. W.B. Saunders Company, St. Louis, Missouri.

Mader, D.R. and E. Rudloff. 2006. Emergency and critical care, chapter 31:533-548, In: D.R. Mader (Editor), Reptile Medicine and Surgery, Second Edition. W.B. Saunders Company, St. Louis, Missouri.

Manire, C.A., H.L. Rhinehart, G.J. Pennick, D.A. Sutton, R.P. Hunter and M.G. Rinaldi. 2003. Steady-state plasma concentrations of itraconazole after oral administration in Kemp's ridley sea turtles, *Lepidochelys kempii*. J. Zoo. Wildl. Med. 34(2):171-178.

Meylan, P., A. Meylan and J. Gray. 2003. Procedures Manual for the Bermuda Turtle Project. Bermuda Aquarium, Museum and Zoo. Flatts, Bermuda. 37 pp.

Mitchell, M.A. 2006. Therapeutics, chapter 36:631-664, In: D.R. Mader (Editor), Reptile Medicine and Surgery, Second Edition. W.B. Saunders Company, St. Louis, Missouri.

Moe, M.A., Jr. 1992. The Marine Aquarium Reference: Systems and Invertebrates. Green Turtle Publications. Plantation, Florida. 512 pp.

Mortimer, J.A. 1982. Feeding ecology of sea turtles, p.103-109. In: K.A. Bjorndal (Editor), Biology and Conservation of Sea Turtles. Smithsonian Institution Press, Washington, D.C.

Musick, J.A. and C.J. Limpus. 1997. Habitat utilization and migration in juvenile sea turtles, p.137-163. In: P.L. Lutz and J.A. Musick (Editors), The Biology of Sea Turtles. CRC Press, Boca Raton, Florida.

Norton, T.M. 2005a. Chelonian emergency and critical care. Seminars in Avian and Exotic Pet Medicine 14(2):106-130.

Norton, T.M. 2005b. Sea turtle conservation in Georgia and an overview of the Georgia Sea Turtle Center on Jekyll Island, Georgia. Georgia Journal of Science 63(4): 208-230.

NYS/CCE. 2005. Lethal Tools and Techniques (Chapter 5), Best Practices for Nuisance Wildlife Control Operators in New York State. New York State (NYS) Department of Environmental Conservation and Cornell University Cooperative Extension (CCE).
http://nwco.net/0531-StepThreeLethalToolsAndTechniques/5-6-0-Stunning.asp

Phelan, S.M. and K.L. Eckert. 2006. Marine Turtle Trauma Response Procedures: A Field Guide. WIDECAST Technical Report No. 4. Beaufort, North Carolina**.** 71 pp.
http://www.widecast.org/Resources/Docs/Phelan_and_Eckert_2006_Sea_Turtle_Trauma_Response_Field_Guide.pdf

Phillips, E.J. 1977. Raising hatchlings of the leatherback turtle, *Dermochelys coriacea*. Brit. J. Herpetology 5:677-678.

Pough, H.F. 1992. Recommendations for the Care of Amphibians and Reptiles in Academic Institutions. National Academy Press. 33, S1-S21.

Pritchard, P.C.H. and J.A. Mortimer. 1999. Taxonomy, external morphology and species identification, p.21-40. In: K.L. Eckert, K.A. Bjorndal, F.A. Abreu G. 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. http://iucn-mtsg.org/publications/techniques-manual-en/

RAC/SPA. 2004. Guidelines to Improve the Involvement of Marine Rescue Centres for Marine Turtles. UNEP Mediterranean Action Plan, Regional Activity Centre for Specially Protected Areas (RAC/SPA), Tunis. 48 pp. http://www.rac-spa.org/sites/default/files/doc_turtles/glrs.pdf

Rhinehart, H.L., C.A. Manire, L. Byrd and N.M. Garner. 2003. Use of human granulocyte colony-stimulating factor in a green sea turtle, *Chelonia mydas*. J. Herp. Med. Surg. 13(3):10-14.

Santoro, M., E.C. Greiner, J.A. Morales, and B. Rodríguez-Ortíz. 2006. Digenetic trematode community in nesting green sea turtles (*Chelonia mydas*) from Tortuguero National Park, Costa Rica. J. Parasitology 92(6):1202-1206.

Shaver, D.J. and W.G. Teas. 1999. Stranding and salvage networks, p.152-155. In: K.L. Eckert, K.A. Bjorndal, F.A. Abreu G. and M. Donnelly (Editors), Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publication 4. Washington, D.C. http://iucn-mtsg.org/publications/techniques-manual-en/

Shigenaka, G. (Editor). 2003. Oil and Sea Turtles: Biology, Planning, and Response. NOAA National Ocean Service, Office of Response and Restoration. Washington, D.C. 111 pp.
http://response.restoration.noaa.gov/book_shelf/35_turtle_complete.pdf

Stamper, M.A., M.G. Papich, G.A. Lewbart, S.B. May, D.D. Plummer and M.K. Stoskopf. 1999. Pharmacokinetics of ceftazidime in loggerhead sea turtles (*Caretta caretta*) after single intravenous and intramuscular injections. J. Zoo. Wildl. Med. 30(1):32-35.

Stamper, M.A., M.G. Papich, G.A. Lewbart, S.B. May, D.D. Plummer and M.K. Stoskopf. 2003. Pharmacokinetics of florfenicol in loggerhead sea turtles (*Caretta caretta*) after single intravenous and intramuscular injections. J. Zoo. Wildl. Med. 34(1):3-8.

Stocker, L. 2005. Practical Wildlife Care. Blackwell Publishing. 352 pp.

Therrien, C.L., L. Gaster, P. Cunningham-Smith and C.A. Manire. 2007. Experimental evaluation of environmental enrichment of sea turtles. Zoo Biology 26:407-416.

Walsh, M. 1999. Rehabilitation of sea turtles, p.202-207. In: K.L. Eckert, K.A. Bjorndal, F.A. Abreu G. 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. http://iucn-mtsg.org/publications/techniques-manual-en/

Winder, C. 2001. The toxicology of chlorine. Environmental Research 85(2):105-114.

Witham, R. 1977. *Dermochelys coriacea* in captivity. Marine Turtle Newsletter 3:6.

Witherington, B.E and R.E. Martin. 2003. Understanding, Assessing and Resolving Light Pollution Problems on Sea Turtle Nesting Beaches, Third Edition. Florida Marine Research Institute Technical Reports, TR-2. St. Petersburg, Florida. 73 pp. http://research.myfwc.com/publications/publication_info.asp?id=39080

Work, T.M. 2000. Sea Turtle Necropsy Manual for Biologists in Remote Refuges. U.S. Geological Survey, National Wildlife Health Center, Hawai'i Field Station. 25 pp. http://www.nwhc.usgs.gov/publications/necropsy_manuals/Sea_Turtle_Necropsy_Manual-English.pdf

Wyneken, J. 2001. The Anatomy of Sea Turtles. NOAA Technical Memorandum NMFS-SEFSC-470. U.S. Dept. Commerce, Miami. 172 pp. http://courses.science.fau.edu/~jwyneken/sta/

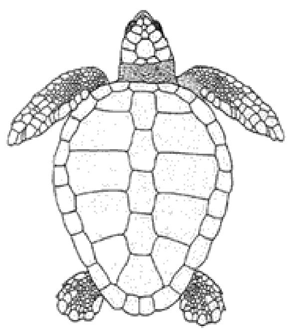
Wyneken, J. 2003. The external morphology, musculoskeletal system, and neuro-anatomy of sea turtles, p.39-77. In: P.L. Lutz, J.A. Musick and J. Wyneken (Editors), The Biology of Sea Turtles Volume II. CRC Press, Boca Raton, Florida.

Wyneken, J., D.R. Mader, E.S. Weber III and C. Merigo. 2006. Medical care of sea turtles, chapter 76: 972-1007, In: D.R. Mader (Editor), Reptile Medicine and Surgery, Second Ed. W.B. Saunders Co., St. Louis, Missouri.

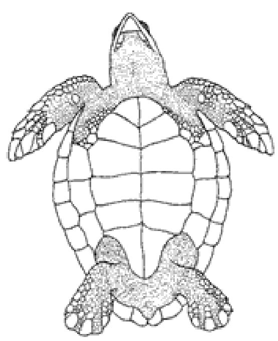
APPENDIX A

SPECIES IDENTIFICATION

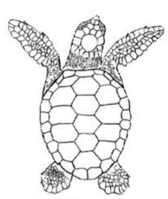
***Caretta caretta*: Loggerhead (Eng), Caguama (Sp), Caouanne (Fr)**



Adult (top)



Adult (bottom)



Hatchling

Head

Physical Characteristics

- Named for: Relatively large head (up to 10 inches [25 cm] in width)
- Length-adult: Carapace (upper shell) length of 3-4 feet (ca. 1-1.2 m)
- Length-hatchling: Carapace length of 1.7-1.8 in (ca. 44-48 mm)
- Weight-adult: to 400 lb (ca. 100-180 kg)
- Color-adult: Carapace is reddish-brown; plastron (belly) is light yellow to light brown
- Color-hatchling: Uniform in color, red-brown to grey-black

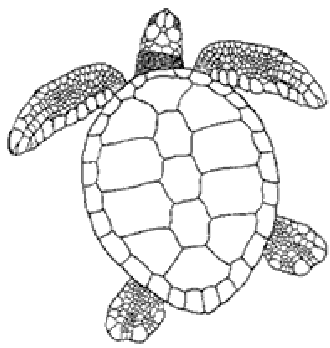
Caribbean Reproduction/Nesting

- Peak nesting: May-July
- Number of nests: On average, 3-4 per season at 13-15-day intervals
- Average "clutch size" (=eggs per nest): 100-120 eggs
- Incubation time: ca. 50-75 days

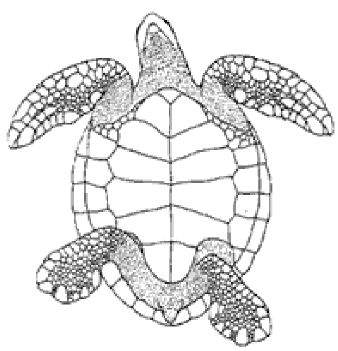
Global Status

- Endangered (IUCN *Red List of Threatened Species*); international trade prohibited by CITES; protected under the Protocol concerning Specially Protected Areas and Wildlife (SPAW) to the UNEP Cartagena Convention; protected under the Inter-American Convention for the Protection and Conservation of Sea Turtles

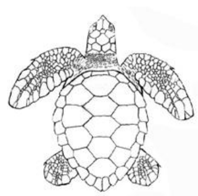
***Chelonia mydas*: Green Turtle (Eng), Tortuga verde (Sp), Tortue verte (Fr)**



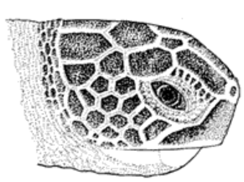
Adult (top) *



Adult (bottom)



Hatchling



Head

(*) drawings are not to scale with respect to size differences among species

Physical Characteristics

- Named for: Color of body fat (tinted from a diet of seagrass)
- Length-adult: Carapace (upper shell) length of 3-4 feet (ca. 1-1.2 m)
- Length-hatchling: Carapace length of 1.9 in (ca. 49 mm)
- Weight-adult: to 400 lb (ca. 120-180 kg)
- Color-adult: Carapace is mottled gray, green, brown and black; plastron (belly) is pale yellow
- Color-hatchling: black carapace, white plastron

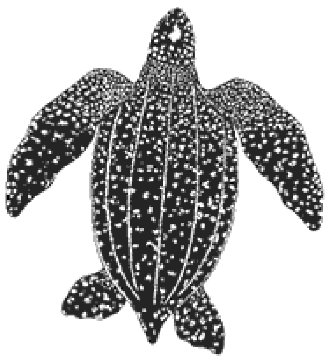
Caribbean Reproduction/Nesting

- Peak nesting: May-September
- Number of nests: On average, 3-5 per season at 12-14 day intervals
- Average "clutch size" (=eggs per nest): 110-140 eggs
- Incubation time: 50-70 days

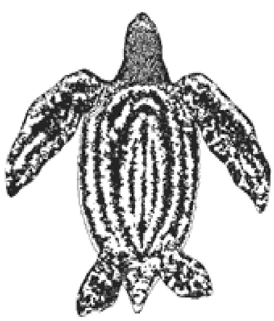
Global Status

- Endangered (IUCN *Red List of Threatened Species*); international trade prohibited by CITES; protected under the Protocol concerning Specially Protected Areas and Wildlife (SPAW) to the UNEP Cartagena Convention; protected under the Inter-American Convention for the Protection and Conservation of Sea Turtles

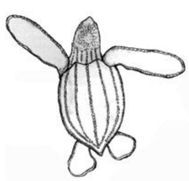
***Dermochelys coriacea*: Leatherback (Eng), Tortuga Laúd (Sp), Tortue luth (Fr)**



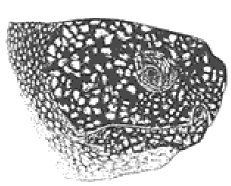
Adult (top)



Adult (bottom)



Hatchling



Head

Physical Characteristics

- Named for: Lack of a bony carapace (upper shell); leathery skin
- Length-adult (female): Carapace length of 4.5-6 feet (ca. 1.4-1.8 m), with 7 prominent ridges
- Length-hatchling: Carapace length of 2.4-2.6 in (ca. 60-65 mm)
- Weight-adult (female): 550-1400 lb (ca. 250-650 kg) [males to 2000 lb (920 kg)]
- Color-adult: Carapace and plastron (belly) both gray/black with white or pale spots
- Color-hatchling: Carapace is black with white spots, plastron is mottled black and white

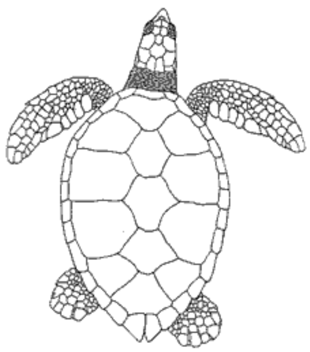
Caribbean Reproduction/Nesting

- Peak nesting: March-July
- Number of nests: On average, 6-9 times per season at 9-11 day intervals
- Average "clutch size" (=eggs per nest): 80-90 [yolked] eggs
- Incubation time: 50-75 days

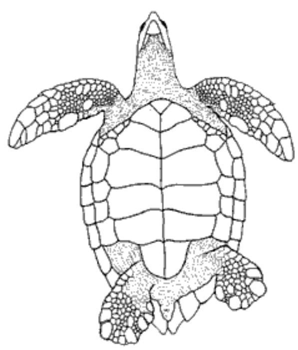
Global Status

- Critically Endangered (IUCN *Red List of Threatened Species*); international trade prohibited by CITES; protected under the Protocol concerning Specially Protected Areas and Wildlife (SPAW) to the UNEP Cartagena Convention; protected under the Inter-American Convention for the Protection and Conservation of Sea Turtles

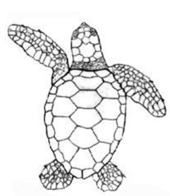
***Eretmochelys imbricata*: Hawksbill (Eng), Tortuga Carey (Sp), Tortue imbriquée (Fr)**



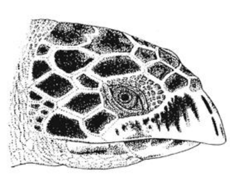
Adult (top)



Adult (bottom)



Hatchling



Head

Physical Characteristics

- Named for: Hawk-like beak
- Length-adult: Carapace (upper shell) length of 2-3 feet (ca. 60-90 cm)
- Length-hatchling: Carapace length of 1.6-1.8 in (ca. 40-45 mm)
- Weight-adult: 132-176 lb (ca. 60-80 kg)
- Color-adult: Carapace is brown, black, and amber; Plastron (belly) is yellow
- Color-hatchling: Uniform in color, grey or brown

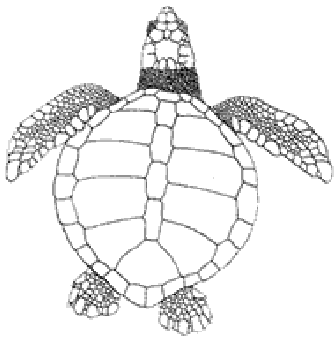
Caribbean Reproduction/Nesting

- Peak nesting: April-November
- Number of nests: On average, 4-5 times per season at 14-15 day intervals
- Average "clutch size" (=eggs per nest): about 160 eggs
- Incubation time: 50-75 days

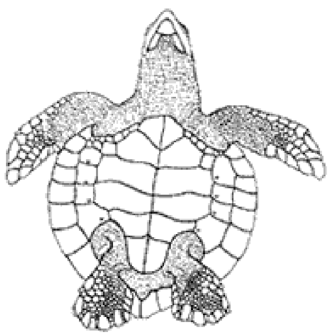
Global Status

- Critically Endangered (IUCN *Red List of Threatened Species*); international trade prohibited by CITES; protected under the Protocol concerning Specially Protected Areas and Wildlife (SPAW) to the UNEP Cartagena Convention; protected under the Inter-American Convention for the Protection and Conservation of Sea Turtles

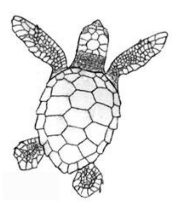
***Lepidochelys kempii*: Kemp's ridley (Eng), Tortuga Lora (Sp), Tortue de Kemp (Fr)**



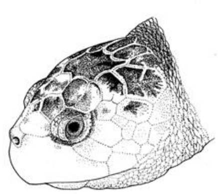
Adult (top)



Adult (bottom)



Hatchling



Head

Physical Characteristics

- Length-adult: Carapace (upper shell) length of 2-2.5 feet (ca. 60-75 cm), smallest sea turtle
- Length-hatchling: Carapace length of 1.6-1.8 in (ca. 40-47 mm)
- Weight: 75-110 lb (ca. 35-50 kg)
- Color-adult: Carapace is grey or black; Plastron (belly) is pale yellow (a single pore is evident in each inframarginal scute)
- Color-hatchling: Uniform in color; grayish black.

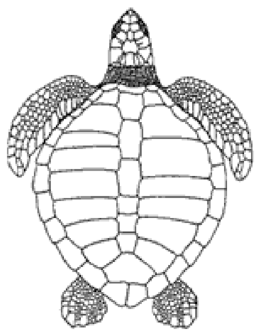
Caribbean [Gulf of Mexico] Reproduction/ Nesting

- Peak nesting: April-July, nests only in the Gulf of Mexico
- Number of nests: On average, 2-3 times per season; daytime nester
- Average "clutch size" (=eggs per nest): 100-105 eggs
- Incubation time: about 45-55 days

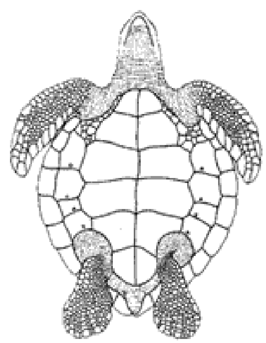
Global Status

- Critically Endangered (IUCN *Red List of Threatened Species*); international trade prohibited by CITES; protected under the Protocol concerning Specially Protected Areas and Wildlife (SPAW) to the UNEP Cartagena Convention; protected under the Inter-American Convention for the Protection and Conservation of Sea Turtles

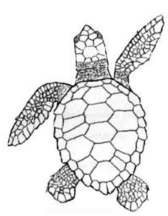
Lepidochelys olivacea: Olive ridley (Eng), Golfina (Sp), Tortue olivâtre (Fr)



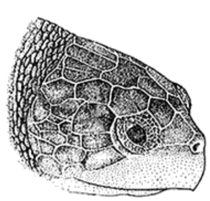
Adult (top)



Adult (bottom)



Hatchling



Head

Physical Characteristics

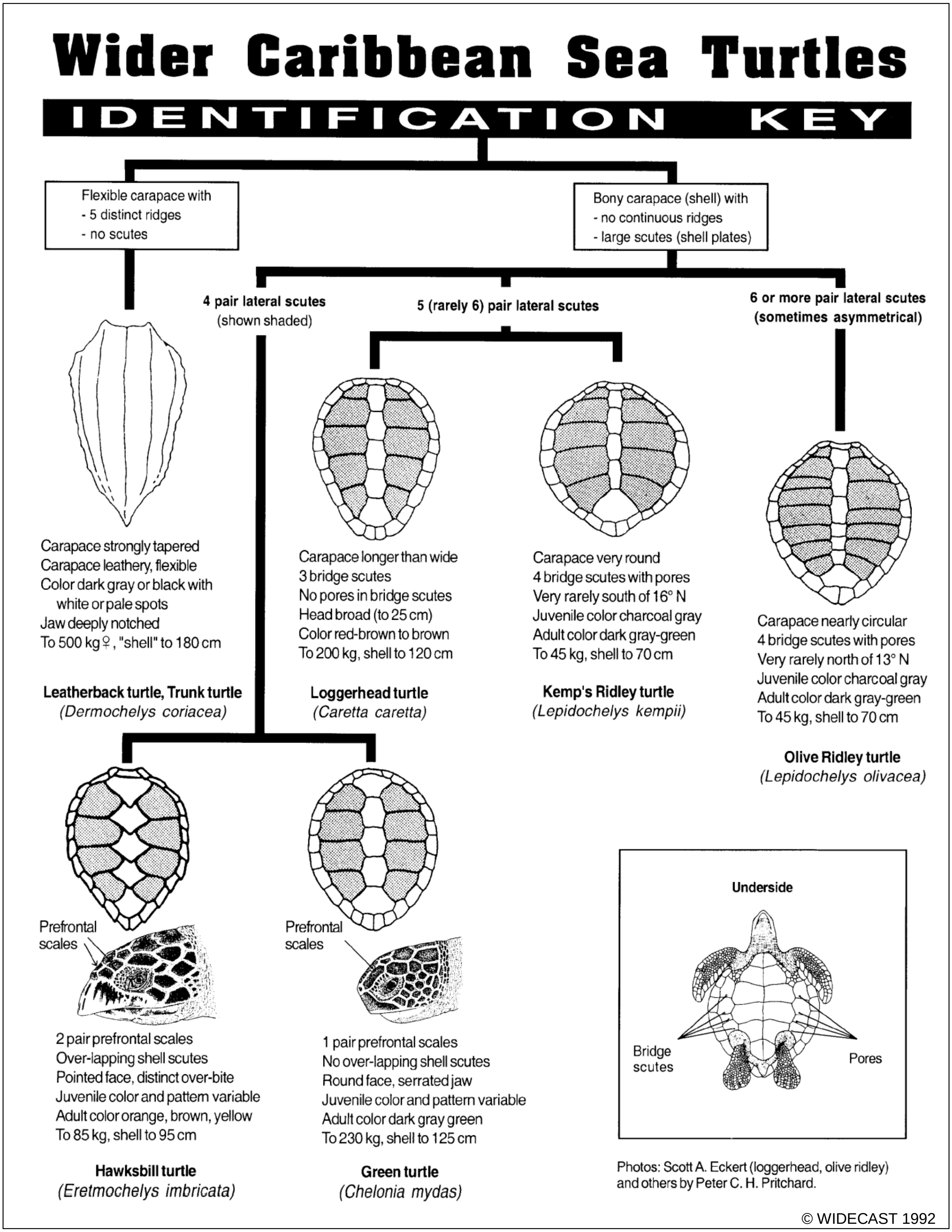
- Length-adult: Carapace (upper shell) length of 2-2.5 ft (ca. 60-75 cm)
- Length-hatchling: Carapace length of 1.5-2 in (ca. 38-50 mm)
- Weight: 75-110 lb (ca. 35-50 kg)
- Color-adult: Carapace is dark grey/green; Plastron (belly) is yellowish-white (a single pore is evident in each inframarginal scute)
- Color-hatchling: Uniform in color, grayish black

Caribbean Reproduction/Nesting

- Peak nesting: April-August
- Number of nests: On average, 1-2 times per season at 17-30 day intervals
- Average "clutch size" (=eggs per nest): 105-115 eggs
- Incubation time: about 55 days

Global Status

- Vulnerable (IUCN *Red List of Threatened Species*); international trade prohibited by CITES; protected under the Protocol concerning Specially Protected Areas and Wildlife (SPAW) to the UNEP Cartagena Convention; protected under the Inter-American Convention for the Protection and Conservation of Sea Turtles


Wider Caribbean Sea Turtles
IDENTIFICATION KEY
Flexible carapace with
- 5 distinct ridges
- no scutes
Bony carapace (shell) with
- no continuous ridges
- large scutes (shell plates)
4 pair lateral scutes
(shown shaded)
5 (rarely 6) pair lateral scutes
6 or more pair lateral scutes
(sometimes asymmetrical)
Carapace strongly tapered
Carapace leathery, flexible
Color dark gray or black with white or pale spots
Jaw deeply notched
To 500 kg♀, "shell" to 180 cm
Leatherback turtle, Trunk turtle
(Dermochelys coriacea)
Carapace longer than wide
3 bridge scutes
No pores in bridge scutes
Head broad (to 25 cm)
Color red-brown to brown
To 200 kg, shell to 120 cm
Loggerhead turtle
(Caretta caretta)
Carapace very round
4 bridge scutes with pores
Very rarely south of 16° N
Juvenile color charcoal gray
Adult color dark gray-green
To 45 kg, shell to 70 cm
Kemp's Ridley turtle
(Lepidochelys kempii)
Carapace nearly circular
4 bridge scutes with pores
Very rarely north of 13° N
Juvenile color charcoal gray
Adult color dark gray-green
To 45 kg, shell to 70 cm
Olive Ridley turtle
(Lepidochelys olivacea)
Prefrontal scales
2 pair prefrontal scales
Over-lapping shell scutes
Pointed face, distinct over-bite
Juvenile color and pattern variable
Adult color orange, brown, yellow
To 85 kg, shell to 95 cm
Hawksbill turtle
(Eretmochelys imbricata)
Prefrontal scales
1 pair prefrontal scales
No over-lapping shell scutes
Round face, serrated jaw
Juvenile color and pattern variable
Adult color dark gray green
To 230 kg, shell to 125 cm
Green turtle
(Chelonia mydas)
Underside
Bridge scutes
Pores
Photos: Scott A. Eckert (loggerhead, olive ridley) and others by Peter C. H. Pritchard.
© WIDECAST 1992

APPENDIX B

SAMPLE DOCUMENTATION FORMS

There is no “one correct way” to document the rehabilitation process, but procedures and protocols should be established in such a way that they are (i) easily understood by staff and volunteers, (ii) meet the demands of the attending veterinarian, and (iii) meet the requirements of relevant permits or policy.

The following forms can be used as templates, or models, for your use:

After completing a stranding form, including complete information on where and when the turtle was found, and contact details for the observer(s) involved (**Form A**), each turtle should be subjected to an initial assessment (**Form B** and/or **Form C**, or some combination that meets your needs) prior to admittance to the facility. Once a turtle is admitted, daily logs should be kept for water quality (**Form D**) and medications dispensed (**Form E**), as well as for recording details associated with feeding, diet, and behavior (**Form F**). Individual charts should be available for veterinary exams (**Form G** and **Form H**).

Form A[10]

Stranding Event Data Sheet

Key

Turtle Condition	Weather
Alive	Broken Clouds
Fresh Dead	Clear
Moderately Decompos	Overcast
Unknown	Rain
Very Decomposed	Stormy/Strong Wind
	Unknown

Species

Gender

Project

Page #

Date

Time

Project ID

Weather

Location

Location Name

Zone Name

Longitude

Latitude

Observers

Tag Number

		New
Flipper		☐
Flipper		☐
Flipper		☐
Flipper		☐
Flipper		☐
PIT		☐
PIT		☐

	Landmark Name / Number	Dist. from Landmark
A		
B		
C		

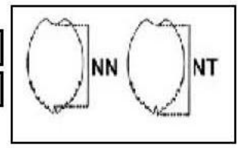
Turtle Condition

Necropsy Report

Notes

Physical Description

	NT	NN
CCL (cm)		
SCL (cm)		
CCW (cm)		
SCW (cm)		



☐ Does carapace damage affect measurement ?

Weight (kg):

Diagnostic Injuries

Parasites and Ectobiota

Tag Scars

☐ Left Front
☐ Right Front
☐ Left Rear
☐ Right Rear

Stranding Event Reporting Form designed by the Wider Caribbean Sea Turtle Conservation Network - www.widecast.org

[10] WIDECAST provides free tags, tagging equipment, training, and database management software from its regional Marine Turtle Tagging Centre at the University of the West Indies, Barbados (http://www.widecast.org/What/Regional/Tagging.html). This stranding report form is one of several standard entry forms associated with the relational database. See Phelan and Eckert (2006) and Eckert and Sammy (2008) for detailed instructions on how to complete the data form.

Form B

WIDECAST SEA TURTLE TRAUMA RESPONSE CORPS: FIRST-RESPONSE DATA FORM

Observer (name/ tel #): ____
Location: ____
Date: ______________________ **Time:** __________ **AM PM**
Species (if known): ______________________ **Condition: LIVE DEAD**

Instructions: **check all that apply**, and use the back of the form for notes. If the animal is dead, attach the form to the completed STRANDING DATA FORM. If the animal is alive, use this form to document any first response action. If the animal is released on-site, submit this form to your national STTRC Coordinator or other authority. If the animal is transported for additional care, make sure that this form stays with the animal (your initial observations are important to the veterinarian) and that the Observer can be contacted again if necessary.

Healthy

☐ The turtle lifts its head strongly when breathing.

☐ When a flipper is gently pulled, there is a strong withdrawal reaction.

☐ When placed on solid ground, the turtle attempts to make crawling movements.

☐ When the turtle is lifted, it moves as if swimming and it holds its limbs and head above the plane of the ventral surface of the body. → **Released to the sea: ☐ YES ☐ NO**

Injured/Sick

☐ Movements are very erratic or spasmodic and non-directional, appearing uncontrolled.

☐ The turtle shows a weak localized flinch response by closing its eyes when you lightly touch the eye or the upper eyelid with your finger.

☐ The turtle shows only a weak withdrawal, or no response, when a flipper is gently pulled or when light pressure is applied to the neck.

☐ When the turtle is lifted it does not move, and its limbs and head are held below the plane of the ventral (lower) surface of the body.

☐ There are visual signs of trauma, such as deep cuts, shell breakage, fishing gear (line, net, hook) entanglement or ingestion, oil/tar contamination, or the results of blunt force.

☐ The turtle is covered in parasites or shows signs of dehydration, e.g. sunken eyes and skin, soft shell, unnaturally thin (neck or shoulders shrunken away from the shell).

Inactive

☐ No response, or an undetectable response, when you lightly touch the eye or upper eyelid with your finger.

☐ No withdrawal reaction when a flipper is gently pulled or light pressure is applied to the neck.

☐ The turtle makes no attempt to move on solid ground.

Dead

☐ The turtle does not respond to any physical stimulus.

☐ The turtle's flesh has begun to decompose (rot) and there is a foul odor.

☐ *Rigor mortis* is apparent.

Form C

Turtle Assessment Sheet

Head
retract when slightly pulled: Y N
lesions or abnormalities: Y N If Y describe______________________

Resp
sound: clear gurgle other: ______________________
Strength: head up/mouth open Y N If Y: weak moderate strong
head down/mouth open Y N
head down/mouth closed/throat expansion only Y N
carapace expansion none weak moderate strong

Eyes
open closed
menace response: Left: Y N
Right: Y N
palpebral reflex: Left: Y N
Right: Y N
lacrimal secretion: not present present
lesions or abnormalities: Y N If Y describe______________________

Nose
discharge: Y N If Y describe ______________________
lesions or abnormalities: Y N If Y describe______________________

Mouth
jaw tone: strong moderate weak slack
color of MM: normal pale hyperemic jaundice cyanotic
lesions or abnormalities: Y N If Y describe______________________

Beak
note any abnormalities

Carapace
lesions or abnormalities: Y N If Y describe:______________________
epibiota: Y N type of eptibiota: leeches barnacles
epitbiota coverage: 0-25% 26-50% 51-75% 76-100%

Plastron
sunken appearance: Y N If Y: mild moderate severe
lesions or abnormalities: Y N If Y describe:______________________
epibiota: Y N type of eptibiota: leeches barnacles
epitbiota coverage: 0-25% 26-50% 51-75% 76-100%

Flippers
lesions or abnormalities: Y N If Y describe: ______________________
motion of appendages appear normal: Y N If N explain: ______________________
pinch/pull away reflex present: Y N If Y: weak moderate strong

Skin-
lesions or abnormalities: Y N If Y describe:______________________
epibiota: Y N type of eptibiota: leeches barnacles
epitbiota coverage: 0-25% 26-50% 51-75% 76-100%

Urogenital
cloacal tone: Y N If Y: weak moderate strong
lesions or abnormalities: Y N If Y describe______________________
defecation: Y N If Y describe amt/type______________________

Tail
lesions or abnormalities: Y N If Y describe:______________________
pinch/pull away reflex present: Y N If Y: weak moderate strong

Swimming Evaluation

Able to submerge and swim normally Y N
If N: describe
Floating Y N
If Y: Able to submerge
Listing Y N if Y : right left alternates

Form D

GENERAL WATER QUALITY LOG

Exhibit or ID#

DATE	Temp AM	Temp PM	pH	alk mg/L	salinity ppt	ammonia mg/L	nitrite mg/L	nitrate mg/L	cu $^{+2}$ mg/L	Bicarb added	Reef Build added	% H20 change	Notes

Form E

Species/Common Name:______________________________ **Case #**________________

Medical problem: ______________________ **Location:** ________ **Wt./Vol.:** ___________

Medication: ____________________ **Drug Concentration:** ____________ **Dosage:** ________

DOSE: __________ **FREQ:** ______________ **Route:**________ **Start:**________ **Stop:**________

Special Instructions ____

____

Date	Time	Treatment/Observations/Remarks	Initial

Frequency
OID = One time a day
BID = Two times a day
TID = Three times a day
QID = Four times a day

QnH = Every n hours
QnD = Every n days

Route
SC = Subcutaneous
IM = Intramuscular
IP = Intraperitoneal
IV =Intravenous

PO = Oral
ID = Intradermal
IT = Intratracheal
IC = Intracardiac

Form F

Sea Turtle Rehabilitation Daily Log

Name and Case No. ______________

Date	Temp	Fish (Type)	Other	Blue Crab	Vitamins	Total Fed (lbs)	Logged meds?	Hydroclean	Pump Basket	Water Δ (%)	Scub Tank	Behavior/Comments	Initials

BF-Butterfish **BR**-Blue Runner **B**-Bluefish **C**-Capelin **H**-Herring **M**-Mackerel **S**-Salmon **SM**-Smelt

Form G

Initial Sea Turtle Examination Form

Date:	Species:	Animal Name:
Field #:	Weight:	Examiner:

Stranding Circumstances:

Physical Examination (Circle One)

Attitude:	alert	depressed	lethargic		non-responsive
Condition:	normal	thin	emaciated		obese
MM:	normal	pale	injected	jaundiced	cyanotic

Initial Stats

Temperature: Heart Rate: Heart rhythm:

Able to log: **Y N**

Downloaded data**: Y N**

Samples/Diagnostics

1. Blood:

Date/Time			
Amount			
Initials			

Tests requested:

2. Cultures: Sample site:

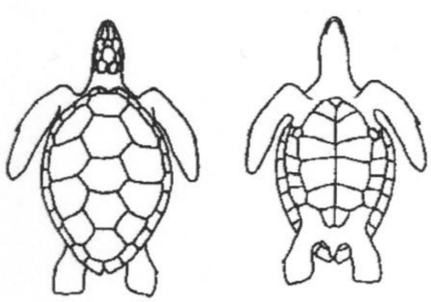
3. Fecal collected **Y N** Completed smear **Y N** Baermann Funnel used **Y N**

stored in refrigerator**: Y N**

4. Radiographs taken: **Y N** # taken: Views:

Primary Findings: ____________________

Mark wounds or abnormalities on diagrams below and describe to right



Initial Disposition

Water or Dry docked? Why:____________________

Health category: Intensive care Recovery Maintenance Probable Healthy

Behavior Assessment completed**: Y N** Physical Assessment completed**: Y N**

Form H [11]

Daily Soap Sheet

Field #: ______________________ **Species:** ______________ **Date:** ______
Location: ______________________________ **M T W TH F S SU**

Subjective: ____

Objective:
Weight: ____________ **Heart Rate:** ____/minute **Respiration:** ________/minute

Assessment/Problem:
1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________
6. ______________________________

Plan:
Diagnostic Procedures:
1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________
6. ______________________________

Treatment:
1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________
6. ______________________________

Comments: ______________________________

[11] S.O.A.P. is an acronym for the data form's entry sections: **S**ubjective/ **O**bjective/ **A**ssessment/ **P**lan.

APPENDIX C

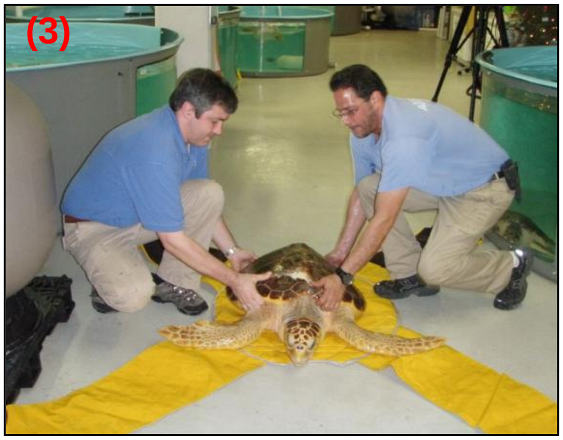
CUSTOMIZED TURTLE STRETCHER

When the need arises to restrain a sea turtle, the Sea Turtle Rescue Program at the South Carolina Aquarium (http://www.scaquarium.org/STR) uses a custom-made “turtle stretcher” with Velcro™ flaps that can be secured cross-ways over the flippers and on top of the carapace. These stretchers are best used with sea turtles that have severely compromised shells (such as a fracture resulting from a boat strike) or severely debilitated turtles with soft, unstable shells. In cases such as these, handling the shell could further injure the turtle.

The photo essay presented here, courtesy of Kelly Thorvalson at the SCA Sea Turtle Rescue Program, illustrates the technique on a turtle *without* a severe shell injury – but remember that the idea is to use the stretcher, not your hands, to lift and handle a turtle with a severely injured or unstable shell.

For more information, please contact the manufacturer:

William Blanchard Company, Inc.
Attn: Diane Davis
Email: wmblanchardco@verizon.net
Telephone: + (781) 245-8050




(4)


(5)


(6)


(7)


(8)

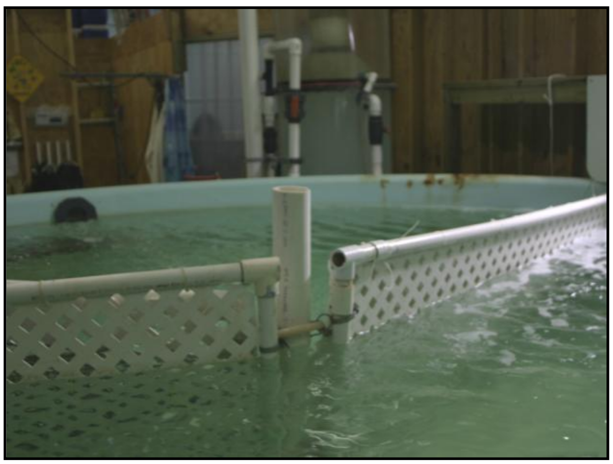
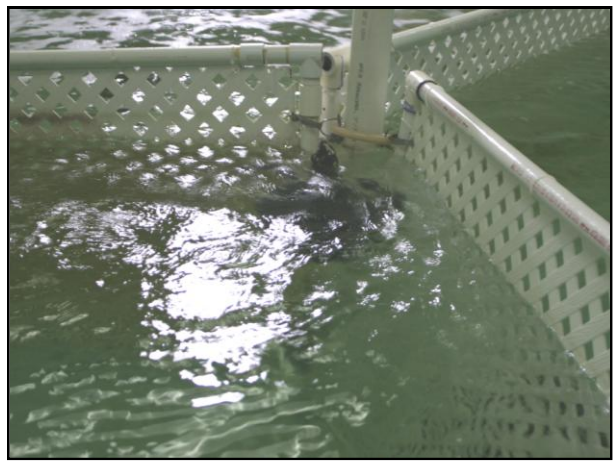
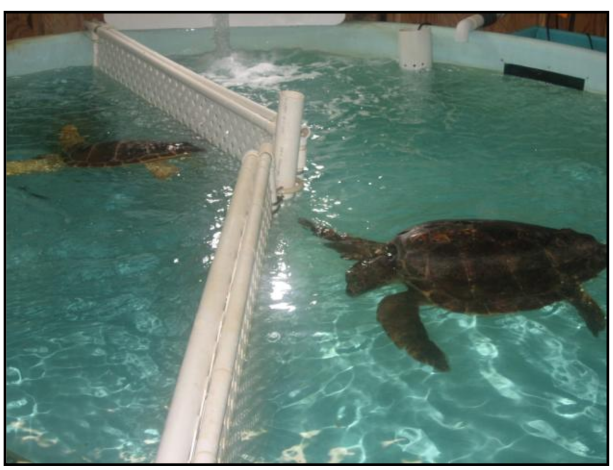

(9)

APPENDIX D

TANK DIVIDERS

The dividers are made of 5 cm (2 inch) PVC pipe around the perimeter with lattice in the center. To create, attach the lattice to the PVC pipe using screws, clamps and/or nylon cable ties. Use flexible tubing for the curved area of the divider that will run along the side of the tank. Add approximately 30-45 cm (1.0-1.5 feet) of extra PVC pipe on the top to overhang the tank.

The center pole is 7.5 cm (3 inch) PVC with cement on the bottom (be sure the cement is sealed so that it doesn't break down in the salt water). Attach a bone ring for dogs to the top and bottom of the divider with hose clamps, then slip the bone ring over the 7.5 cm (3 inch) PVC pipe in the center.

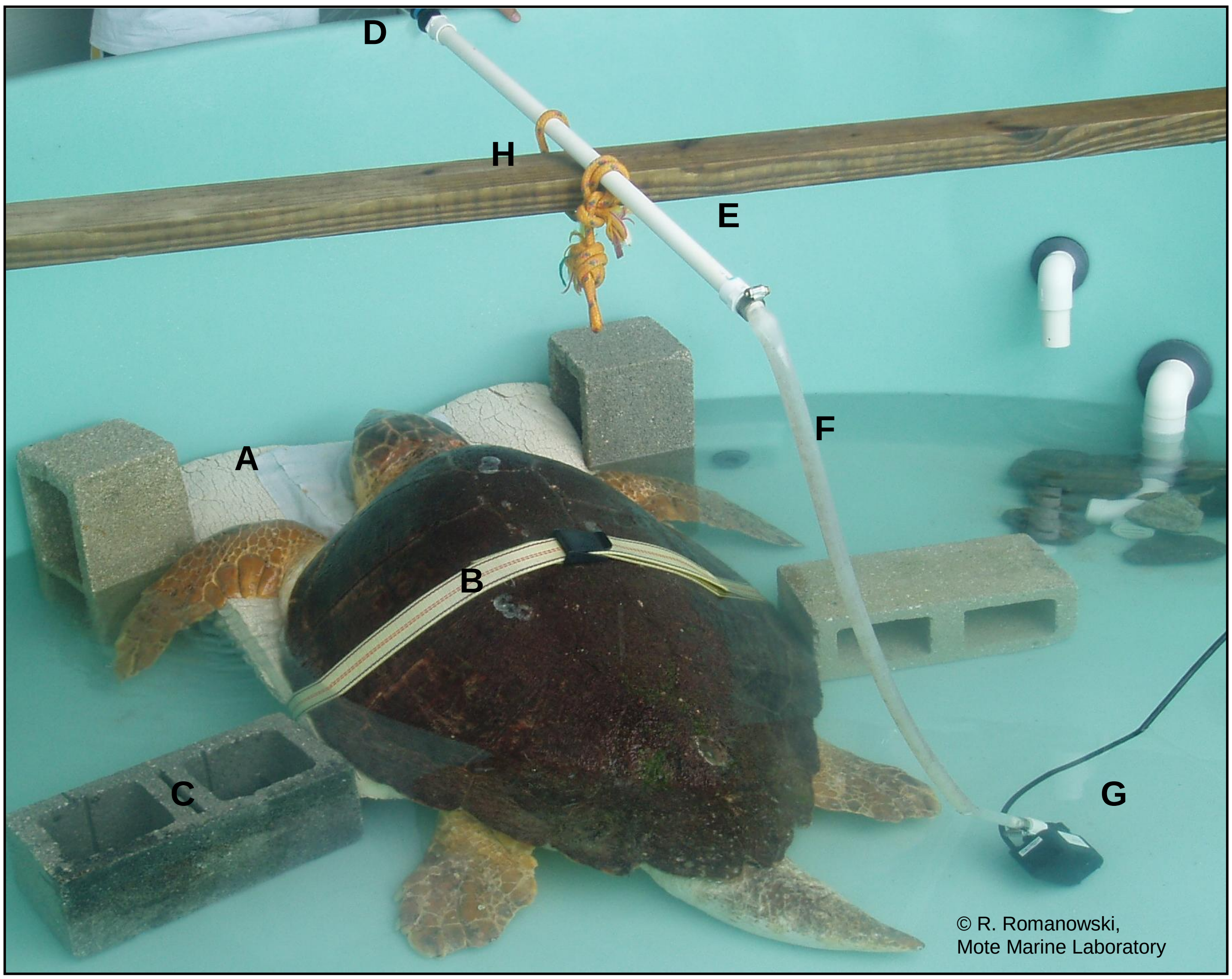





APPENDIX E

ADVANCED DRY-DOCK SET-UP

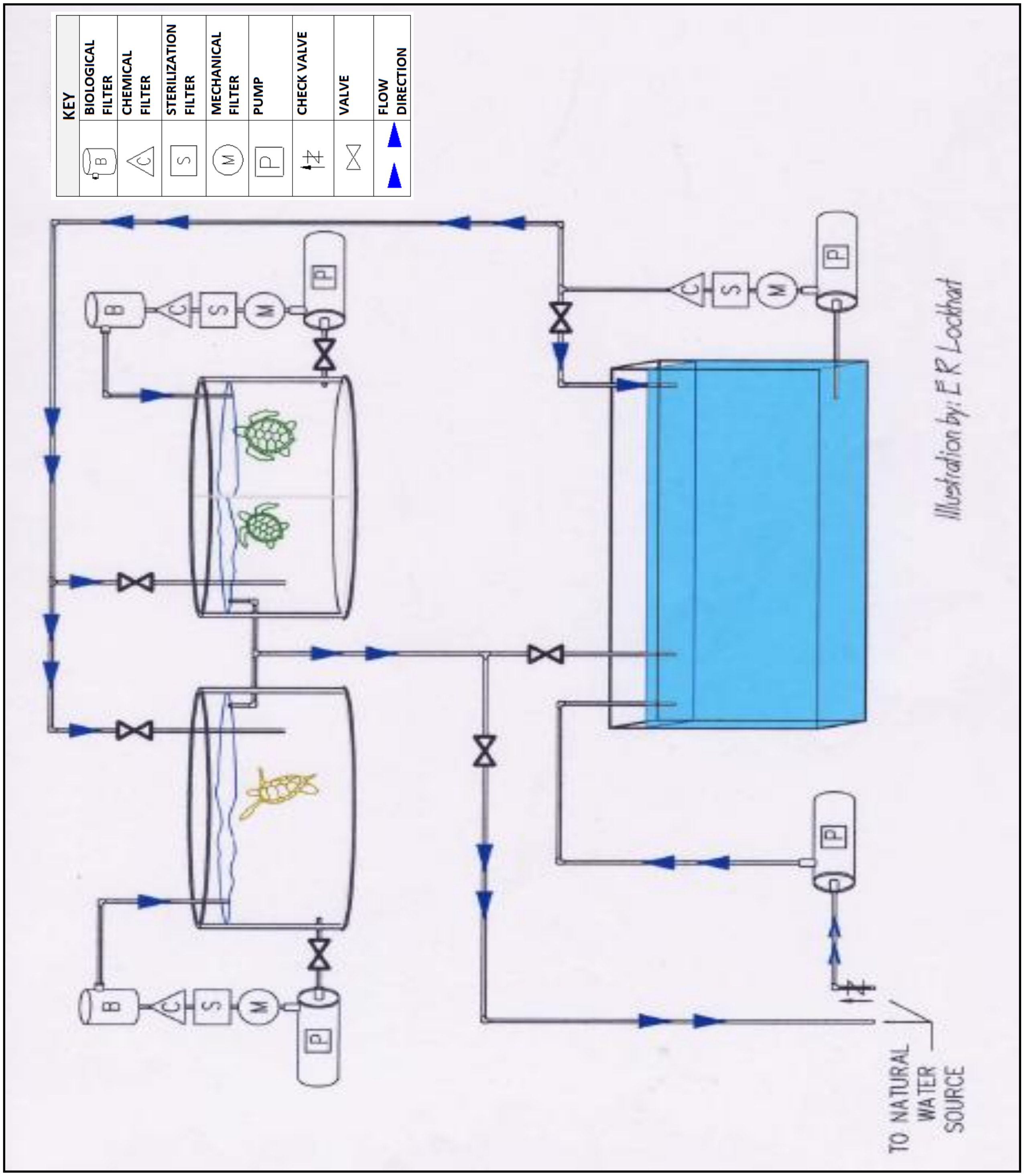
For advanced set-up, secure the turtle on a padded or foam cushion (A). A dive belt (B), surrounding both the turtle and the padding, is useful to ensure that the turtle does not slip. Cement blocks (C) may be placed around turtle for additional support. Overhead, a mister (D) may be attached to a pipe (E), hose (F), and small pump (G). Attach the mister by rope to a piece of wood or PVC pipe (H) that hangs over the tank.

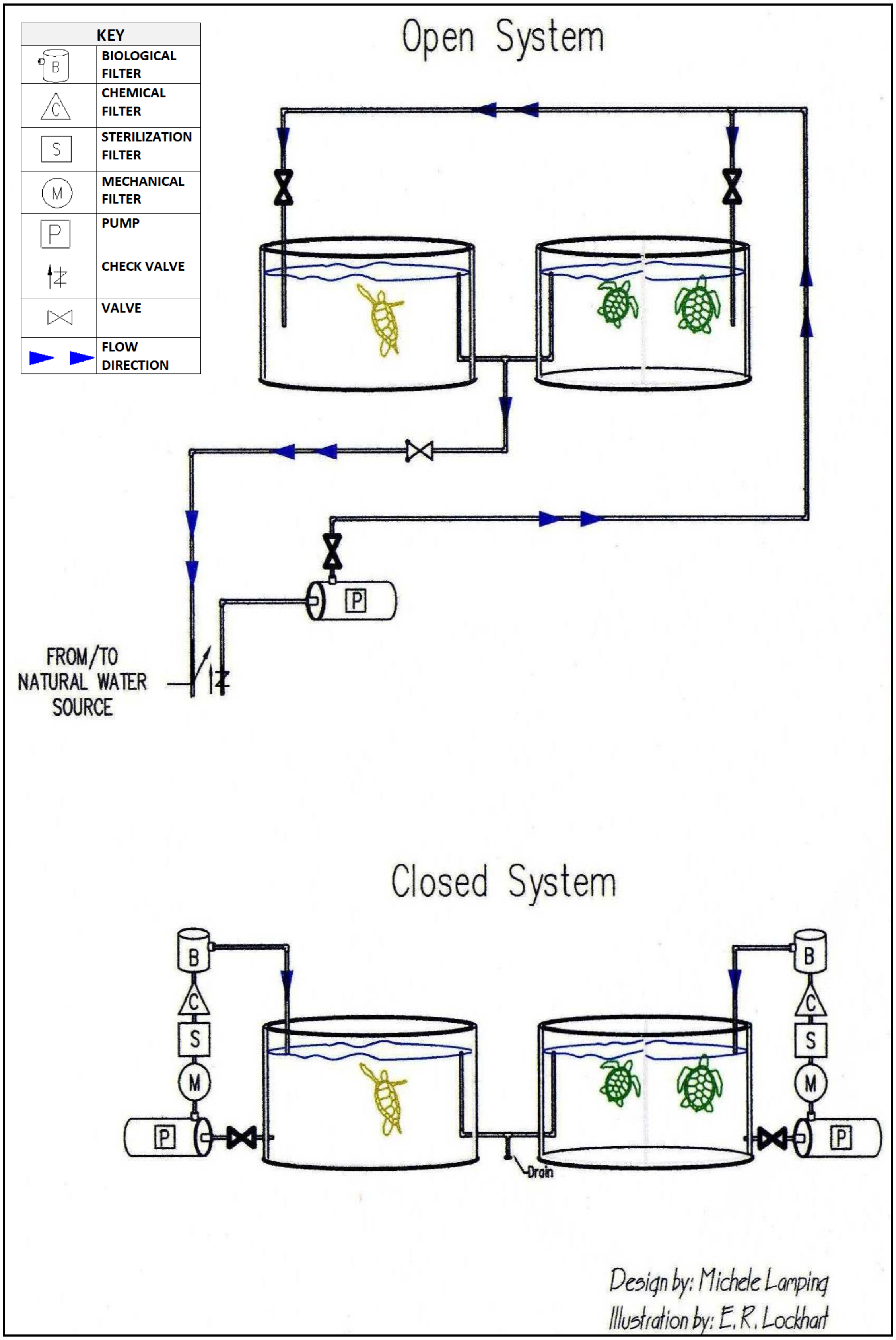
Note: This type of set-up is for severely debilitated turtles that are not active. Once the sea turtle becomes active, this type of set-up should *not* be used. If an active sea turtle is placed in this configuretion, there is a risk of harm to the animal due to entanglement in or ingestion of small pipes, hoses, cords, and so on.



APPENDIX F

WATER SYSTEM DIAGRAMS




KEY
BIOLOGICAL FILTER
CHEMICAL FILTER
STERILIZATION FILTER
MECHANICAL FILTER
PUMP
CHECK VALVE
VALVE
FLOW DIRECTION
B
C
S
M
P
Open System
FROM/TO NATURAL WATER SOURCE
Closed System
Drain
Design by: Michele Lamping
Illustration by: E.R. Lockhart

APPENDIX G

FOOD GUIDE

The nutritional requirements of amphibians and reptiles (including sea turtles) are poorly understood (Goldman et al., 1998), and the foods that can be provided to these creatures in captivity rarely resemble their natural diets. Providing balanced nutrition for amphibians and reptiles is challenging, but a varied diet is likely to be more nutritious and more readily accepted than a diet consisting of only one kind of food (Pough, 1992).

Sea turtles, which in general are omnivorous in the wild (e.g., Mortimer, 1982; Bjorndal, 1985, 1997), are typically fed a selection of locally available vegetables and seafood during periods of captivity. The typical diet consists of a leafy, dark green vegetable such as Romaine or cos lettuce (*Lactuca sativa* L. var. *longifolia*) mixed with cut-up whole fish, crabs, whole shrimp (with shell), and/or squid. This simple mixed diet will sustain a juvenile or adult turtle (not a hatchling) for a month or two, but, for long-term residents, multivitamin supplements (e.g., Mazuri®, SeaTabs®, multi-vitamins used in humans) should be administered twice weekly. Thiamine (25 mg/ kg fish) and vitamin E (100 IU/kg of fish) are particularly important (Terry Norton, DVM, pers. comm.).

As a general guide, turtles should be fed 1-3 times per day (for a total of 1-5% of their body weight on a daily basis), tending to the lower percentage for maintenance and the higher percentage for sick, emaciated and/or younger turtles. The number of meals is dependent upon the amount of food desirable for the turtle to consume, as well as the frequency that any medications need to be given. Additional feedings may be necessary for turtles that require more food, or to encourage reluctant eaters; for these and other reasons, several smaller meals are generally preferred over fewer larger meals. Larger food items should be cut into smaller pieces to minimize the risk of intestinal blockage.

Each meal should be prepared under sanitary conditions, properly weighed and recorded for each turtle prior to feeding, any uneaten food should be collected and discarded, and food items should not be shared among turtles (see *Section VI: Diet* for details on food quantity, storage and preparation, as well as on feeding techniques).

Special Cases

The green turtle (*Chelonia mydas*) is the only herbivorous sea turtle. It relies on fermentative digestion and shows characteristic morphological and physiological specializations of the gut. Food particle size, the ratio of fruit to foliage, and the ratio of plant to animal material can affect digestibility and the assimilation of energy and nutrients (Bjorndal, 1989, 1991; Bjorndal et al., 1990). It is a common mistake to feed captive green turtles a strict diet of lettuce, which compares poorly (from a nutritional standpoint) with a diet of seagrass.

The leatherback turtle (*Dermochelys coriacea*) should not be confined. The species' unique needs (e.g., unobstructed long-distance swimming, jellyfish diet) cannot be met without specialized facilities and a highly trained and experienced staff. Leatherback hatchlings have been successfully reared, but typically only for short periods (a few weeks to a few months) and their health and development have not been optimal. The most recent success was at the University of British Columbia (Jones, 2009) where hatchlings were hand-fed turtles 3-5 times per day to satiation on an enriched squid-gelatin diet. See "A Note about Leatherback Turtles" in *Section IV: Admitting a Patient*.

Recipes

The following recipes were contributed by experienced sea turtle rehabilitation facilities and represent special cases, such as tube-feeding of severely dehydrated turtles and gelatin diets for hatchlings and very young sea turtles.

Gruel

Purpose: Tube-feeding dehydrated turtles

Ingredients: Fish – any fish can be used, but herring is particularly good for emaciated sea turtles

Technique: Fillet fish, remove the skin. Add enough water so that, when blended, the mixture is runny enough to flow easily for tube feeding. The mixture tends to thicken and may need to be flushed with additional water prior to or during feeding.

As with most food preparation, the gruel should be made the morning of feeding, properly weighed, and refrigerated prior to use. The amount of gruel fed to the turtle is determined by percent body weight, and it should be administered with the advice of a veterinarian.

Gelatin Diet #1 **(courtesy of Virginia Aquarium and Marine Science Center)**

Purpose: This diet is intended primarily for hatchlings to ensure proper nutrients, but it can also be used for other life stages

Note: The type of fish used can change according to location and availability. The recipe is designed to provide several feedings for hatchlings, but may need to be doubled or tripled, or additional batches may need to be made, to meet the needs of larger turtles.

Ingredients:

426g	trout chow (sinking pellets), see *Commercial Diets and Supplements*
71g	cod filet pieces
71g	haddock filet pieces
71g	whiting filet pieces
71g	whole smelt pieces
170g	squid (with pens removed)
170g	shrimp (with shell on)
142g	broccoli or bok choy (fresh leaves)
142g	chopped carrots (fresh)
8	finely ground tablets of Pet-Cal® Vitamin Supplement
15	finely ground tablets of SeaTabs®
227g	unflavored gelatin[12]
750-1000ml	fresh water (tap water is fine)

[12] Both plant- and animal-based gelatins are available on the market and no difference in palette preference or product result was reported by experts reviewing this Husbandry Manual. However, it was noted that bulk quantities of edible gelatin are difficult to find and that animal-based products tend to be easier and cheaper to acquire.

Technique: Soak pellets in 250ml fresh water. Grind up vitamins with a mortar/pestle. Combine seafood, vegetables, and soaked pellets in a food processor and blend. Add ground-up vitamins and blend again. Boil 500ml water, remove from heat, add gelatin mixture, and mix well to remove any lumps. Add food processor mixture to gelatin mixture. Mix well and set into a clean tray (13 x 9 inch flexible plastic trays work well). The gelatin mixture can be stored in the refrigerator (maximum: one week) or freezer (maximum: six months).

Yields: From a 13 x 9 inch tray, cut 12 blocks of 3 x 2 x 1.25 inches (vary the cut to your preference, based on turtle size and weight).

Commercial Diets and Supplements

We realize that some of the commercial diets and supplements called for in these recipes may not be readily available in Wider Caribbean countries and territories. In most cases, especially for short-term care, you can substitute a product of similar nutritional value – in particular for protein, fat, carbohydrates, and vitamins. Dog food (small chunk), for example, might substitute for trout chow. If you are establishing a rescue and rehabilitation facility, or if you have reason to believe that you will be routinely called upon to care for sick or injured sea turtles, it would be useful to explore online sources of these diets and supplements so that they are available to you as needed.

Commercial Diets

“Trout chow” is a growth valued chow commonly used in the aquaculture industry. Any 40/10 (40% protein and 10% fat), high growth fish chow is acceptable, but particularly useful are the sinking (*vs*. floating) chows because they cause the gelatin to sink, making it easier for the sea turtle to consume. Some examples can be found in the *AquaMax* product line http://aquamax.purinamills.com/

AquaMax™ Brand FISH DIETS

April-07

Product Code	Product Number	Product Name	Product Inches	Product mm	Product Form	Minimum Protein, %	Minimum Fat, %	Maximum Fiber, %
5D00	7684	AquaMax Fry Power	Powder	Powder	Meal - Sink	50	17	3
5D01	5553	AquaMax Fry Starter 100	1/32	0.8 mm	Crumble - Sink	50	17	3
5D02	5554	AquaMax Fry Starter 200	3/64	1.2 mm	Crumble - Sink	50	17	3
5D03	5555	AquaMax Fingerling Starter 300	1/16	1.6 mm	Extruded - Sink	50	16	3
5D04	1466	AquaMax Grower 400	3/32	2.4 mm	Ext. - Sink/Float	45	16	3
5D05	45303	AquaMax Grower 500	3/16	4.8 mm	Extruded - Float	41	12	4
5D06	1468	AquaMax Developer 600	9/32	7.1 mm	Extruded - Float	41	12	4
5D07	1469	AquaMax Pond 2000	5/16	7.9 mm	Extruded - Float	32	3	5
5D08	7685	AquaMax Plus 3000	3/16	4.8 mm	Extruded - Float	32	5	5
5D09	1470	AquaMax Dense 4000	3/16	4.8 mm	Extruded - Float	36	6	5
5DA1	66904	AquaMax Largemouth	3/4 X 1	19.0 mm	Extruded - Float	45	10	3
5D19**	42146	AquaMax Grower - AX	7/32	5.6 mm	Extruded - Float	41	12	4
5D50**	66493	AquaMax Grower 400	1/16	1.6 mm	Ext. - Sink/Float	45	16	3

** Two (2) Ton Minimum

Source: http://aquamax.purinamills.com/aquamaxproductlist.pdf

Also used and recommended by some curators is Zeigler *Finfish Silver*, a fishmeal-based diet: http://www.zeiglerfeed.com/product_literature/aquaculture%20literature_finfish/Finfish%20Silver.pdf

Guaranteed Analysis

Crude Protein	Minimum	40%
Crude Fat	Minimum	10%
Crude Fiber	Maximum	4%
Moisture	Maximum	12%
Ash	Maximum	8%

Ingredients

This product contains marine protein and oil products, processed grain and vegetable products, processed poultry by-products, vitamins (including stable vitamin C), minerals and amino acids.

Note: If the gelatin diet is to be used for juveniles or adults that are healthy and not in need of additional caloric intake, we recommend a maintenance valued (*vs*. growth valued) chow.

Supplements

It can be difficult to acquire exotic animal supplements in some countries. Here we provide standard nutritional breakdowns for some commonly used products, recognizing that similar products with comparable nutritional components can be substituted based on local availability.

SeaTabs® vitamins come in two sizes and formulations: original *SeaTabs*® for larger marine animals (cetaceans and pinnipeds, such as dolphins, whales, seals, etc.), and a second formulation for birds, turtles, fish and smaller-sized sharks. The second formulation is used for sea turtles. For a guaranteed analysis or to make an order, visit http://www.pacificresearchlabsinc.com/seatabs.php

SEA TABS®
for Birds, Turtles, Fish and Sharks
GUARANTEED ANALYSIS

Per Tablet	Amount
Vitamin A (Acetate)	1,000 I.U.
Vitamin D3	20 I.U.
Vitamin E (DL-Alpha Tocopheryl Acetate)	50 I.U.
Vitamin C (Ascorbate)	10 mg.
Vitamin B1 (Thiamine Mononitrate)	50 mg.
Vitamin B2 (Riboflavin)	.25 mg.
Vitamin B6 (Pyridoxin)	.15 mg.
Vitamin B12 (Cyancobalamin)	2.0 mcg.
Niacin	.15 mg.
Pantothenic Acid	1.5 mg.
Folic Acid	.1 mg.
Biotin	2.0 mcg.
Choline	5.0 mcg.
Inositol	5.0 mcg.
Taurine	5.0 mcg.
Iodine (K1)	7.0 mcg.
Iron (FeSO4)	1.0 mg.
Copper (CuSO4)	.1 mg.
Magnesium (MgO)	.5 mg.
Zinc (ZnO)	.05 mg.
Manganese (MnSO4)	Trace
Kelp	1.0 mg.

Mazuri® products are available online at http://shop.mazuri.com/. Recommended are the *Mazuri® Vita-Zu® Shark/Ray* tablets (http://shop.mazuri.com/mazurivita-zusharkraytablets.aspx), see guaranteed analysis below. There are authorized Mazuri Exotic Animal Diet dealers in several Caribbean countries, including Aruba, Cayman Islands, Grenada, Jamaica, Mexico, Panama, USA (including Puerto Rico), and Venezuela (https://www.mazuri.com/Home.asp?Products=1&Opening=4).

Mazuri® Vita-Zu® Sharks/Rays **5M24**
Vitamin Supplement (1 tablet per 1/2 pound fish)
(Available at our TestDiet Unit (765)966-1885/testdiet@purinamills.com)

Description
Mazuri® Vita-Zu® Sharks/Rays tablets are formulated to provide supplemental water and fat soluble vitamins to sharks and rays.

Feeding Directions
- Feed to sharks/rays by placing tablet into the food fish.
- Feed 1 tablet per ½ pound of fish fed.

Product Form **Catalog #**
- Each tablet is 1.5 grams 7538
  - Elongated and scored in the middle so it can be easily broken in half.
  - 600 tablets per canister; 12 canisters per case.

Nutrient Composition (per 1.5 gm tablet)

Vitamin A	7,730 IU
Vitamin D_3	690 IU
Vitamin E	54 IU
Vitamin C	531 mg
Vitamin B_{12}	3.74 mcg
Thiamin	83 mg
Riboflavin	1.5 mg
Niacin	8 mcg
Pyridoxine	1.5 mg
Biotin	0.0285 mcg
Folic Acid	0.0004 mg
Pantothenic acid	4.1 mg
Iodine (as calcium iodate)	231 mg

Ingredients
Ascorbic acid (vitamin C), calcium iodate, dicalcium phosphate, dl-alpha tocopheryl acetate (source of vitamin E), dried corn syrup, thiamin mononitrate, microcrystaline cellulose, dried brewers yeast, vitamin A acetate, calcium pantothenate, pyridoxine hydrochloride, corn oil, riboflavin, cholecalciferol (vitamin D_3), vitamin B_{12} supplement, nicotinic acid.

Storage Conditions
For best results, replace lid on container after removal of tablet dosage required. Store in original container in a cool (75°F or colder), dry (approximately 50% RH) location.

Pfizer's Pet-Cal® Vitamin Supplement is a "palatable calcium-phosphorus-vitamin D preparation for dogs and cats" and is widely available online, for example at http://www.vetdepot.com/Pet-Cal-60-Tablets.html which also provides a guaranteed analysis (per tablet), see below:

Guaranteed Analysis

Crude Protein (minimum)	4.0%
Crude Fat (minimum)	1.0%
Crude Fiber (maximum)	1.0%
Moisture (maximum)	4.0%

Minerals:

Calcium (minimum)	17.5%
Calcium (maximum)	21.0%
Phosphorus	14.0%
Salt (minimum)	0.10%
Salt (maximum)	0.60%
Chloride	0.10%
Magnesium	0.02%

Vitamins:

Vitamin D	400 IU

APPENDIX H

QUARANTINE

All sea turtles should initially be treated as quarantine patients when they enter a rehabilitation facility. If, on the advice of the attending veterinarian, a turtle requires isolation from others due to fibropapillomatosis[13] (see photo inserts) or other disease, or other reasons requiring necessary precautions, the following guidelines are offered. In the special case of fibropapilloma disease, protocols developed by the Bermuda Turtle Project are appended and may be useful.

Green sea turtle with fibropapilloma ("FP") disease, ©

Basic Quarantine Guidelines

Due to the lack of specific quarantine procedures for marine turtles, the text on this page is adapted from the AZA Recommended Quarantine Procedures (AZA, 2010). Although these precautions are broad and are generally meant for collected species at zoos and aquariums, the basic ideas and themes can be adapted for sea turtle rehabilitation:

Green sea turtle with fibropapilloma disease, © LMLC

A facility should be available which can provide for the isolation of newly acquired turtles in such a manner as to prohibit cross-contamination resulting from physical contact, disease transmission, aerosol spread, waste drainage, or the reuse of untreated water. Tanks must be located in a way that prevents the spread of any disease from animal to animal through natural water movement and at a distance from other penned animals deemed adequate by the supervising veterinarian. If a receiving institution does not have appropriate isolation facilities, the staff should arrange for quarantine at an acceptable alternate site or only receive animals which do not require quarantine.

Green sea turtle with fibropapilloma disease, © C. Harms, NCSU

Attendants should be designated to care only for quarantine animals or to attend quarantined animals only after fulfilling their responsibilities for others. If care is given to quarantine animals, a three day minimum should be enforced until allowable contact with non-quarantine animals. Attendants provided with quarantine clothing and washing facilities designed to prevent disease transmission may be allowed to attend to non-quarantine animals after working with quarantined specimens if approved by the supervising veterinarian. Equipment used to feed and clean animals in quarantine should be used only with those animals or should be thoroughly cleaned and disinfected, as designated by the supervising veterinarian, before use with post-quarantine animals.

Institutions must take precautions to minimize the risk of exposure of animal personnel to zoonotic diseases that may be present in newly acquired animals if the attending veterinarian deems that such risk exists. These precautions should include using disinfectant foot baths, wearing appropriate protective clothing, and minimizing physical contact.

[13] A comprehensive bibliography of marine turtle fibropapilloma disease is available at www.turtles.org/nmfsbib.htm

SAMPLE PROTOCOL: COURTESY OF THE BERMUDA TURTLE PROJECT[14]

Sea turtle fibropapilloma disease (FP) is a debilitating and sometimes fatal disease of sea turtles. It is seen most often in green turtles but is also known to occur in loggerheads and ridleys. It is currently unknown from Bermuda. However, because so little is known about the natural routes of transmission of FP, it is best at this time to work on the assumption that it is highly communicable[15] and take appropriate precautions. Researchers should make every effort to keep the disease out of populations where it does not occur. The following protocol has been developed to reduce the possibility of fibropapilloma becoming established in Bermuda, and is set forward to guide the handling of potentially infected turtle onboard the research vessel *Calamus*. *Note*: There is no nesting in Bermuda; thus, sea turtles are only handled following capture during organized offshore research expeditions.

Recognizing fibropapilloma disease: Fibropapilloma disease is most easily recognized by the external tumor-like growths that it produces. These can occur on any of the soft tissues of the turtle but are most commonly seen on the softest areas of the head and neck, especially around the eyes, and at the base of the fore and hind flippers. They will appear as pea-sized to grapefruit-sized growths, variable in color but usually pink to red, or gray to black. They often have a floral appearance, with a surface texture like a head of cauliflower, but may also be smooth. These tumors are well vascularized and will bleed readily when cut or abraded by the capture net.

Preventing the spread of fibropapilloma disease: Healthy turtles with no evidence of the external tumor-like growths can carry the virus that apparently causes FP, as well as other pathogenic agents of sea turtles. Turtles can also carry a tumor burden internally, with or without any external signs of infection. Thus, we must always use extreme caution with the body fluids of the sea turtles we handle. The tagging punch must be cleared of tissue and the punch and tag applicators disinfected (for 20 minutes) with mild bleach solution (or other appropriate disinfectant; e.g., Betadine®, alcohol, chlorhexidine) after every turtle. Blood or other body fluids from one turtle should not be allowed to get on another turtle during sampling or at any other time.

Do not use syringe needles or other instruments that break the skin (e.g., PIT tag applicators, tagging punch) on multiple animals without disinfecting them thoroughly between animals. Use exam gloves when performing various procedures on turtles, as it is difficult to keep your hands clean under field conditions. When gloves are not available, frequent hand wiping with sanitizing hand wipes is mandatory. *Note*: Be aware of possible contamination to clothing or skin, and not only to hands.

Capture of a papilloma-bearing turtle in the entrapment net: A turtle with obvious FP should not be placed directly in the catch boat, especially with other turtles. The turtle should be handled with gloves and placed (along with the used gloves) into the equipment bucket (removing the GPS and other equipment first) in order to isolate it from other turtles and to avoid contamination of the deck surface. The bucket should be scrubbed thoroughly with a 10% Clorox™ solution (for 20 minutes) and rinsed thoroughly with freshwater before being used again. Turtles with obvious FP should not be taken on board *Calamus* or to the Aquarium. The virus that is associated with the disease may survive for long periods outside of the host, especially if it is kept wet or moist. Thus, thorough treatment of all possibly infected surfaces with detergents, disinfectants, or prolonged drying would be required to make certain that the disease would not be transmitted. With this in mind, all turtles suspected to be infected with FP virus should be kept away from all areas where turtles are kept, including the decks of the catch-boat and *Calamus*, and the Aquarium, its tanks, and its water system.

---

[14] Source: Meylan, P., A. Meylan and J. Gray. 2003. Procedures Manual for the Bermuda Turtle Project. Bermuda Aquarium, Museum and Zoo. 37 pp. Used with permission.
[15] That FP is "highly communicable" is not widely accepted as fact, but these protocols are explicitly very conservative.

A live turtle with FP should not be tagged, weighed or measured. It should be photo-documented, appropriate samples of the tumors should be taken and preserved directly in 10% buffered formalin (1:10 tissue : formalin ratio; maximum width of tissue is 1 cm for appropriate fixation) without being frozen[16], and the animal should be removed from contact with all other sea turtles and kept out of any facility that houses sea turtles. If the affected turtle has a heavy tumor burden that seems clearly to be FP and the animal is very seriously debilitated, euthanization should be considered by the government veterinarian. Samples of several tumors should be preserved in 10% buffered formalin. If the tumor burden is small or there is suspicion that the tumor is not FP, the animal should be isolated and appropriate samples taken for assessment. Afflicted animals may be sent to an appropriate facility, such as The Turtle Hospital in Marathon Key, Florida, for further observation and possible rehabilitation.

It is very important to confirm any possible cases of FP. This can best be done by collecting biopsies for complete pathological evaluation[17]. Thus, a biopsy kit with gloves, 10% buffered formalin, appropriate-sized vials, scalpels, a small plastic ruler, and Clorox™ for clean up, should be assembled. This could be used for taking samples from a badly infected individual after it was euthanized, a mildly affected individual that will remain in isolation until the samples can be examined, or a dead stranded animal with suspicious tumors.

Stranding of a papilloma-bearing turtle: If a papilloma-bearing turtle is dead when it strands, it should be photo-documented at the stranding site. Photographs should be made of all surfaces, and a description recorded of the tumors, including measurements. If the turtle is fresh, a necropsy should be performed provided that the necropsy can be done under isolation conditions to avoid contaminating facilities where turtles are kept. If a complete necropsy cannot be performed, then a sample of the suspect tumor should be preserved in formalin for pathologic evaluation and the carcass disposed of (incinerated or buried on land). Even if the carcass is too poor to necropsy, get a sample of suspect tissue and dispose of the rest.

Any time that a suspect turtle is handled, all equipment used during handling and necropsy should be disinfected with 10% Clorox™ (for 20 minutes) and rinsed thoroughly in freshwater before being returned to the Aquarium. Gloves must be worn at all times. Do not transport the carcass using Aquarium vehicles and do not transport to the Aquarium for necropsy or freezing. If a papilloma-bearing turtle strands alive, isolate it in a suitable-sized container at an appropriate location and take biopsies of suspect tissue for evaluation. The turtle should remain in isolation until the evaluation of the biopsy is complete. Based on the biopsies and the extent of any infection, a decision will be made regarding euthanasia[18] or transport of the animal to an outside facility for care.

[16] Frozen samples can, however, be used for PCR confirmation of FP and other skin lesions (T. Norton, DVM, pers. comm).

[17] Only trained individuals should biopsy FP lesions. Lesion biopsies are painful, a local anesthetic should be used. Biopsied FP lesions may bleed heavily, pressure with sterile gauze may help stop the bleeding (T. Norton, DVM, pers. comm).

[18] This Husbandry Manual offers guidelines for euthanasia (see *Appendix I: Euthanasia in Sea Turtles*), but, especially in areas where FP is already documented in the wild, these turtles can be treated, cared for, and, ideally, released. While in captivity, every effort should be made to maintain a separate water and filtration system from other resident sea turtles. While there are no documented cases of water-borne transmission of FP, or transmission resulting from direct contact with an infected animal, we recommend that until researchers have a better understanding of this often fatal disease, for which there is no known cure, strict precautions be emphasized at all levels. One strategy is to always work on non-afflicted turtles first, then FP turtles, followed by decontamination. Also important are the following: gloves are mandatory for veterinary staff when handling FP turtles; all laundry, water supply, and equipment are entirely separate between FP and non-FP turtles; and everything is disinfected with 10% bleach solution (and rinsed thoroughly with fresh water) after having been exposed to FP turtles. Experience in Florida with rehabilitation suggests that all FP turtles undergoing rehabilitation should remain at the rehabilitation facility for a period of one year following removal of the last tumor to ensure that re-growth does not take place; notwithstanding, others argue that this is costly and subjects the animal, unnecessarily, to the ongoing stress of captivity.

APPENDIX I

EUTHANASIA IN SEA TURTLES

Sea turtles are highly adaptive. They can survive unthinkable traumas, and continue to live productive lives. Euthanasia should only be considered in the worst of cases; for example, when an interrupted poaching event has resulted in the amputation of all four flippers or a blunt trauma renders the turtle comatose and unresponsive. The unique ectothermic physiology of reptiles and their ability to maintain brain function under long periods of anoxia make humane euthanasia of this group a challenge. For example, even when the cranial nerves and brain are deprived of a blood supply, certain reflexes such as limb withdrawal can persist for some time.

Euthanasia is defined as the “humane destruction of an animal, using a method that produces near instantaneous unconsciousness and rapid death without evident pain or distress, or using anesthesia to produce painless loss of consciousness” (Geraci and Lounsbury, 1993). Death should come without signs of panic, pain or distress; with minimum time to loss of consciousness; and under conditions that are safe for the personnel involved (CCAC, 1993).

Euthanasia is an option when:

- It is necessary to end the suffering of an animal in irreversibly poor condition,
- The decision can be made and the action directed by an experienced, qualified person,
- Essential materials and equipment are available,
- The procedure can be carried out humanely,
- No rehabilitation facility is available, and/or
- Rescue is impossible and no care facility is available.

The most humane and least traumatic euthanasia technique is to have a veterinarian administer a lethal dose of an anesthetic or euthanasia drug.

If (and only if) a veterinarian is not available, we recommend destroying the brain by penetrating the skull, in the middle and just posterior to the eyes (see Figures 1-4), with a captive bolt.

A penetrating captive bolt pistol (used to kill livestock) is an effective, but expensive, tool powered by gunpowder charges or compressed air that drives a metal rod through the animal’s skull into its brain. The same result can be achieved under field conditions with a metal rod and a hammer. Proper placement of the bolt on the head is crucial, so the animal (and particularly the head) must be either immobile or securely restrained, and with the chin and neck on a hard surface (e.g. board, rock) (NYS/CCE, 2005). ***Be prepared*** for the animal to thrash. *Note*: An approach with a bolt from the top of the head can result in the fracture of the skull, often exposing brain-like tissue. This is salt gland tissue (see Figure 4). The brain is located in a boney chamber beneath the muscles underlying the skull.

To ensure complete destruction of the brain, the captive bolt technique should be followed by “pithing”: a sharp, pointed probe is inserted through the skin between the skull and the atlas, then pushed forward through the foramen magnum into the cranial cavity using a twisting motion. If the neurocranium is fractured, pithing can be performed through that opening. *Note*: Pithing requires considerable skill. It can be bloody and traumatic. Professionals caution that it should only be attempted after acquiring knowledge of anatomy using skeletons, and after a period of training including practice on dead animals, because this method can cause pain and suffering if the proper regions of the brain are not completely destroyed (CCAC, 1993).

Concerns and Warnings

A powerful blow, designed to penetrate the skull into the brain, is **not** equivalent to bludgeoning the animal to death. Nor is it appropriate to use any blunt object that happens to be at hand. Consider carefully the bolt (metal rod) that will be used, the location of its placement, and the hammer that will deliver the blow. Keep in mind that the target – the brain – is both small and deep within the skull.

Never attempt to kill a sea turtle by freezing it (this method is ineffective and inhumane). Humane decapitation is unlikely to be possible in sea turtles larger than very young juveniles, and is not recommended. Exsanguination (rapidly draining blood from the body after severing major blood vessels, usually those in the neck) is never recommended for sea turtles, nor is shooting with a regular gun recommended under field conditions unless the gun is in the hands of a trained and skilled shooter.

Terminating a sea turtle, a protected animal in many countries, **may carry legal consequences**. Always contact the authorities, and make every attempt to have a veterinarian or medical technician present. Never consider euthanasia unless it is clear to all concerned that no other humane course of treatment is feasible.

Animals containing administered toxic substances or drugs (including euthanasia agents) must not be disposed of in areas where they may become part of the natural food web (HACC, 2004).

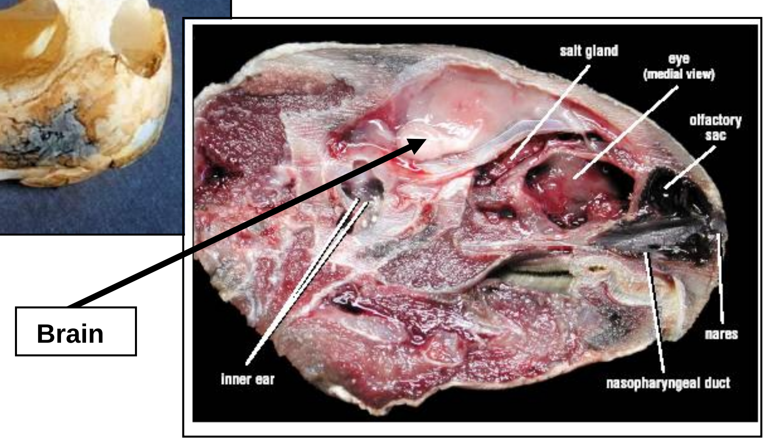


Figure 1. The skull of a green sea turtle (L), with cutaway (R) revealing the sense organs. The arrow indicates the location of the brain – the target for penetration of the captive bolt – deep within the skull and posterior to the eyes. *Sources*: http://www.skulls-skeletons.com (L); Wyneken, 2001 (R).

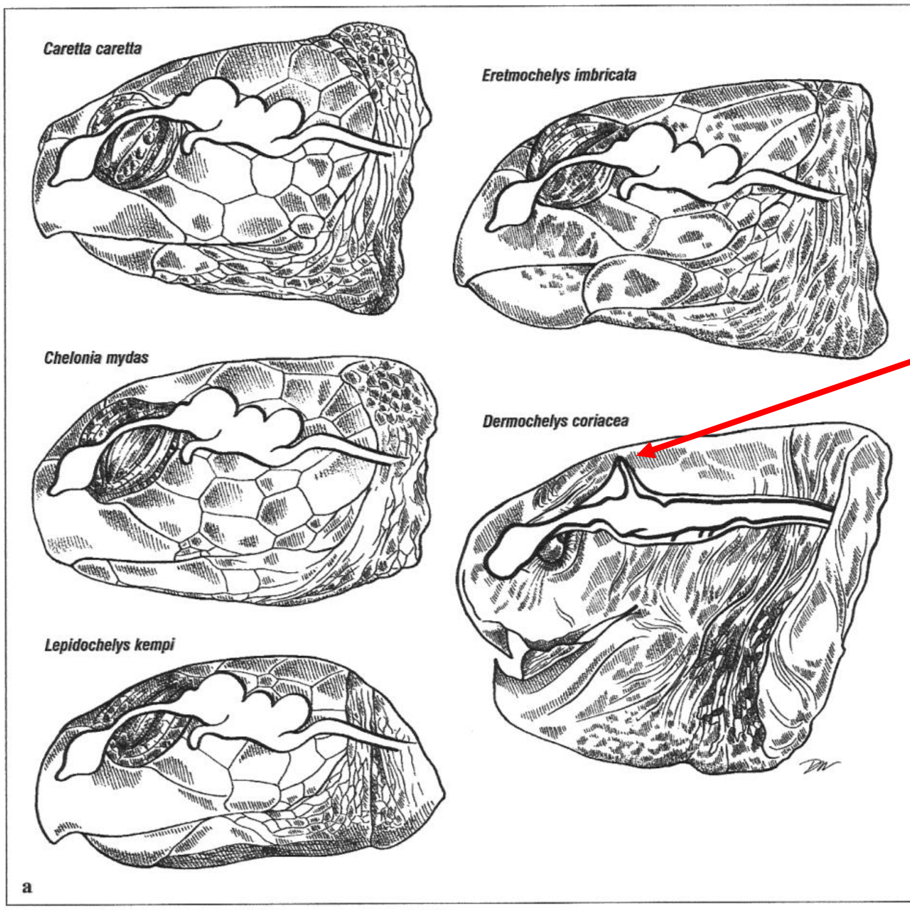
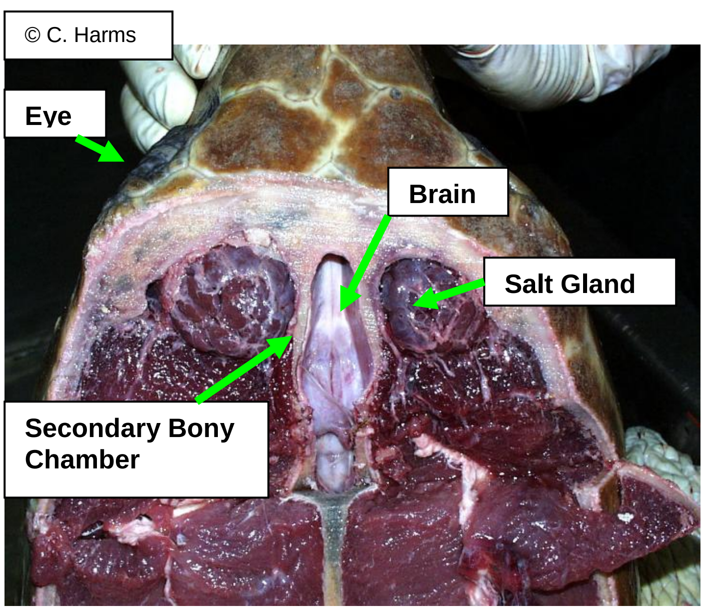
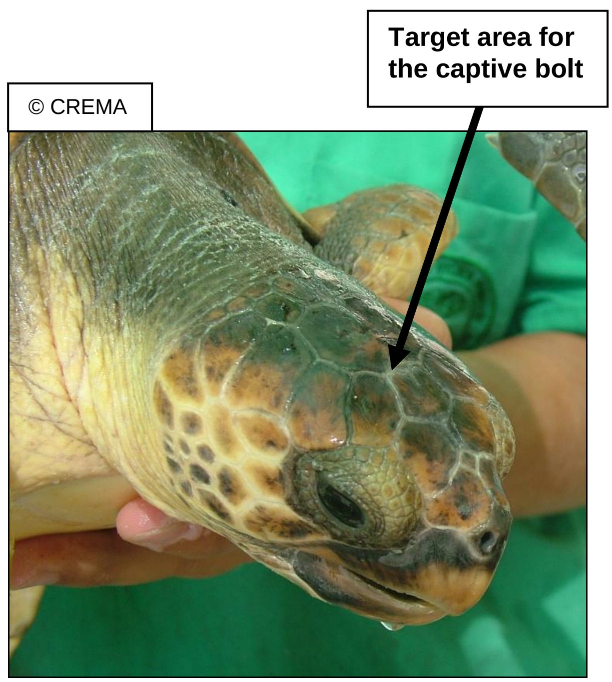


Fig. 192. *Brain landmarks for marine turtles. Overlays of brain positions are shown for 5 species. The position of the head scales, the eye, and the ear provide some reference points for identifying the position of the brain, which varies in dorsal-ventral position with species. The brain position of the leatherback, in this drawing, is based more upon the shape of the braincase because of the poor condition of all leatherback brains examined. The landmarks shown are accurate for large turtles, however the brains of hatchlings and juveniles are disproportionately larger.*

Figure 3. The location of the brain in sea turtles. Note the spatial relationship of the brain mass to the eyes. In the leatherback, the brain is effectively targeted through the characteristic "pink spot" on the crown of the head. *Source*: Wyneken, 2001.

Figure 4. In hard-shelled sea turtles the captive bolt should be placed along the midline of the skull, posterior to the eyes. A dorsal cut-away (L) reveals the brain protected by a secondary boney chamber, presenting a comparatively long but narrow target.





***Source**: excerpted from* The American Veterinary Medical Association Guidelines on Euthanasia (AVMA, 2007).
http://www.avma.org/issues/animal_welfare/euthanasia.pdf

WILDLIFE

For wild and feral animals, many recommended means of euthanasia for captive animals are not feasible. The panel recognizes there are situations involving free-ranging wildlife when euthanasia is not possible from the animal or human safety standpoint, and killing may be necessary. Conditions found in the field, although more challenging than those that are controlled, do not in any way reduce or minimize the ethical obligation of the responsible individual to reduce pain and distress to the greatest extent possible during the taking of an animal's life. Because euthanasia of wildlife is often performed by lay personnel in remote settings, guidelines are needed to assist veterinarians, wildlife biologists, and wildlife health professionals in developing humane protocols for euthanasia of wildlife.

In the case of free-ranging wildlife, personnel may not be trained in the proper use of remote anesthesia, proper delivery equipment may not be available, personnel may be working alone in remote areas where accidental exposure to potent anesthetic medications used in wildlife capture would present a risk to human safety, or approaching the animal within a practical darting distance may not be possible. In these cases, the only practical means of animal collection may be gunshot and kill trapping.[13,180-184]

Under these conditions, specific methods chosen must be as age-, species-, or taxonomic/ class-specific as possible. The firearm and ammunition should be appropriate for the species and purpose. Personnel should be sufficiently skilled to be accurate, and they should be experienced in the proper and safe use of firearms, complying with laws and regulations governing their possession and use.

Behavioral responses of wildlife or captive non-traditional species (zoo) in close human contact are very different from those of domestic animals. These animals are usually frightened and distressed. Thus, minimizing the amount, degree, and/ or cognition of human contact during procedures that require handling is of utmost importance. Handling these animals often requires general anesthesia, which provides loss of consciousness and which relieves distress, anxiety, apprehension, and perception of pain. Even though the animal is under general anesthesia, minimizing auditory, visual, and tactile stimulation will help ensure the most stress-free euthanasia possible. With use of general anesthesia, there are more methods for euthanasia available.

A 2-stage euthanasia process involving general anesthesia, tranquilization, or use of analgesics, followed by intravenous injectable pharmaceuticals, although preferred, is often not practical. Injectable anesthetics are not always legally or readily available to those working in nuisance animal control, and the distress to the animal induced by live capture, transport to a veterinary facility, and confinement in a veterinary hospital prior to euthanasia must be considered in choosing the most humane technique for the situation at hand. Veterinarians providing support to those working with injured or live-trapped, free-ranging animals should take capture, transport, handling distress, and possible carcass consumption into consideration when asked to assist with euthanasia.

Alternatives to 2-stage euthanasia using anesthesia include a squeeze cage with intraperitoneal injection of sodium pentobarbital, inhalant agents (CO2 chamber, CO chamber), and gunshot. In cases where preeuthanasia anesthetics are not available, intraperitoneal injections of sodium pentobarbital, although slower in producing loss of consciousness, should be considered preferable over intravenous injection, if restraint will cause increased distress to the animal or danger to the operator.

Wildlife species may be encountered under a variety of situations. Euthanasia of the same species under different conditions may require different techniques. Even in a controlled setting, an extremely fractious large animal may threaten the safety of the practitioner, bystanders, and itself.

When safety is in question and the fractious large animal, whether wild, feral, or domestic, is in close confinement, neuromuscular blocking agents may be used immediately prior to the use of an acceptable form of euthanasia. For this technique to be humane, the operator must ensure they will gain control over the animal and perform euthanasia before distress develops.

AMPHIBIANS, FISH, AND REPTILES

Euthanasia of ectothermic animals must take into account differences in their metabolism, respiration, and tolerance to cerebral hypoxia. In addition, it is often more difficult to ascertain when an animal is dead. Some unique aspects of euthanasia of amphibians, fishes and reptiles have been described.[13,51,186,187]

Literature Cited

13. Cooper JE, Ewbank R, Platt C, et al. *Euthanasia of amphibians and reptiles*. London: UFAW/WSPA, 1989.

51. *Humane killing of animals*. Preprint of 4th ed. South Mimms, Potters Bar, Herts, England: Universities Federation for Animal Welfare, 1988; 16-22.

180. Acceptable field methods in mammalogy: preliminary guidelines approved by the American Society of Mammalogists. *J Mammal* 1987; 68(Suppl 4):1-18.

181. American Ornithologists' Union. Report of committee on use of wild birds in research. *Auk* 1988; 105(Suppl):1A-41A.

182. American Society of Ichthyologists and Herpetologists, Herpetologist League, Society for the Study of Amphibians and Reptiles. Guidelines for the use of live amphibians and reptiles in field research. *J Herpetol* 1987; 21(suppl 4):1-14.

183. American Society of Ichthyologists and Herpetologists, American Fisheries Society, American Institute of Fisheries Research Biologists. Guidelines for use of fishes in field research. *Copeia Suppl* 1987; 1-12.

184. Cailliet GM. *Fishes: a field guide and laboratory manual on their structure, identification, and natural history*. Belmont, Calif: Wadsworth, 1986.

186. Zwart P, deVries HR, Cooper JE. The humane killing of fishes, amphibia, reptiles and birds. *Tijdsehr Diergeneeskd* 1989; 114:557-565.

187. Burns R. Considerations in the euthanasia of reptiles, fish and amphibians, in *Proceedings*. AAZV, WDA, AAWV Joint Conference 1995; 243-249.

NOTES

NOTES

“Working together to build a future where all inhabitants of the Wider Caribbean Region, human and sea turtle alike, can live together in balance.”

The Wider Caribbean Sea Turtle Conservation Network (WIDECAST) is a regional coalition of experts and a Partner Organization to the U.N. Environment Programme’s Caribbean Environment Programme. WIDECAST was founded in 1981 in response to a recommendation by the IUCN/CCA *Meeting of Non-Governmental Caribbean Organizations on Living Resources Conservation for Sustainable Development in the Wider Caribbean* (Santo Domingo, 26-29 August 1981) that a “Wider Caribbean Sea Turtle Recovery Action Plan should be prepared ... consistent with the Action Plan for the Caribbean Environment Programme.”

WIDECAST’s vision for achieving a regional recovery action plan has focused on bringing the best available science to bear on sea turtle management and conservation, empowering people to make effective use of that science in the policy-making process, and providing a mechanism and a framework for cooperation within and among nations. By involving stakeholders at all levels and encouraging policy-oriented research, WIDECAST puts science to practical use in conserving biodiversity and advocates for grassroots involvement in decision-making and project leadership.

Emphasizing initiatives that strengthen capacity within participating countries and institutions, the network develops and replicates pilot projects, provides technical assistance, enables coordination in the collection, sharing and use of information and data, and promotes strong linkages between science, policy, and public participation in the design and implementation of conservation actions. Working closely with local communities and resource managers, the network has also developed standard management guidelines and criteria that emphasize best practices and sustainability, ensuring that current utilization practices, whether consumptive or non-consumptive, do not undermine sea turtle survival over the long term.

With Country Coordinators in more than 40 Caribbean nations and territories, WIDECAST is uniquely able to facilitate complementary conservation action across range States, including strengthening legislation, encouraging community involvement, and raising public awareness of the endangered status of the region’s six species of migratory sea turtles. As a result, most Caribbean nations have adopted a national sea turtle management plan, poaching and illegal product sales have been dramatically reduced or eliminated at key sites, many of the region’s largest breeding colonies are monitored on an annual basis, alternative livelihood models are increasingly available for rural areas, and citizens are mobilized in support of conservation action. You can join us! Visit www.widecast.org for more information.

WWW.WIDECAST.ORG