

7

Cross-Cutting Issues: Data, Education, Permits, and Coordination

DATA MANAGEMENT

This report describes extensive data requirements for accurate assessments of sea-turtle populations. Many of the required data have yet to be collected. Other data resources currently exist but have not been used to address data gaps because the data are not accessible or have inadequate access and are at risk of being lost as data owners change fields, retire, or die. Most of those datasets cannot be replaced because they were collected in past years or even decades under different environmental conditions and turtle densities.

The situation is not unique to sea turtles. The need for open access to data has been recognized for decades, and many committees and workshops have been convened to discuss and develop methods to address the need. A recent National Research Council (2009) report, *Ensuring the Integrity, Accessibility, and Stewardship of Research Data in the Digital Age*, cites 36 reports of the National Academy of Sciences, the National Academy of Engineering, the Institute of Medicine, and the National Research Council published since 1985 that have addressed the issue. A recent editorial (Whitlock et al., 2010) by editors of four prestigious scientific journals emphasized the need for archiving raw data—not data summaries—to prevent the loss of critical data to science and announced a new policy. Several journals of ecology and evolution will now require authors to submit to an appropriate public archive all the raw data on which their articles are based.

Three critical issues emerge (National Research Council, 2009): data

integrity; data access, sharing, and ownership; and data stewardship and management plans. The National Research Council report concluded that explicitly outlining the roles and responsibilities of the various entities—data providers, host institutions, and data users—is essential.

In this report, the committee has not repeated information that was so thoroughly reviewed elsewhere. Rather, it has described the current situation for sea-turtle data and has recommended what should be done to make data accessible for research and management and to reduce the risk of data loss.

Current Status

The fractured status and lack of coordination of sea-turtle databases are major impediments to the management and conservation of sea turtles. Throughout the United States, hundreds of projects (of varied duration) have been established to monitor sea-turtle populations and conduct research on sea-turtle biology. The projects have been conducted by people in federal and state agencies, universities, and nongovernmental organizations (NGOs) and by private individuals.

Data resulting from those projects have varied integrity, accessibility, and stewardship. The integrity (structural completeness, including metadata [data that provides information about other data]) and quality of the data vary greatly, depending on many factors. Quality control of data collection is a major factor. Factors affecting data-collection quality include the extent and consistency of training given to data collectors; the experience and number of data collectors; and the quality of equipment used, such as tags and instruments to measure turtles. Transcription of data from field or laboratory notes to digital databases is a common source of errors. Quality control of data transcription is essential to maintain the integrity of the database. Accurate metadata can help to offset some data-quality problems. For example, accurate reporting of annual survey efforts can offset problems of uneven effort among years. An important difficulty in sea-turtle count data is understanding whether each zero count is the result of the absence of turtles or the result of zero effort.

Many databases resulting from sea-turtle studies have little or no access for people other than the data owners. Data accessibility is determined by the willingness of a data owner to share the data, the ease of data use, and the presence of essential metadata so that data can be interpreted. Some data, particularly those from federal and state agencies, are available as digital databases but only in summary form.

Current stewardship of the data resulting from the projects ranges from well-curated, computerized databases with safeguarded backups to boxes of loose data sheets stored in a single vulnerable location. Data

from some studies have been lost and cannot be reconstructed. The risk of loss of the databases depends on a number of factors, including the form of the data, arrangements for perpetual management, and the number of people and type of organization involved.

Examples of Sea-Turtle Databases Established to Share Data

Some databases provide information to locate data sources or to avoid duplication and confusion in sea-turtle studies. Because that type of database does not threaten "ownership" status, participation tends to be good, depending largely on the benefit to participants, which varies from certain and immediate (e.g., Marine Turtle DNA Sequences) to less certain and future (e.g., the Sea Turtle Tag Inventory). Some examples of such databases are noted below:

- *In-Water Sea Turtle Monitoring and Research in Florida: Review and Recommendations* (Eaton et al., 2008) lists all 42 known in-water sea-turtle research projects in Florida (active and inactive) with maps, brief summaries of results, and lists of publications. Given funding opportunities, the Florida Fish and Wildlife Conservation Commission has tentative plans to update this database and initiate coordination among projects.

- Marine Turtle DNA Sequence Web sites assign haplotype (i.e., nucleotide sequence) designations to all mitochondrial DNA sequences for green turtles (*Chelonia mydas*) and loggerhead turtles (*Caretta caretta*) in the Atlantic (University of Florida, 2001) and Pacific green turtles (Southwest Fisheries Science Center, 2008) as they are discovered to facilitate coordination and to avoid the confusion of duplication of sequence designations in publications. The databases are updated as new sequences are submitted.

- The Sea Turtle Tag Inventory (University of Florida, 1999a) lists all flipper-tag sequences used by programs around the world to avoid duplication of tag numbers when tags are purchased by different research programs and to assist in reporting data on the recapture of turtles when only the tag number has been recorded. The database is updated as new tag series are submitted.

Several databases secure data from sea-turtle projects (protect them from loss) and provide partial access or access to data summaries. However, long-term continuation of the host institution is not always ensured. A few examples are the following:

- The Cooperative Marine Turtle Tagging Program (University of Florida, 1999b) is a centralized program funded by the Southeast Fisheries

Science Center of the National Marine Fisheries Service (NMFS) and managed by the Archie Carr Center for Sea Turtle Research at the University of Florida to distribute sea-turtle tags, manage tagging data, correspond with people who capture tagged turtles, and facilitate exchange of tag information in the Atlantic. All data owners allow NMFS to use their data for management purposes and stipulate any additional extent to which their data are accessible. All data owners allow the Archie Carr Center for Sea Turtle Research to release original tagging data to people who report the capture of tagged turtles.

- Satellite tracking (Seaturtle.org, 2009) displays maps of sea-turtle tracks generated by satellite telemetry with contact information on data owners. Raw data are not available, and use of data is not allowed without permission from data owners.

- Sea-turtle nest-count data for Florida (Florida Fish and Wildlife Conservation Commission, 2009) are displayed in a summary table of the statewide nesting totals for each year beginning in 1979 for each species and for the most current year (updated each February) only as a summary of nests and nonnesting emergences by county for each species.

- Data on sea turtles that stranded along the coast from Maine to Texas in 1998–2005 (Southeast Fisheries Science Center, 2010) are available from as monthly totals for each species for each county. Beginning in 2006, data are available as weekly totals for each species for each NMFS zone, divided into inshore and offshore categories.

- Nesting and stranding data on a few areas are available from Seaturtle.org (2010a, b).

Few databases secure the data and provide complete access to raw data. The following describes the two major types of data collected (tagging data and geographic distribution and abundance data):

- The Legacy Database Initiative of the Archie Carr Center for Sea Turtle Research (University of Florida, 2010) will consist of many datasets. The first (completed) contains the tagging data on nesting sea turtles at Melbourne Beach, Florida, collected by Billy J. Turner and colleagues in 1972–1981. The second will contain the tagging data on nesting sea turtles on Jupiter Island, Florida, collected by Frank Lund and colleagues in 1969–1981. All data, with accompanying metadata, will be available on the Web.

- The Ocean Biogeographic Information System Spatial Ecological Analysis of Megavertebrate Populations (OBIS-SEAMAP; Duke University, 2009) is a spatially referenced online global database on megavertebrate (including sea-turtle) distribution. The database can be searched and viewed through online mapping applications. Raw data are available

to download under the agreement that data contained in OBIS-SEAMAP will not be used in any publication, product, or commercial application without prior written consent of the original data provider. OBIS-SEAMAP is in OBIS, which was established by the Census of Marine Life.

Centralized Data Facility

Perhaps the most efficient and secure approach for making sea-turtle data accessible would be to have all databases available through a single, permanent facility that would ensure long-term management of the data. For tagging data, one possible program is the Cooperative Marine Turtle Tagging Program, described above. For geographic distribution and abundance data, a possibility is the Global Biodiversity Information Facility (GBIF), an international organization whose goal is to make biodiversity data accessible everywhere in the world. OBIS is an associate member of GBIF, which is the only intergovernmental organization mandated to make data on global biodiversity freely accessible. It is now the largest, most comprehensive portal to biodiversity information with more than 177 million biodiversity data records (Gilman et al., 2009).

Top priority needs to be given to coordinating data from within the United States and its territories. That effort would require extensive coordination among federal and state agencies, NGOs, and individual citizens. Because sea-turtle populations are shared by many nations, concerted efforts could also be made to coordinate with governments and NGOs in other countries. International networks, such as the Wider Caribbean Sea Turtle Conservation Network, could be valuable partners.

Data Protocols

Consistent data collection maximizes the ability to combine and compare data among studies. Attempts have been made to standardize protocols for collection of data on sea turtles by a wide range of techniques (e.g., Bjorndal and Balazs, 1983; Higgins et al., 1997; Eckert et al., 1999; National Marine Fisheries Service Southeast Fisheries Science Center, 2008). Because many sea-turtle research programs have been underway for extended periods, it is understandable that researchers would be reluctant to change or add methods to their own data protocols.

Archives

In addition to the data archives discussed above, there is a great need for archives to store tissue samples from sea turtles. An archive for genetics samples already exists at the NMFS Southwest Fisheries Sci-

ence Center, and the National Oceanic and Atmospheric Administration Center for Coastal Environmental Health and Biomolecular Research in Charleston, South Carolina, maintains a small archive of sea-turtle tissues. Additional archives are needed for various tissue types to support analyses of somatic growth through skeletochronology, of resource use through stable isotope analyses, and of contaminant loads through analyses of pollutants. The archives need to be curated carefully and provide long-term storage and access to researchers. Incentives in the form of analytical assistance, collaboration help, and facilitated access will be needed to maximize contributions to archives.

EDUCATION AND CAPACITY BUILDING

Chapter 1 emphasizes the need for U.S. management agencies to apply a more complete and quantitative understanding of sea-turtle population dynamics to management policy. Limits on quantitative information pertinent to sea-turtle management stem from both inadequate quantitative expertise and insufficient guidance of study designs and data analyses of policy information needs. Short-term remedies for the problem might include recruiting statistics and modeling specialists into management agencies from fields outside conservation biology. However, effective analyses applied to pertinent management needs would require difficult science and policy translation between fields. That translation has been especially difficult in the interpretation of scientific uncertainty (Bradshaw and Borchers, 2000) and in the use of caution in management decisions (Cooney, 2004). The present committee proposes that long-term remedies for pertinent quantitative information deficits include interdisciplinary training of fishery and conservation professionals. (See the discussion of assessment procedures in Chapter 6.)

There is interest both nationally (Jacobson and Robinson, 1990; National Research Council, 2000) and internationally (Buitrago et al., 2008) in the interdisciplinary challenges of educating quantitative fishery and conservation professionals. There is general agreement that the education of effective professionals needs to be broadly based and interdisciplinary (Massey, 1989; National Research Council, 1998; Clark, 2001). Training needs to include both quantitative and biological subjects, such as population and ecosystem ecology, statistics, and modeling; but it also needs to include economics, policy, and decision-analysis courses, for example, to provide insight into how conservation of natural resources can be achieved. Students are generally eager to take fundamental biology courses, such as physiology and anatomy, but commonly avoid the fundamental courses in mathematics and statistics that are needed to establish

sufficient quantitative skills. Although there is general agreement, realization of interdisciplinary education faces structural barriers in colleges and universities (Jacobson, 1990; Jacobson and Robinson, 1990).

Capacity building includes the development of partnerships between government and NGOs. With respect to sea-turtle conservation and management, they would include NMFS, the U.S. Fish and Wildlife Service (USFWS), the U.S. Geological Survey, state resource agencies, universities, aquariums, NGOs, biology consultants, and international collaborators. In addition to the development of partnerships, capacity building includes public outreach and improvement of scientific infrastructure.

An example of the difficulty in improving human resources for conservation work can be found in a report by the U.S. Department of Commerce and the U.S. Department of Education (2008). The fishery-management and marine-conservation agencies face the same challenges that were identified in a National Research Council (2000) report on recruiting quantitative scientists to the agency despite aggressive actions to provide educational opportunities. More than 15 U.S. universities are engaged in cooperative programs with NMFS, along with Sea Grant-administered Graduate Fellowships in Population Dynamics and Marine Resource Economics. Other programs, such as the NMFS-Recruiting Training Research Program at Virginia Polytechnic Institute and State University, undertake special population-dynamics workshops annually for undergraduates. Despite those advances, conservation education faces the challenges of providing interdisciplinary education within a traditional academic framework (Le Tissier et al., 2004; Kroll, 2007).

Important quantitative elements of interdisciplinary training for conservation students include a working knowledge of basic models and statistical evaluation of data. Students need to be aware of quantitative analysis' value as a provider of recommendations and as an evaluator of potential sources of bias and uncertainty and key evidence for motivating conservation action. All students who major in natural or social sciences require an understanding of models and population effects of management actions if they are to evaluate critically and correctly the tools that are used in decision making.

To promote a broader appreciation of the uses, and potential misuses, of quantitative analysis, universities need to make population-dynamics training more widely accessible to undergraduates (Hard, 1995; Matter and Steidl, 2000; Burger and Leopold, 2001). Existing biology and natural-resource programs sometimes leave out population-dynamics education beyond basic theoretical models presented in ecology or leave a gap between basic, introductory courses and highly technical quantitative courses for graduate students.

ALLOCATION OF MANAGEMENT AND RESEARCH FUNDS

Federal agencies need to ensure that funds available to support research—both internal and external funds—are invested wisely. At a minimum, all research proposals generated in federal agencies have to be reviewed by panels that include federal and nonfederal scientists.

An example of one system that is working well is the Western Pacific Regional Fisheries Management Council (WPRFMC) Sea Turtle Conservation Program. The committee summarizes its approach here, not as a description of what should be done but as a starting point for agency-appropriate plans. The program was established in 2002 to ensure the sustainability of Hawaii-based longline fisheries, contribute to the international transfer of sustainable fishery technology and knowledge, and aid in the recovery of Pacific sea-turtle populations. Since then, WPRFMC has played an instrumental role in fostering collaboration, transferring bycatch-mitigation technology, and advancing the sustainability of fisheries by convening a number of international meetings. It has also played a key role in encouraging sea-turtle research, monitoring, and conservation projects in the Pacific where funding may not have been otherwise available, and its program annually receives a portion of the congressional funding dedicated to Pacific sea-turtle research and conservation. With the advice of its Sea Turtle Advisory Committee (STAC), WPRFMC has been supporting conservation measures since 2003 to offset adverse effects on sea-turtle populations from the Hawaii-based longline fishery. STAC was formed by WPRFMC at the 114th council meeting (August 2002) to direct and advise on its turtle-conservation activities. STAC generally meets once a year and comprises eight well-known sea-turtle biologists and scientists. In FY 2010, WPRFMC initiated an annual unified request for proposal (RFP) process for WPRFMC-funded sea-turtle conservation projects. The RFP process solicits projects focusing on one or more of WPRFMC's high-priority species and activities, as defined by its five-year plan for 2010–2014 and recommended by STAC. Proposals are reviewed by a panel consisting of WPRFMC staff, STAC members, and additional external reviewers if necessary. All previously funded projects requesting continued support from WPRFMC are subject to annual review through the same RFP process.

PERMITTING

Before initiating a research project on sea turtles in the United States that has potential for take, investigators must obtain one or more research

permits. The NMFS Office of Protected Resources is responsible for permitting studies conducted in the water, and USFWS is responsible for research conducted or initiated on land. For example, USFWS would issue a permit to attach a satellite transmitter to a sea turtle that has come ashore to nest and will return to the ocean. USFWS has established cooperative agreements with states and territories (Florida, Georgia, South Carolina, North Carolina, Puerto Rico, and the U.S. Virgin Islands) that have dedicated staff with sea-turtle expertise so that state agencies may grant permits under the auspices of Section 6 of the Endangered Species Act for research and educational programs on threatened sea-turtle species. NMFS does not have a similar relationship with states so a sea-turtle research project that is to take place in state waters usually requires permits from both NMFS and the state in which the work is to be conducted, although in some cases the federal permit is all that is required.

The committee has found broad consensus among researchers studying sea turtles that the permitting process is a greater obstacle to research than is necessary for the protection of the turtles or for meeting the requirements under the Endangered Species Act. There are three major concerns. First, the process is too slow; permits often take six months and sometimes much longer to be issued or denied. Second, the review is redundant and sometimes inconsistent with other required reviews, such as those rigorously conducted by internal and external scientific peer review of proposed research by funding agencies and by Institutional Animal Care and Use Committees; there is also redundancy between federal and state or territorial agencies that have federal permitting authority. Third, the reasons for rejecting a permit request are not always provided, and mechanisms for appeals are not specified.

New research projects with innovative techniques will need to be initiated to meet data needs outlined in this report. However, in numerous examples presented during committee meetings, the U.S. permitting process delayed or denied research projects, particularly when innovative techniques were involved. The permitting process need not unnecessarily delay or hamper these critical studies. Considering the balance between overregulation and underregulation, it is clear that the sea-turtle research-permitting process is not underregulated. Evidence of that is the absence of third-party lawsuits challenging granted research permits, whereas numerous lawsuits have resulted from the issuance of nonresearch incidental-take permits. Permitting agencies need to improve efficiency and change research-permitting processes so that the Endangered Species Act mandates are met in a timely and transparent process for permit applicants.

RECOMMENDATIONS

Data Management

- To avoid the overlooking of data sources, NMFS should create a metadatabase¹ identifying as many of the sea-turtle datasets in the United States and its territories as possible, similar to the document created for in-water projects in Florida. The online database should be updated regularly. As was done with the Florida in-water project, the permits granted for monitoring and research through federal and state agencies can be used to identify many of the projects. The database would provide information on available data, status of each dataset (e.g., computerized, hard-copy only, lost), and contact information but would not include the data.
- NMFS and USFWS should partner with other government agencies, universities, and NGOs to develop a mechanism to obtain, computerize, maintain, and make accessible as many sea-turtle databases as possible. There is some urgency in this task while data collectors are still available to provide essential metadata. Such issues as data ownership, authorship requirements, and ensuring appropriate use of data will need to be addressed through data safeguards, extensive outreach, and participant incentives. Priorities for selecting which databases to conserve should be based on the integrity of the data, the amount and type of data, and risk of loss.
- NMFS and USFWS should partner with other government agencies, universities, and NGOs to improve coordination among data holders. Incentives should be developed to encourage data sharing; these may include providing participating researchers with data-analysis services and data products, regional data summaries, data backup assurance, assistance with publication of results, and facilitation of collaborative relationships.
- The Sea Turtle Stranding and Salvage Network should make information on all stranded turtles available for evaluation at least by review teams and assessment modelers.
- NMFS and USFWS should convene a working group of experts in government agencies, academia, and NGOs to consider establishing centralized databases of all sea-turtle data collected in the United States and its territories.
- NMFS and USFWS should convene a task force of experts in government agencies, academia, and NGOs to establish standard research

¹ A metadatabase manages data that provide information about other data or are derived from other data.

and data-collection protocols, building on earlier work (Eckert et al., 1999; National Marine Fisheries Service Southeast Fisheries Science Center, 2008), with emphasis on techniques that have recently emerged. The task force should also develop incentives for researchers to adopt the protocols and outline a plan for continuing training in methods and analytical techniques.

- NMFS and USFWS should establish and maintain long-term tissue banks, similar to the genetics tissue bank now at the Southwest Fisheries Science Center, for other types of tissues. The agencies should develop effective incentives to encourage participation in tissue banking, such as collecting humeri from turtle carcasses and tissue samples from turtles captured incidentally in fisheries.

Education and Capacity Building

Most of the recommendations presented in an earlier report of the National Research Council (2000) are still relevant today, and many of them remain unfulfilled. In addition, the present committee recommends the following:

- Increase opportunities for undergraduates to have hands-on experiences with sea-turtle conservation and population dynamics. That could be done by increasing funding of existing cooperative programs or by developing summer programs similar to the National Science Foundation's Research Experience for Undergraduates. Because quantitative skills are essential for species management generally, summer courses could be directed toward a broader audience of undergraduates and beginning graduate students who are pursuing careers in conservation of marine mammals, sea birds, and other marine species.

- Increase opportunities for graduate and postgraduate students to pursue quantitatively oriented careers in conservation biology. That could be accomplished by funding additional scholarships in the NMFS-Sea Grant Joint Graduate Fellowships in population dynamics and in marine-resource economics.

- Provide support for hands-on workshops that include (1) introductory materials (in English and Spanish) that provide a basic overview of why quantitative evaluation and statistical rigor in data collection are important for sea-turtle conservation and (2) data analysis and modeling guidance on how to analyze data and interpret model results. The workshops would be valuable tools in connecting data holders across regions.

- Provide outreach and training in how scientific information shapes conservation policy.

- Expand and facilitate involvement in student internships in the NMFS Office of Protected Resources.
- Formalize an outreach program aimed at informing professionals in conservation biology about how the information that they gather is used in management decisions. Clearly broadcast updated information and data needs for assessments of risks and population viability.

Allocation of Research Funds

- To ensure that research funds are invested wisely, NMFS and USFWS should have all research plans generated in federal agencies reviewed by panels that include federal and nonfederal scientists.

Permits

- NMFS and USFWS should convene a working group to evaluate the permitting process for research projects and develop methods to expedite the process while meeting legislative requirements and intent. Participants should include representatives of the permitting agencies and research scientists. The review should weigh unintended consequences of permitting delays and lost research opportunities, should review the potential risks and benefits to the listed species of changing permitting requirements and procedures, and should assess the extent to which scrutiny of research permits has resulted in substantial take reductions.

Assessment of Sea-Turtle Status and Trends

Integrating Demography and Abundance

Committee on the Review of Sea-Turtle Population Assessment Methods

Ocean Studies Board

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Cover: The front cover images include five of the six species of sea turtles found in U.S. waters (from top to bottom and left to right): leatherback (provided by Guillaume Feuillet, Association Kwata), Kemp's ridley (provided by Selina Heppell, Oregon State University), hawksbill (provided by the National Oceanic and Atmospheric Administration), olive ridley (provided by Guillaume Feuillet, Association Kwata), and green (provided by Claire Fackler, National Oceanic and Atmospheric Administration). The back cover image is the sixth species, which is the loggerhead (provided by William Precht, National Oceanic and Atmospheric Administration).

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