

# Sea Turtle Assessment Status and Research Needs

National Marine Fisheries Service



U.S. Department of Commerce  
National Oceanic and Atmospheric Administration  
National Marine Fisheries Service

NOAA Technical Memorandum NMFS-F/SPO-131  
July 2013



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## List of Acronyms

<b>AMAPPS</b>	Atlantic Marine Assessment Program for Protected Species
<b>BOEM</b>	Bureau of Ocean Energy Management
<b>CMR</b>	Capture-Mark-Recapture
<b>CPUE</b>	Catch per Unit Effort
<b>CV</b>	Coefficient of Variation
<b>DPS</b>	Distinct Population Segment
<b>EEZ</b>	Exclusive Economic Zone
<b>ESA</b>	Endangered Species Act
<b>FRMD</b>	Fisheries Research and Monitoring Division (PIFSC)
<b>FSB</b>	Fisheries Sampling Branch (NEFSC)
<b>FTE</b>	Full-Time Employee
<b>FY</b>	Fiscal Year
<b>HSU</b>	Harvesting Systems Unit (SEFSC)
<b>MMPA</b>	Marine Mammal Protection Act
<b>MTAP</b>	Marine Turtle Assessment Program (PIFSC)
<b>MTEAP</b>	Marine Turtle Ecology and Assessment Program (SWFSC)
<b>MTGP</b>	Marine Turtle Genetics Program (SWFSC)
<b>MTRP</b>	Marine Turtle Research Program (PIFSC)
<b>MSA</b>	Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act)
<b>NEFSC</b>	Northeast Fisheries Science Center
<b>NERO</b>	Northeast Regional Office
<b>NGO</b>	Non-Governmental Organization
<b>NMFS</b>	National Marine Fisheries Service
<b>NMTGL</b>	National Marine Turtle Genetics Laboratory
<b>NOAA</b>	National Oceanic and Atmospheric Administration
<b>NRC</b>	National Research Council
<b>NRDA</b>	Natural Resources Damage Assessment
<b>NSTAL</b>	National Sea Turtle Aging Laboratory
<b>PIFSC</b>	Pacific Islands Fisheries Science Center
<b>PIRO</b>	Pacific Islands Regional Office
<b>PIT</b>	Passive Integrated Transponder
<b>PSB</b>	Protected Species Branch (NEFSC)
<b>RFP</b>	Request for Proposals
<b>SAIP</b>	Stock Assessment Improvement Plan
<b>SEFSC</b>	Southeast Fisheries Science Center
<b>SNP</b>	Single Nucleotide Polymorphisms
<b>STSSN</b>	Sea Turtle Stranding and Salvage Network
<b>SWFSC</b>	Southwest Fisheries Science Center
<b>SWRO</b>	Southwest Regional Office
<b>USC</b>	<i>United States Code</i>
<b>USFWS</b>	United States Fish and Wildlife Service

## Executive Summary

Sea turtles' long lifespans, dependence on both beach and in-water habitats, and often wide-ranging migrations make them difficult to monitor and susceptible to many threats. All sea turtle species that occur in the U.S. are protected under the Endangered Species Act (ESA) and have been listed under the Act since the 1970s. Globally, many nesting populations are believed to be at a fraction of historic levels. The National Marine Fisheries Service (NMFS), a part of the Department of Commerce's National Oceanic and Atmospheric Administration (NOAA), has lead responsibility for sea turtles in the marine environment, whereas the Department of the Interior's U.S. Fish and Wildlife Service has lead responsibility for sea turtles when they are on land. NMFS programs conduct a variety of sea turtle activities, but conservation and assessment-relevant research is also conducted by other agencies, states, academic institutions, and non-governmental organizations.

Sea turtle assessments inform ESA processes and ecosystem management and aid NMFS' evaluation of the nation's progress in reducing impacts of fisheries on protected species. Regular population assessments are necessary to measure progress toward sea turtle recovery goals under the ESA and to provide the foundation for evaluating management activities. Data-rich assessments not only help NMFS work toward its own goals and responsibilities but likely benefit other agencies and stakeholders by providing a solid foundation for evaluation and permitting of specific anthropogenic activities. Baseline data are also important for developing response plans for and evaluating the population and ecosystem impacts of catastrophic events.

### **Scope**

This document summarizes the current state of sea turtle assessment and related NMFS research activities and provides an overview of resource requirements. It describes the present status of U.S. sea turtle assessments under the ESA; ongoing NMFS research and analysis activities; assessment themes and gaps; NMFS sea turtle assessment staff, vessel, and aircraft resources; and estimates of resources needed to maximize the utility of existing data and survey efforts and to better meet relevant mandates of the ESA. Assessment data categories examined are reflective of sea turtle recovery plans, NMFS stock assessment improvement initiatives, and the 2010 National Research Council (NRC) report, *Assessment of Sea-Turtle Status and Trends: Integrating Demography and Abundance*.

### **Assessment Tiers**

The 2004 protected species stock assessment improvement plan (SAIP) provided a basis for improving assessments by evaluating NMFS' research activities relative to specific data categories (stock/population identification, life history characteristics and vital rates, nesting and in-water abundance, anthropogenic impacts, assessment frequency, and assessment quality). The SAIP framework may be revised or replaced in the future, but its score-based tier system is currently used by the agency as a performance metric. The scoring system was laid out such that "Tier I" protected species assessments maintained the *status quo* (Fiscal Year 2003, FY03) with no new surveys or observers, but made better use of existing programs and data. The agency currently considers protected species assessments at the next SAIP level, "Tier II," or higher, to be "adequate" for the purposes of its Government Performance and Results Act reporting. This tier meets the objectives of NOAA's Healthy Oceans Goal and is also in-line with the 2010 NRC recommendations. The SAIP also acknowledged the need to move to more ecosystem-based assessment approaches (Tier III), and it is clear that the integration of habitat, ecosystem processes, historical data, climate, and other mechanisms potentially

influencing vital rates and distributions is necessary for forecasting sea turtle populations' distribution and abundance.

### ***Assessment Status and Resource Needs***

Fourteen U.S. sea turtle "stocks" were defined based upon species' ESA listing status and ocean basin delineations. Although the use of the term "U.S. stocks" is not intended as synonymous with the ESA term, "distinct population segment" (DPS), the recently defined loggerhead DPSs were considered to also be "stocks."

There has been some improvement in quality of data for species with recently revised recovery plans and/or listing decisions, but all 14 sea turtle stocks remain at the Tier I level of assessment, as was concluded in the 2004 protected species SAIP. Tier II ("adequate") assessments require relatively robust stock identification, life history and vital rate, abundance, and anthropogenic impact information, and assessment at least every 5 years using new data and advanced modeling techniques. Robust assessment-relevant data were especially lacking for life history and vital rates, in-water abundance, and anthropogenic impacts, whereas higher quality stock identification and nesting abundance data were available for some, but not all, stocks. Assessment frequency is relatively high (within the past 2-6 years) for most stocks when publication dates and ESA five-year reviews are considered. However, in many instances, the best available information is over 5 years old and/or covers only a portion of the stock's range, and frequency of quantitative analysis is relatively low among sea turtle populations. Assessment quality could be improved not only with expanded spatial coverage and continued sampling, but also with more detailed demographic and in-water information and analysis.

### ***Regional Assessment Needs***

Common themes among center-identified, regionally-relevant assessment activities to improve assessments include increasing quality and frequency by:

- Continuing, reinitiating, and expanding ongoing and past in-water surveys (on-water and aerial), sampling, and tagging;
- Conducting surveys and sampling at regular intervals suitable for assessing abundance and distribution patterns;
- Improving methods and using multidisciplinary approaches for stock determination and estimation of population- or stage-specific abundance, vital rates, and anthropogenic impacts;
- Increasing integration of habitat, ecosystem, environmental, and climatic data into analyses; and
- Improving coverage of lesser-studied species and/or life stages in a given region.

Increases in NMFS staff, access to vessel and aircraft resources, and collaborations with external partners are necessary to improve U.S. sea turtle assessment quality, and long-term commitments to data collection are essential for providing the building blocks of assessments. Without regular, high-quality assessments, the agency's ability to monitor species recovery will be curtailed and uncertainty may result in overly precautionary, or even counter-productive, decisions in regulatory, permitting, and interagency consultation processes. Increasing base costs and constrained budget environments have eroded the agency's ability to expand and improve assessments since the protected species SAIP was finalized in 2004. The agency must pursue new avenues of funding even to be able to sustain the current level of assessment activities, make difficult decisions regarding priorities, or anticipate that its ability to improve sea turtle assessments will be further impaired.



### ***National-Level Assessment Needs***

National-level needs for increasing efficiency, better tracking progress, and strategically addressing regional sea turtle assessment gaps include:

- Use of novel approaches, advanced technology, and integrated/multi-taxa surveys to reduce costs and increase efficiency;
- Increased interagency and international partnerships;
- Development, evaluation, and compilation of analysis tools to assess anthropogenic impacts;
- Improved administration and revision of performance metrics to better reflect data and analysis gaps;
- Development of a consistent reporting mechanism and schedule for compiling U.S. population abundance, demographic, anthropogenic impact, and status information (perhaps in concert with performance metric reporting); and
- Capacity building, recruitment, and training.

### ***Next Steps***

An immediate use of this document will be to guide NMFS' internal sea turtle assessment request for proposals (RFP), replacing an interim document used by the Office of Science and Technology during FY11-FY13. This report also serves to inform NMFS protected species science planning initiatives. The identification of resource and data gaps herein will provide a baseline for future comparisons, as well as a framework for prioritizing specific assessment research activities. Many regional sea turtle assessment priorities are already inherent in center planning documents and are related to broader agency initiatives on habitat, ecosystem, and climate, but agency criteria and methods to prioritize data gaps and analysis needs among protected species and populations are still in the early stages of development. Once prioritization criteria are established, a research implementation plan should be developed, with input from managers and other agency partners, to ensure that the most pressing and long-term assessment needs, as well as other protected species priorities, are met.



# I. Sea Turtle Assessment

## A. Introduction

Sea turtles' long lifespans, dependence on both beach and in-water habitats, and often wide-ranging migrations make them difficult to monitor and susceptible to many threats. All sea turtle species that occur in the U.S. are protected under the Endangered Species Act (ESA; Title 16 *United States Code [USC]*, Sections 1531-1544) and listed as either threatened or endangered. Jurisdiction over U.S. sea turtle populations is shared by the National Marine Fisheries Service (NMFS), housed in the U.S. Department of Commerce's National Oceanic and Atmospheric Administration (NOAA), and the Department of the Interior's U.S. Fish and Wildlife Service (USFWS)<sup>1</sup>. NMFS has lead responsibility for sea turtles in the marine environment, whereas USFWS has lead responsibility for sea turtles when they are on land. NMFS programs conduct a variety of sea turtle conservation and assessment activities, but a substantial amount of research is conducted by other agencies, states, academic institutions, and non-governmental organizations (NGOs), many of whom partner with NMFS to better achieve mutual goals.

In accordance with the ESA, NMFS and USFWS have developed joint recovery plans for U.S. sea turtle populations. Each recovery plan outlines "management actions as may be necessary to achieve the plan's goal for the conservation and survival of the species" and "objective, measurable criteria which, when met, would result in a determination, in accordance with the provisions of [the ESA], that the species be removed from the list" (ESA Section 4(f)1).

Sea turtle species occurring in U.S. waters and/or interacting with U.S. fisheries operating in national and international waters of the Atlantic Ocean, Caribbean Sea, Gulf of Mexico, and Pacific Ocean include the loggerhead (*Caretta caretta*), green (*Chelonia mydas*), leatherback (*Dermochelys coriacea*), hawksbill (*Eretmochelys imbricata*), Kemp's ridley (*Lepidochelys kempii*), and olive ridley (*L. olivacea*). The leatherback, hawksbill, and Kemp's ridley have been listed as U.S. endangered species since their initial listing under the Endangered Species Conservation Act (Public Law 91-135) in 1970, and the loggerhead, green, and olive ridley were listed under the ESA in 1978. To date, no sea turtle populations have been delisted or downlisted under the ESA. Globally, many nesting populations are believed to be at a fraction of historic levels, with some experiencing recent increases and others decreasing or stable.

Regular population assessments are necessary to measure progress toward achieving recovery goals for these species and to provide the foundation for evaluating current and proposed protected species and fishery management activities. Sea turtle assessments can also inform other ESA decisions and aid NMFS' evaluation of the nation's progress in reducing impacts of fisheries on protected living marine resources, as mandated by the Magnuson-Stevens Fishery Conservation and Management Act (MSA; Title 16 *USC*, Sections 1801-1884). Additionally, agency mandates to conserve and recover marine protected species and reduce and mitigate fisheries bycatch are integral components of NOAA's "Healthy Oceans Goal" (NOAA 2010).

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<sup>1</sup> Although the agencies share jurisdiction for sea turtles, this document focuses only on NMFS' assessment responsibilities and does not comment on those of USFWS. Similarly, all recommendations and priorities are targeted to NMFS.

## **B. Assessment Applications**

Many of the forces driving the need for improved sea turtle assessments have remained the same over the past decade, including ESA-related activities such as regulatory actions, permitting, and monitoring recovery and increasing interests in ecosystem approaches to management (e.g., NMFS 2004, Merrick et al. 2007, NOAA 2012a). Additional considerations include identifying new sites for clean and renewable energy development, reducing uncertainty in abundance and bycatch estimates, evaluation of impacts from specific human activities and catastrophic events (e.g., *Deepwater Horizon*), and supporting international conservation approaches (NMFS 2011, Simpkins and Srinivasan 2013). Sea turtle assessments should ideally encompass a comprehensive set of stock (population) identification, nesting and in-water abundance, life history, and anthropogenic impact data and analyses (NMFS 2004, National Research Council [NRC] 2010). Such assessments are valuable not only for informing ESA decisions and evaluating conservation strategies and species recovery, but they also provide a baseline for future assessments and evaluation of recovery status. Baseline data are also important for evaluating the impacts of and developing response plans for rare, catastrophic events (e.g., oil spills, toxic algal blooms), as well as for assessing and mitigating (as possible) the cause(s) of a sudden increase in a particular interaction with human activities (e.g., sudden increase in bycatch) or an unusual mortality event (e.g., a mass stranding event).

Data-rich assessments likely benefit other agencies and stakeholders, as well as NMFS itself, by providing a solid foundation for the evaluation and permitting of specific anthropogenic activities. U.S. Government agencies such as the Department of the Interior's Bureau of Ocean Energy Management (BOEM), the Department of Energy, the U.S. Army Corps of Engineers, and the U.S. Navy rely on timely interagency consultations and issuance of relevant guidance, mitigation measures, and permits in order to undertake, permit, and/or fund projects that are related to oil and gas development, alternative energy development, channel dredging, naval operations, and other activities that are vital to the country's economy, energy, and military needs. Additionally, assessment information is central to NMFS' fulfilling its supportive and advisory role in state-, territory-, and tribal-managed areas and providing scientific and policy leadership and guidance to regional and international bodies such as multi-state marine fishery commissions, U.S. fishery management councils, international fishery management organizations, and the Convention on International Trade in Endangered Species of Wild Fauna and Flora.

## **C. Scope and Development**

The NRC sea turtle assessment report, *Assessment of Sea-Turtle Status and Trends: Integrating Demography and Abundance* (2010), provided an impetus for NMFS to expand upon the original protected species SAIP (NMFS 2004), with an emphasis on sea turtles, as the two documents overlap in subject matter and in their overarching goal to improve the quality of scientific information available to inform sea turtle management and promote recovery. This document broadly integrates sea turtle recovery plan priorities and addresses recommendations made in recent external reviews of U.S. sea turtle programs (e.g., NRC 2010, Government Accountability Office 2012). It also serves to inform ongoing, broader NMFS protected species science planning and prioritization initiatives and should be used to complement future strategic and implementation planning for sea turtle, habitat, and ecosystem-wide assessments. A nationally-focused section also provides a framework for the annual

internal (NMFS) sea turtle assessment request for proposals (RFP), which is administered by the Office of Science and Technology.

Many, but not all, of the NRC panel's recommendations, are addressed in this report, which focuses on assessment science issues. Other science-related NRC recommendations, which fall outside this document's scope, were related to: development of a sea turtle meta-database, conducting a national peer review of current sea turtle research programs, identification of a process to conduct peer reviews of science completed by the Centers, and enhancing agency population assessment skills and expertise. These recommendations are being addressed through other processes. For example, all projects funded under NMFS Office of Science and Technology RFPs, including sea turtle assessment awards, are required to upload metadata to the NMFS InPort (Information Portal) Catalog. Reviews of NMFS sea turtle research programs will ultimately be conducted under a NMFS-wide, five-year science review cycle currently being implemented by the Office of Science and Technology, and the agency is also developing a national review process for its scientific publications. Assessment expertise may be augmented, in part, through agency-wide initiatives, including the NMFS Recruiting, Training, and Research Program and the NMFS/Sea Grant Graduate Fellowship Program in population dynamics.

Initial steps undertaken by NMFS to begin addressing the NRC panel's recommendations (2010) have included:

- Development of an interim sea turtle research plan by the NMFS Office of Science and Technology, with input from NMFS Fisheries Science Centers, the NMFS Office of Protected Resources, and external reviewers (November 2010);
- Establishment of a national sea turtle assessment team, composed of representatives from the four relevant Fisheries Science Centers and the Office of Science and Technology (February 2011); and
- Development of a strategic plan that identifies the data and analysis needed to accomplish and improve sea turtle assessments (provided, in part, by this document).

This document is intended to reflect the current state of sea turtle assessment and related research activities and to provide an overview of resource requirements for sea turtle assessments. Its assessment data categories are reflective of NMFS stock assessment improvement initiatives and the 2010 NRC report. In addition to documenting the current status of U.S. sea turtle assessments under the ESA, this report describes NMFS staffing, vessel, and aircraft resources used to conduct sea turtle assessment activities in FY11, as well as estimated resources needed to make better use of existing data and survey efforts and to better meet relevant mandates of the ESA. This document also includes sections on national-level data gaps and science activities geared toward improving NMFS sea turtle assessments. Also discussed are ongoing regional sea turtle activities and potential steps for improving regional research, monitoring, and analysis. Should NMFS protected species assessment measures change, the identification of resource and data gaps herein will provide a baseline for future comparisons and may be used as a framework for developing and prioritizing specific assessment research priorities.

#### **D. Assessment Responsibilities**

NMFS, one of NOAA's six line offices, is responsible for the management, conservation, and protection of living marine resources within the 200-mile U.S. Exclusive Economic Zone (EEZ). The agency also plays a supportive and advisory role in state-managed coastal areas and provides scientific and policy leadership internationally, as appropriate. The NMFS mission to provide "stewardship of living marine

resources through science-based conservation and management and the promotion of healthy ecosystems” is reflective of its primary mandates, the ESA, MSA, and the Marine Mammal Protection Act (MMPA). This mission is also complementary to the NOAA-wide vision of “healthy ecosystems, communities, and economies that are resilient in the face of change” (NOAA 2010) and the overarching goal of the National Ocean Policy (Executive Order 13547) “to achieve an America whose stewardship ensures that the ocean, our coasts, and the Great Lakes are healthy and resilient, safe and productive, and understood and treasured so as to promote the well-being, prosperity, and security of present and future generations.” Beyond receiving protection as threatened and endangered species and being a component of bycatch reduction strategies, sea turtles are components of healthy ecosystems (Bjorndal and Jackson 2003), and their continued presence can positively impact communities and economies via ecotourism, education, research, and intrinsic cultural value (Campbell 2003).

### ***NOAA’s Next Generation Strategic Plan***

NOAA is committed, under its Healthy Oceans Goal, to two objectives directly related to protected species science and management: “improved understanding of ecosystems to inform resource management decisions” and “recovered and healthy marine and coastal species.” Evidence of progress toward these objectives will include:

- “Next-generation fish and protected resource stock assessments incorporating habitat, ecosystem, and climate information;”
- “Living marine resource managers using high-quality data to inform management plans and decisions;”
- “Stabilized or increased abundance of species that are depleted, threatened, or endangered;”
- “Decreased bycatch of protected species;” and
- “Increased number of protected species with improving status” (NOAA 2012a).

These responsibilities fall under NMFS jurisdiction, and meeting such objectives will require assessments of each protected species, population, or stock’s status and threats as well as forecasting of future status. Fully achieving this suite of milestones will require inclusion of new and historic information on habitat and ecosystem characteristics, anthropogenic threats, and impacts of climate and other environmental factors in sea turtle assessments. Additionally, high-quality temporal and spatial abundance data for sentinel species such as sea turtles will enable better understanding of climate impacts and ecosystem changes, supporting NOAA’s multidisciplinary approach to climate science and assessment.

Long-term commitments to data collection and analysis are essential for providing the building blocks for sea turtle assessments, as well as for determination of habitat preferences and impacts of environmental change and anthropogenic threats. Additionally, NOAA recognizes that assessments for many species, including sea turtles, will require national and international collaboration on data collection, assessments, and management (NOAA 2010), as well as advanced technology and more efficient and integrated survey designs and techniques.

### ***Endangered Species Act and Assessments***

Within the context of the ESA, assessment information is primarily used to inform activities conducted under Sections 4, 7, and 10, which focus primarily on species listings, critical habitat, and recovery planning; consultation on actions authorized, funded, or carried out by federal agencies; and scientific research and incidental take permitting, respectively. Under the ESA, the listing agency (both NMFS and USFWS, in the case of sea turtles) must base decisions under these sections on the “best scientific and

commercial data available.” The “benefit of the doubt” must be given to the listed species in the face of uncertainty, possibly resulting in precautionary and costly measures that, with better information, could have been avoided (NMFS 2004). Other linkages between assessment and the ESA are found in Sections 6 (partnerships with states, tribes, and local entities) and 8 (cooperation on international issues). Further information on the linkages between protected species assessments and the ESA, as well as the MMPA and National Environmental Policy Act, can be found in the protected species stock assessment improvement plan (SAIP; NMFS 2004) and in the acts themselves.

### ***Protected Species Stock Assessment Improvement Plan***

A protected species SAIP entitled, *A Requirements Plan for Improving the Understanding of the Status of U.S. Protected Marine Species*, was published by NMFS in 2004. The document was modeled after an earlier plan that aimed to improve fish stock assessments (NMFS 2001). The SAIP provided a basis for improving protected species assessments by evaluating the status of NMFS’ sea turtle and marine mammal research activities relative to the stock (population) structure, abundance, life history, and threats data required to conduct assessments that assist NMFS in meeting MMPA and ESA (NMFS 2004). Tiers I and II were defined relative to levels achieved for specific data categories, whereas Tier III represented not yet fully defined, “next generation” assessments incorporating ecosystem-based approaches (NMFS 2004). In the SAIP, NMFS concluded that assessment data were inadequate to fully evaluate population structure, status, and progress towards certain recovery plan goals for all sea turtle populations that occur in U.S. waters. A workshop was held in 2006 to further define Tier III for protected species (Merrick et al. 2007), but no further development has occurred since, due in part to budgetary constraints and lack of success in elevating turtle assessments beyond Tier I.

### ***National Research Council Review of Sea Turtle Assessments***

The NRC was commissioned by NMFS in 2009 to assemble a panel to review and provide advice on methods to improve recent sea turtle assessments and to evaluate the state of relevant science and research. The panel’s 2010 report concluded that the current attempts at assessing the status of sea turtle populations, while “valiant,” suffer from a “debilitating lack of data.” The report’s recommendations “on the research, monitoring and data needed to improve sea turtle population assessments in the short- and long-term” (NRC 2010) reflect the information needed to complete assessments to better evaluate and inform sea turtle management. The panel’s assessment science recommendation categories (units of assessment, abundance and trends, demographic rates, and integrating demographic information with abundance estimates; NRC 2010) are inherent in U.S. sea turtle recovery plans, ESA five-year reviews, and Turtle Expert Working Group (TEWG) reports (e.g., TEWG 2000, 2007, and 2009) and are in-line with the protected species SAIP’s categories (NMFS 2004). The NRC report also provided recommendations beyond the scope of the SAIP (NMFS 2004) and this document that were related to national (interagency) sea turtle assessment strategy, data management, education, and permitting (NRC 2010).

## **E. Use, Implementation, and Next Steps**

Assessment results will be used by NNFS to inform sea turtle management strategies and actions to achieve recovery and will be applicable to broader habitat, ecosystem, and climate initiatives. This document should be used to inform and complement near-term research prioritization activities and long-term strategic and implementation planning. Sections related to the status of sea turtle assessments should be updated regularly to track the agency’s progress in improving assessment

quality, either under the original tier system (NMFS 2004) or using any new prioritization scheme, metrics, or other tools developed for NMFS protected species science and assessments.

An immediate use of this document will be to guide the sea turtle assessment RFP, replacing the interim research plan used by the Office of Science and Technology during FY11-FY13. Implementation of the activities herein will be largely dependent on NOAA- and NMFS-wide strategic planning, as well as development of priority-setting processes for protected species science. The report may be used to inform broader NMFS protected species and ecosystem science planning and prioritization initiatives, such as follow-up to the NMFS Protected Resources Science Investment Plan workshop (Arlington, Virginia; November 2012). This workshop brought together scientists and managers and focused primarily on sea turtles and marine mammals. Its objectives included: characterizing internal and external (non-NMFS) science needs to inform protected species management deliberations and decisions; beginning development of strategies for meeting those needs both now and in the future; and improving communication to decision-makers regarding the value of protected species science. The workshop's report provides a meeting summary, as well as outlining next steps to develop processes to identify, prioritize, and communicate protected species science needs (Simpkins and Srinivasan 2013). The center-specific sea turtle activities detailed in the current document provide a starting point for applying prioritization tools, as well as any other metrics, as they are developed.



## II. Status of Sea Turtle Assessments

NMFS acknowledged in the protected species SAIP that the document was not a final step in improving protected species assessments (NMFS 2004), and the agency subsequently held a workshop to begin developing a framework for “Next Generation Assessments,” which would embrace a more ecosystem-based approach (Merrick et al. 2007). Improvements have been called for in recent sea turtle recovery plan revisions (NMFS and USFWS 2008, NMFS et al. 2011), listing decisions (NMFS and USFWS 2011), and ESA five-year reviews (e.g., NMFS and USFWS 2007a-d), as well the NRC report (2010). However, little progress has been made in significantly improving the status of sea turtle assessment, due in large part to budgetary constraints. The agency’s budget is unlikely to change in the near-term to fully support the assessment resource needs outlined here and throughout this document. However, there are ongoing agency efforts to apply prioritization tools more effectively, leverage funding and partnerships to meet management-critical assessment needs, improve efficiencies in survey and monitoring operations, and improve messaging about the economic and ecological value of conducting regular and precise assessments (e.g., Simpkins and Srinivasan 2013).

### A. Sea Turtle Assessments and Data Categories

The protected species SAIP (NMFS 2004) defined “stock assessment” as “collecting, analyzing, and reporting information related to the status of protected species and the impacts of human activities upon protected species.” There are also a variety of assessment documents that can be produced during ESA processes, which must be based upon the best available data and do not require the generation of new data through surveys or research (see Section II-B). Such assessments may be a compilation of current information on a species and its ESA status, or they may include quantitative approaches such as statistical analyses and modeling.

The SAIP laid out a system for determining and prioritizing resources needed first to improve protected species assessments under then-existing (FY03) data collection resources (Tier I assessments) and then elevate assessments to “new national standards of excellence” to meet ESA and MMPA mandates (Tier II assessments). It also identified five data categories of primary importance for sea turtle assessment and management: stock/population identification, life history (stage-based) characteristics and vital rates, abundance (nesting and in-water), anthropogenic impacts (with emphasis on fisheries), assessment frequency, and assessment quality (NMFS 2004). Given the congruities among these categories, the NRC report’s recommendations, and NMFS’ science-based management approaches, the protected species SAIP’s data categories provide a relevant framework for guiding sea turtle assessment data collection and analysis activities. Each of these categories is described below, and data scoring levels are detailed in Table 1.

#### ***Stock Identification***

A fundamental aspect of assessment is the identification of stocks or populations. For the purposes of this document, “U.S. stocks” include those sea turtle populations that occur in U.S. waters and/or interact with U.S. fisheries operating in international waters of the Atlantic Ocean, Caribbean Sea, Gulf of Mexico, and Pacific Ocean during one or more life stages. U.S. stocks were defined according to species, ESA listing status, and ocean basin, including the recently defined Northwest Atlantic and North Pacific loggerhead distinct population segments (DPSs; Conant et al. 2009, NMFS and USFWS 2011) and each of the listed (e.g., endangered or threatened) populations of the green turtle and olive ridley. The

use of the term “U.S. stocks,” however, is not intended as synonymous with the ESA term “DPS.” It should also be noted that stock delineations may change as new data become available and that geographically-based entities identified as stocks herein (Appendix I) may each include more than one genetically-defined population.

### ***Life History, Abundance, and Anthropogenic Impacts***

Life history and vital rates, nesting and in-water abundance, and anthropogenic impacts information and analyses are key components of sea turtle assessments. The NRC panel emphasized the need to obtain vital rate estimates (e.g., stage-specific survival rates, age of sexual maturity, breeding and nesting frequency, and reproductive output) at the stock (population) level, as well as for better stage-specific in-water trend and abundance information to complement that available from nesting beaches. While analysis of nesting female data is important, it is insufficient for a fully complete assessment, which would include both males and females over all age or stage classes. For most sea turtle populations, fishery bycatch is the greatest source of human-induced (anthropogenic) mortality (NRC 1990), but numerous other threats are known, and all should be investigated at stage-specific and regional scales. When sufficient data are available for assessments to include stage-specific vital rates, abundance, and cause-specific mortality estimates, the development of management measures can be better informed and better tailored.

### ***Assessment Frequency and Quality***

Assessments that are too old relative to current management needs, or those that need to incorporate improved or new data, must be periodically updated or redone to incorporate new information to, as accurately as possible, reflect a population’s status, and inform recovery and management activities. Frequency of assessments, however, cannot alone sufficiently describe the state of the science available to inform management decisions. The quality or completeness of an assessment is also important. Assessments must be defensible and rely on the best data available. They will usually involve the application of models, ranging from simple, nesting-based trends to more complex, population-specific models that integrate data such as vital rate estimates and abundances of multiple life stages.

Given the variety of assessment types available for U.S. sea turtles and a lack of national consistency in the interpretation and implementation of the assessment frequency and quality scoring criteria (Table 1), these categories were not explicitly scored in this document. In the interest of providing more useful information on these topics, the Team was instructed to present descriptions of the most recently available quantitative and ESA assessments for each stock, including the most recent year of data and types of information and analyses included in each assessment (Appendix I, Tables 2-3). In some instances, a quantitative assessment was contained in an ESA document.

### ***Other Applicable Information***

Although not explicitly included in its data categories, the SAIP highlighted the importance of better integration of habitat, ecosystem, and climate information into protected species assessments (NMFS 2004, Merrick et al. 2007). NOAA considers these linkages to be key components of “next generation” assessments for all marine species (NOAA 2012a), and the NMFS Habitat Assessment Improvement Plan (2010), while focused on managed fish species, can be broadly applied to protected species. Additionally, historical data are important assessment components that can inform ESA listing and delisting decisions, development of demographic recovery criteria, and estimation of climate impacts by providing baseline data for abundance, distribution, population structure, and other characteristics. The importance of habitat, ecosystem, climate, and historical information and analyses for sea turtle

assessment is not explicit in the data categories scored in this document, but it is reflected in regional Tier II- and Tier III-equivalent activities identified by the centers (Appendix II).

**Table 1.** Assessment data categories and levels as defined in the protected species SAIP (reproduced from NMFS 2004). "CV" is the coefficient of variation.

<b>Category/ Level</b>	<b>Description</b>
<b>Stock/Population Identification</b>	
<b>0</b>	No information (qualitative or otherwise) available
<b>1</b>	Structure inferred from analyses undertaken for other purposes (e.g., distribution, differences in trends, differences in life history)
<b>2</b>	Structure inferred from an analysis specifically aimed at investigating population differentiation (e.g., pollutants, stable isotopes, genetics, tagging)
<b>3</b>	Structure inferred from an integrative analysis of at least two lines of evidence of the type listed under Level 2
<b>4</b>	Estimates of dispersal rate that include estimates of uncertainty
<b>Life History</b>	
<b>0</b>	No information
<b>1</b>	Basic life history understood
<b>2</b>	Some age/stage parameters available
<b>3</b>	Age/stage parameters fully specified with uncertainty estimates
<b>4</b>	Seasonal and/or spatial information available
<b>Abundance (Nesting and In-Water)</b>	
<b>0</b>	No information (qualitative or otherwise) available
<b>1</b>	Minimum count, abundance estimate, or index count
<b>2</b>	Unbiased estimate of abundance (CV $\geq$ 30%)
<b>3</b>	Unbiased estimate of abundance (CV<30%) with seasonally OR geographically-explicit density
<b>4</b>	Seasonal and geographic-specific density estimates
<b>Anthropogenic Impacts</b>	
<b>0</b>	No information (qualitative or otherwise) available
<b>1</b>	Qualitative evidence of anthropogenic impacts
<b>2</b>	Minimum estimate of anthropogenic impacts
<b>3</b>	Unbiased estimate of anthropogenic impacts (CV $\geq$ 30%)
<b>4</b>	Precise estimate of anthropogenic impacts (CV<30%) OR no evidence of human-induced mortality
<b>Assessment Frequency</b>	
<b>0</b>	No assessment conducted
<b>1</b>	Most recent assessment is $\geq$ 10 years old
<b>2</b>	Most recent assessment is 6-9 years old
<b>3</b>	Most recent assessment is 2-5 years old
<b>4</b>	Assessment completed in past year
<b>Assessment Quality</b>	
<b>0</b>	No assessments conducted
<b>1</b>	Assessment with minimum abundance or index only
<b>2</b>	Assessment using simple deterministic models with defaults or proxies
<b>3</b>	Assessment using more advanced deterministic models without defaults or proxies
<b>4</b>	Assessment using species-specific sophisticated models, such as stochastic models, depletion models, or projection models (e.g., population viability analysis, PVA)

## **B. Assessment Tiers**

The protected species SAIP (NMFS 2004) included a tier-based scoring system where Tier I assessments maintained the *status quo* (Fiscal Year 2003, FY03) with no new surveys or observers, but made better use of existing programs and data. Here, the Team has used the same scoring criteria (Table 1) to evaluate the assessment status of each stock, and those stocks with any category scoring 0-2 are considered Tier I. Resource needs (staff, vessel, and aerial; Section V-B) and center-specific research activities (Appendix II) have been described such that they continue and build upon current initiatives (i.e., Tier I-equivalent), without relying on external (non-NOAA) funding sources.

The agency currently considers protected species assessments at Tier II or higher to be “adequate” for the purposes of its Government Performance and Results Act reporting. This tier meets the objectives of NOAA’s Next Generation Strategic Plan’s Healthy Oceans Goal (NOAA 2010) and is also in-line with the NRC (2010) recommendations. Achieving a Tier II level of information for all U.S. sea turtle assessments requires all data categories (stock/population identification, life history, abundance, anthropogenic impacts, and assessment frequency and quality) to reach at least Level 3 (Table 1; NMFS 2004). Such assessments are considered data-rich, and they use higher-precision, more-comprehensive datasets and in-depth analyses, thereby reducing uncertainty. Tier II-equivalent assessments will enable NMFS to more effectively meet its ESA and MSA mandates and, by extension, enhance species survival and recovery. Needs for resources (Section V-B) and center-specific research activities (Appendix II) have been described such that they would enable all stocks to score at least Level 3 (i.e., Tier II-equivalent) in all data categories (Table 1).

Tier III assessments have not yet been formally defined by NMFS (Merrick et al. 2007), but it is clear that the integration of habitat, ecosystem processes, climate, and other mechanisms potentially influencing vital rates and distributions will provide the basis for forecasting sea turtle distribution and abundance. Process-based and interdisciplinary research and analysis will be required to move assessments into the next generation of science information. Oceanographic and climatic data and projections should be integrated not only into sea turtle population models, but also into broader, ecosystem approaches to examinations of anthropogenic threats. In the course of developing this report, two centers chose to provide examples of research activities that would be conducted to facilitate integration of ecosystem approaches into sea turtle assessments, whereas aspects of the work proposed and/or conducted by the other centers under Tiers I and II relate to Tier III goals (Appendix II). All centers are currently conducting a mix of Tier I- and Tier-II equivalent and ecosystem-related activities, but not at levels necessary to raise all data category scores to Level 3.

## **C. Present Status of U.S. Sea Turtle Assessments**

Fourteen U.S. sea turtle “stocks” were identified using the criteria laid out in Section II-A to delineate units for assessment purposes (Appendix I). Although the use of the term “U.S. stocks” is not intended to be synonymous with the ESA term, “DPS,” the recently defined loggerhead DPSs (NMFS and USFWS 2011) were considered to also be “stocks.” Assessment units may need to be revised as more information becomes available.

Although there has been some improvement in data levels for species/stocks with recently revised recovery plans and/or listing decisions, the Team determined that all sea turtle assessments remain at

Tier I. As such, no U.S. sea turtle stocks have an “adequate” assessment, which requires that all categories of information score a Level 3 or greater under the SAIP. It should be noted that increasing base and operational budget costs (e.g., salary, facilities, vehicle and small vessel operation and maintenance, shipping costs) and constrained budget environments have eroded the ability to expand and improve assessments since the protected species SAIP was finalized in 2004. Outside sources of funding (e.g., BOEM, Navy, and the *Deepwater Horizon* Natural Resources Damage Assessment [NRDA] process) have supported some assessment activities in recent years. The science centers must pursue new avenues of funding even to be able to sustain current level of assessment activities, make difficult center-wide decisions regarding priorities, or anticipate that their ability to improve sea turtle assessments will be further impaired. Estimated regional resource needs are described in Section V-B and Appendix III.

Specific information on the status of assessment for each of the 14 U.S. sea turtle stocks is provided in Appendix I. Among the data category scores (Appendix I, Table 1), the only scores at Level 3 were for stock identification (Northwest Atlantic Ocean DPS of loggerhead, Florida and some other Northwest Atlantic breeding colonies of green turtle, and Northwest Atlantic leatherback) and nesting abundance (Northwest Atlantic Ocean DPS of loggerhead and some Pacific leatherback populations). None of the 14 stocks scored above Level 2 in the life history and vital rates, in-water abundance, or anthropogenic impacts categories. Life history and vital rates were identified by the NRC panel, TEWG reports, and recently revised recovery plans as critical to enhancing analytical assessments and to successfully projecting stock size and trends over time. In-water abundance estimates, which the 2007 ESA five-year reviews and NRC panel (2010) highlighted as critically important for assessments, were the only data category where Level 0 was as frequent as Levels 1 and 2. Anthropogenic impact data (scored at Levels 1-2) are also critical components of assessments, especially with regard to helping inform management actions to enhance recovery. Assessment frequency is relatively high (within the past 2-6 years) for most stocks when ESA five-year reviews are considered (Appendix I, Tables 2-3). However, in many instances, the best available data (quantitative or otherwise) were over 5 years old and/or covered only a portion of the stock’s range. Assessment quality could be improved not only with expanded spatial coverage and continued sampling, but also with more detailed demographic, in-water, and threat information and analysis.

### **III. National Sea Turtle Assessment Research Themes**

An interim sea turtle assessment research plan was developed in 2010 under the leadership of the NMFS Office of Science and Technology, with input from the NMFS Office of Protected Resources, NMFS science centers, and two external reviewers, to guide the annual internal (NMFS) sea turtle assessment RFP program. It was a first step toward identifying assessment research themes and activities to improve sea turtle assessments and drew from the goals, priorities, and data gaps highlighted in sea turtle recovery plans, ESA five-year reviews, and the NRC report (2010).

The theme and activities listed below comprise an updated version of the interim plan text, developed to better align with the protected species SAIP (NMFS 2004) data categories and the assessment research and analysis gaps highlighted in the previous section. Although their order does not indicate priority level, some activities may build upon each other or require integration within or between data categories. Further definition of national and regional priorities through regular cross-agency discussions (including both scientists and managers) and development and application of clear priority-setting criteria for protected species science activities would increase efficiency in meeting the agency's goals and responsibilities.

#### **A. Stock Identification**

Recommendations for future actions identified in the 2007 ESA five-year reviews included status reviews to determine the application of DPS policy to most sea turtle species. These efforts will be enhanced by examination of relationships and the level of connectivity among populations, particularly for understudied species and/or regions. Research can also examine the degree of mixing of populations at foraging sites and provide information on genetic resilience and/or ability to adapt to changing environmental conditions. Sea turtle assessments must reach at least Level 3 (structure inferred from an integrative analysis of at least two types of research conducted for the purpose of stock identification) to achieve Tier II (NMFS 2004), and stock identification priorities include:

- Multi-disciplinary studies that use genetics, abundance, and ecological studies (e.g., Capture-Mark-Recapture [CMR], telemetry, toxicology, stable isotope analysis [SIA], etc.) to examine stock/population structure;
- Improving stock definitions and developing science-based definitions of U.S. assessment units using multiple data types (e.g., genetics, tagging, telemetry, toxicology, SIA);
- Development of DNA fingerprints using multi-locus nuclear markers (e.g., microsatellites, single-nucleotide polymorphisms);
- Development of new nuclear markers aimed at increasing understanding of stock/population structure, phylogeography, and genetic resilience; and
- Development of sex-specific models to evaluate male vs. female connectivity.

#### **B. Life History and Vital Rates**

Population models and evaluation of trends, threats, and extinction risk require the best possible regional estimates of vital rates (averages, inter-individual variability, and temporal and spatial variation) and are enhanced by understanding environmental mechanisms that may affect these rates. Priority should be given to the most serious data and analysis gaps with respect to estimation of species- and stage-specific vital rates, and vital rate data should be collected over space and time to improve

trend information. Uncertainty and variability in demographic parameters must be estimated for all life stages to achieve Level 3 (age/stage parameters fully specified with uncertainty estimates) for this data category (NMFS 2004). Activities geared toward addressing life history and vital rate data gaps should focus on:

- Estimation of:
  - Survival rates of immature (oceanic- and neritic-stage) turtles and adult males,
  - Life history stage durations and age at sexual maturity,
  - Stage-specific somatic growth rates,
  - Stage-specific sex ratios,
  - Breeding rates, clutch frequency, and hatchling-cohort production, and
  - Impacts of different habitats and/or migratory patterns (e.g., local vs. long-distance) on stage-specific vital rates;
- Development of sex-specific models to evaluate male vs. female survival and improve understanding of demography; and
- Continued advancements in methods to collect demographic data and prioritize the need to estimate each vital rate.

### **C. Abundance**

Data from nesting beaches provide valuable information on females and reproductive output, but in-water monitoring and subsequent analyses are necessary to characterize other population segments, develop more comprehensive population models, and improve estimates of extinction risks for a population. In-water life stages fall explicitly under NMFS jurisdiction. However, because data from nesting beaches can provide important information about in-water phenomena, nesting beach data collection and analysis may be appropriate for some programs. Sea turtle abundance data must reach at least Level 3 (unbiased estimate of abundance with coefficient of variation, CV, <30% and seasonally- OR geographically-explicit density) to achieve Tier II, and Level 4 data (seasonal and geographic-specific density estimates) are essential to reducing uncertainty in assessments (NMFS 2004). Sea turtle survey, monitoring, and abundance analysis activities should include:

- Improving abundance estimates for poorly-understood life stages (e.g., pelagic- and neritic-stage immature turtles, adult males);
- Improving abundance estimation methods;
- Evaluating the study design of and complementing or expanding past and present long-term studies (if valuable to do so);
- Collecting in-water data on appropriate temporal and spatial scales to estimate stage-specific regional and seasonal abundance, movement rates, survival rates, and growth rates;
- Characterization of seasonal and life-stage-specific estimates of surface time to enable correction of abundance estimates from aerial/shipboard observations to account for turtles not available to be seen at the surface;
- Continued advancements in methods to combine transect survey data and behavioral data; and
- Compilation, synthesis, analysis, and modeling of existing sea turtle, ecosystem, environmental, oceanographic, and climatic data to inform interpretation of in-water and survey data and improve assessment quality.

## **D. Anthropogenic Impacts**

Collection and analysis of anthropogenic impact data, comprising lethal and non-lethal interactions, including fisheries bycatch, vessel strikes, other incidental takes (e.g., by sand dredges, power plant intake systems), and habitat and ecosystem alteration are essential to improving population assessments. Sea turtle anthropogenic impacts data must reach at least Level 3 (unbiased estimates) to achieve Tier II, and improved (Level 4: precise estimate of anthropogenic impacts; NMFS 2004) estimates may reduce uncertainty regarding the population level effects of anthropogenic activities. Investigation of anthropogenic impacts to improve sea turtle assessments should focus on:

- Identification and estimation of anthropogenic impacts on sea turtles and their habitats including temporal and spatial distribution of impacts within foraging and mating areas and along migration routes;
- Continued development of methods for improved estimation of anthropogenic impacts on sea turtle populations and at various life history stages;
- Examination of population-level effects of non-lethal anthropogenic impacts on sea turtle demography and vital rates; and
- Development and evaluation of tools to examine the population-level effects of anthropogenic impacts.

## **E. Assessment Frequency and Quality**

Quantitative assessments should be conducted for each species/stock/population at least once every 5 years (i.e., data quality Level 3), and these assessments should use, at a minimum, advanced deterministic models without defaults or proxies (i.e., data quality Level 3; NMFS 2004). Aside from increasing staff, data collection, and analytical capacity to conduct assessments at regular intervals, priority activities to increase assessment quality include:

- Conducting a review/analysis to prioritize research needs according to which parameters from all of the above data categories will provide the most useful information for diagnosis of trends in each sea turtle species, stock, or population; and
- Development of a “toolbox” for sea turtle assessment that can provide standardized methods for evaluation and review of data-poor and data-rich species/populations.



## IV. Sea Turtle Assessment Research Activities

The NMFS Northeast, Southeast, Pacific Islands, and Southwest Fisheries Science Centers (NEFSC, SEFSC, PIFSC, and SWFSC) each have permanent and contract staff dedicated to collection and analysis of assessment-related sea turtle data. Protected species and bycatch observer programs are administered by the science centers with the exception of the Pacific region, where the Pacific Islands Regional Office (PIRO) and Southwest Regional Office (SWRO) administer the regional observer programs. East coast sea turtle stranding programs are administered by the SEFSC and the Northeast Regional Office (NERO). The Pacific Islands' sea turtle stranding program is administered by the PIFSC in collaboration with U.S. territory government sea turtle programs. The U.S. west coast turtle stranding program is managed collaboratively through the SWFSC and SWRO. All four centers collaborate with NMFS sea turtle "centers of expertise," such as the SEFSC's National Sea Turtle Aging Laboratory (NSTAL) and the SWFSC's National Marine Turtle Genetics Laboratory (NMTGL), which provide cost-effective, coordinated venues for sample analysis and archival. The science centers communicate and coordinate, to varying degrees and as appropriate, with their respective regional offices and the Offices of Protected Resources and Science and Technology regarding issues such as biological reviews, recovery planning and implementation, stranding and bycatch data, science needs for management decisions, budgeting, and funding. The centers also participate in a variety of mutually-beneficial regional collaborations with each other and with other agencies, academic institutions, and other research programs. Ongoing activities and collaborations of each individual center are described below.

### A. Northeast Fisheries Science Center<sup>2</sup>

Sea turtle assessment activities at the NEFSC are split between two administrative units: the Protected Species Branch (PSB) within the Resource Evaluation and Assessment Division, and the Fisheries Sampling Branch (FSB) within the Fisheries and Ecosystems Monitoring and Analysis Division. The PSB conducts in-water abundance research, estimates bycatch in commercial fisheries, and participates in sea turtle assessments. The FSB runs the Northeast Fisheries Observer Program, which is responsible for collection of data on protected species bycatch in selected fisheries.

In sum, the PSB and FSB programs constitute the equivalent of approximately 19 full-time federal employees (FTEs), 48 contract staff (mostly to support the observer program), and 212 observers that are directly or indirectly involved with assessment and conservation of sea turtle species inhabiting the western North Atlantic Ocean, although the vast majority are not paid with turtle funds. The species of primary focus is the loggerhead, though assessment information is also generated for green, Kemp's ridley, leatherback, and occasionally hawksbill sea turtles. All of these sea turtle populations are listed at Tier I under the SAIP, and considerable data deficiencies exist for each. The NEFSC PSB sea turtle program has five FTEs and two contract staff involved, at least partially, with the assessment of sea turtles in the Northwest Atlantic Ocean waters; of these 1.75 FTEs and 50% of two contractor salaries are paid with turtle funds (Appendix III, Table 1). In 2010, approximately 313 observer sea days were assigned based on sea turtle priorities. Data from approximately 15,000 sea days were available for sea turtle bycatch analysis, from either agency or industry-funded days.

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<sup>2</sup> This section was prepared in FY11, and no substantial updates have been made.

### ***NEFSC Sea Turtle Assessment Activities***

NEFSC sea turtle staff activities are directed toward assessing sea turtle populations and improving the quality of future assessments in accordance with the SAIP (NMFS 2004). In addition, several existing projects address assessment needs outlined by the NRC report (2010). Research efforts are directed toward stock/population identification, abundance trends, assessment of anthropogenic impacts, and characterization of life history parameters. Collectively, the goal of these efforts is to allow evaluation of sea turtle stock status in a conceptual framework that facilitates prediction of the effects that various stressors may have on the status of these long-lived, late-maturing species. The NEFSC coordinates with NERO to identify and address regional sea turtle assessment needs, and it frequently works on collaborative or complementary projects with the SEFSC and non-governmental partners on activities related to Atlantic sea turtle stocks. Ongoing NEFSC sea turtle assessment activities are listed below. Regionally-relevant activities identified by the NEFSC that would make better use of existing data and survey efforts (Tier I-equivalent) and better meet relevant mandates of the ESA (Tier II-equivalent) are listed in Appendix II, and estimates of staffing, vessel, and aircraft requirements to achieve those tasks are available in Section V and Appendix III.

***Stock Identification*** – The NEFSC collects tissue samples for analysis by the NMTGL. NEFSC fisheries observers obtain tissues for genetic analysis when they encounter bycaught turtles, and the center’s research programs also include biopsy sampling as part of their protocols. The NERO coordinates the Northeast region’s Sea Turtle Stranding and Salvage Network (STSSN) activities, including those related to stock identification and assessment.

***Life History and Vital Rates*** – The NEFSC has supported assessment of secondary loggerhead sex ratios by collecting and pre-processing blood samples from in-water (neritic) captures. Measurement of testosterone titers in the samples have been conducted by a collaborator at the College of Charleston.

***Abundance*** – NEFSC abundance assessments focus on aerial surveys of turtles in the marine environment. Beginning in 2010, the NEFSC has been part of the Atlantic Marine Assessment Program for Protected Species (AMAPPS), a joint effort between the NMFS Northeast and Southeast Centers and BOEM to obtain seasonal distribution and abundance data for protected species, including sea turtles, along the U.S. Atlantic coast (NEFSC and SEFSC 2011) via large-scale aerial surveys. Because aerial survey results can be confounded by seasonal and/or geographic differences in surfacing intervals, survey efforts now include the deployment of satellite transmitters on sea turtles caught in survey areas. The transmitters provide information regarding turtle movement and seasonal distribution as well as the proportion of time spent at or near the water’s surface, and therefore “availability” to be detected during aerial surveys.

***Anthropogenic Impacts*** – The NEFSC investigates anthropogenic impacts on sea turtle populations at many levels. Baseline values for wild loggerhead turtle health parameters have begun to be characterized in Mid-Atlantic foraging grounds, with a goal of assessing current status and also providing a reference against which to measure future changes in population health, including factors underlying unusual mortality events.

The NEFSC coordinates observer coverage for benthic longline, hand line, bottom otter trawls (fish, scallop, Ruhle, haddock separator, northern shrimp), floating trap, sink gillnet, purse seine, dredge (scallop, ocean quahog, surf clam), mid-water (paired and single) trawl, pots and traps (fish, conch/whelk, hagfish, northern shrimp, lobster, crab), and beam trawl, some of which are used to characterize sea turtle/fishery interactions. To date, sufficient levels of data have been available in

bottom otter trawl (for fish and scallop), gillnet, and scallop dredge gears to estimate the rates and magnitude of sea turtle bycatch between Cape Cod and North Carolina. The NEFSC is actively researching ways to improve existing methods of assessing the population level impact of fishery-related mortality. The NEFSC is also part of the NMFS Atlantic Strategy for Sea Turtle Conservation and Recovery, an effort to reduce sea turtle bycatch by evaluating and prioritizing management of gear types, rather than individual fisheries (note: the Strategy's framework is currently being revised, but the NEFSC will continue to be a participant).

The NEFSC also has an active program to mitigate fisheries impacts while supporting vibrant coastal communities. The details of the mitigation program are not provided here, as the original focus of the regional sections was on stock assessment only.

**Assessment Frequency and Quality** – The NEFSC has participated in numerous TEWGs to assess population status for different species and identify data needs. The products of these efforts are extensively assessed by working group participants and have been disseminated as internally reviewed technical memoranda, with a recent move toward additional review by the Center for Independent Experts.

## **B. Southeast Fisheries Science Center<sup>3</sup>**

The SEFSC sea turtle program encompasses diverse population assessment and conservation efforts and is spread throughout administrative units at four different laboratories: 1) Protected Species and Biodiversity Division, Miami, Florida; 2) Harvesting Systems Unit (HSU) and Resource Surveys Branch, Pascagoula, Mississippi; 3) Protected Resources Branch, Beaufort, North Carolina; and 4) Protected Species Branch, Galveston, Texas. No staff dedicated to sea turtle work is present at the SEFSC's Panama City, Florida laboratory, but this facility regularly hosts activities related to sea turtle/fishery bycatch issues.

In sum, SEFSC sea turtle programs constitute the equivalent of approximately 20 FTE and 7 contract staff. However, as HSU efforts are directed primarily toward bycatch reduction, of this total, approximately 11 FTE and 6 contract personnel are involved with activities related to assessments for the 6 sea turtle species inhabiting the western North Atlantic Ocean, the Gulf of Mexico, and northern Caribbean waters (Appendix III, Table 1). The five species of primary focus are the loggerhead, green, Kemp's ridley, leatherback, and hawksbill. However, the olive ridley also occasionally occurs in southeast U.S. and Caribbean waters and on the high seas and is therefore of potential concern. All of these sea turtle populations are listed at Tier I under the SAIP and considerable data deficiencies exist for each. The SEFSC frequently works on collaborative or complementary projects with the NEFSC on activities related to U.S. Atlantic sea turtles.

### **SEFSC Sea Turtle Assessment Activities**

SEFSC sea turtle program activities are directed toward assessing sea turtle populations and improving the quality of future assessments in accordance with the SAIP. In addition, many programs address the stock/population structure, life history, and vital rate data needs recently outlined by the NRC (2010) in their *Assessment of Sea-Turtle Status and Trends* report. SEFSC sea turtle program research priorities are

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<sup>3</sup> This section was prepared in FY11, and no substantial updates have been made.

also designed to meet NOAA's Ecosystem Mission Goal and are guided by NOAA Ecosystem Performance Measures and SEFSC Annual Operating Plan directives. Research efforts are directed toward stock identification, abundance trends, assessment of anthropogenic impacts, and characterization of life history parameters. Collectively, the goal of SEFSC research efforts is to allow evaluation of sea turtle stock status in a conceptual framework that facilitates prediction of the effects natural and anthropogenic stressors may have on these long-lived, late-maturing species. Ongoing SEFSC sea turtle assessment activities are listed below. Regionally-relevant activities identified by the SEFSC that would make better use of existing data and survey efforts (Tier I-equivalent) and better meet relevant mandates of the ESA (Tier II-equivalent) are listed in Appendix II, and estimates of staffing, vessel, and aircraft requirements to achieve those tasks are available in Section V and Appendix III.

**Stock Identification** –As detailed in the 2010 NRC report, long generation times and cryptic life history stages suggest that the majority of sea turtle stock identification be accomplished through genetic characterization. The SEFSC facilitates this work through collection of tissue samples for analysis by the SWFSC's NMTGL. The STSSN, coordinated by the SEFSC, is a significant source of samples, as participants in this network respond to all live and dead sea turtle strandings along the southeast Atlantic and Gulf of Mexico coasts, allowing wide spatial and temporal coverage. Similarly, SEFSC fisheries observers (see *Anthropogenic Impacts* below) obtain tissues for genetic analysis when they encounter bycaught turtles, and the center's research programs also include biopsy sampling as part of their protocols. Recent products from these efforts include multi-stock analysis of loggerhead and green turtles on inshore North Carolina foraging grounds, as well as loggerheads and leatherbacks on the Grand Banks. The SEFSC is supporting an Atlantic loggerhead turtle genetics working group, whose goal is to compile all available genetic data for the species and evaluate the utility of new analytical tools. The combined results of these efforts assist with delineating stock structure and geographic distribution, to investigate the proportional impacts of potential stressors on the different populations.

**Life History and Vital Rates** – The SEFSC has supported assessment of primary sex ratios for northern and south Florida sub-population loggerheads through laparoscopic and histological examination of the gonads of hatchlings reared in captivity, with results indicating high variability within and among nesting seasons. Secondary and operational loggerhead sex ratios have also been assessed through laparoscopic examination of the gonads and measurement of testosterone titers in the blood of neritic juveniles, as well as necropsy of stranded, dead turtles. Cumulatively, the results have made it possible to evaluate temporal trends in sex ratio for neritic juveniles and assess differences in sex ratios among life stages.

Survival rates are assessed for oceanic juvenile and adult female loggerheads using satellite telemetry, as well as for neritic juveniles and adult females through CMR studies. STSSN data have also been used as the basis for catch-curve analyses to estimate age- (Kemp's ridley) and stage-specific (loggerhead) survival probabilities.

Through CMR studies, growth rates have been determined for Kemp's ridleys and loggerheads, and these data are used also to characterize stage duration. The SEFSC's North Carolina in-water sea turtle study has evaluated dietary influence on growth rates through SIA of carbon and nitrogen to determine individual trophic levels. The SEFSC also hosts the NSTAL, whose focus is to refine and apply techniques for skeletochronological analysis to obtain age and growth-related data from skeletal elements collected by the STSSN from dead strandings. Studies conducted by the NSTAL since its inception in 1997 have allowed estimation of growth rates, stage durations, and age at maturation for loggerheads (North and South Atlantic and North Pacific), Kemp's ridleys, green turtles, and leatherbacks. Collaboration with academic colleagues and the SWFSC to complement skeletochronology with SIA is providing insight into

the timing of ontogenetic habitat shifts. In addition, this integrative approach can allow evaluation of long-term individual and population-wide trophic trajectories, as well as the factors underlying variability in growth rates, size-at-age, and age at maturation.

**Abundance** – Convergent with NRC recommendations, SEFSC abundance assessments have focused on in-water surveys (USFWS is responsible for activities on nesting beaches). The SEFSC in-water sampling program in North Carolina has provided index of abundance estimates for loggerhead sea turtles through sampling of pound nets, with the potential to obtain these data for Kemp’s ridley and green turtles as well. NMFS also supported the South Carolina Marine Resources Division regional trawl survey in the southeast region, which studied trends in the catch per unit effort (CPUE) of sea turtles on the continental shelf near South Carolina, Georgia, and north Florida from 2000 to 2003 and in 2008.

To increase the spatial extent of in-water assessments, aerial platforms have been employed since the 1980s, with surveys during the past decade focusing on: 1) the mid-Atlantic and southeast U.S. (2002); 2) inshore and nearshore waters of North Carolina (2004 to 2006, in cooperation with U.S. Marine Corps Air Station Cherry Point); and 3) the eastern Gulf of Mexico (2007). Beginning in 2010, the SEFSC has been part of AMAPPS, a joint effort between NMFS and BOEM, to obtain seasonal sea turtle distribution and abundance data along the U.S. Atlantic coast (NEFSC and SEFSC 2011). Aerial surveys were initiated in the Gulf of Mexico during 2010 in response to the Deepwater Horizon MC252 oil spill and these continued seasonally in 2011 and 2012 (part of NRDA, NOAA 2012b). Because aerial survey results can be confounded by seasonal and/or geographic differences in surfacing intervals, survey efforts often include deployment of satellite transmitters on sea turtles caught in survey areas. The transmitters provide information regarding the proportion of time spent at or near the water’s surface, as well as turtle movement and seasonal distribution, and therefore “availability” to be detected during aerial surveys.

**Anthropogenic Impacts** – The SEFSC investigates anthropogenic impacts on sea turtle populations at many levels. Baseline values for wild loggerhead health parameters have been characterized in North Carolina to assess current status and to provide a reference against which to measure future changes in population health, including factors underlying unusual stranding events. Pharmacokinetic studies with captive loggerheads have provided a better understanding of appropriate antibiotic dosages for the rehabilitation of sea turtles whose health is often compromised as a result of anthropogenic causes. Analysis of loggerhead tissue samples collected during the North Carolina in-water study through collaboration with academic partners and researchers at the National Institute of Standards and Technology has demonstrated the presence of many potentially deleterious contaminants and facilitated evaluation of temporal and spatial trends in contaminant loads along the U.S. Atlantic coast. Tissue samples collected by the STSSN from wild, stranded turtles and by SEFSC researchers from captive-reared loggerheads are being cultured and analyzed by collaborators at the Institute of Environmental and Human Health at Texas Tech University, yielding insight into the molecular, cellular, and biological effects of environmental pollutants.

Another major role of the STSSN is to monitor levels of live and dead strandings and to detect anomalies or unusual stranding events. This information often prompts scrutiny of human activities in the impacted areas to evaluate potential causes of mortality, such as elevated fisheries interactions. SEFSC analysis of stranded turtle size distributions was instrumental in demonstrating the need for increased turtle excluder device opening size in the U.S. shrimp fishery to decrease mortality of large juvenile and adult loggerhead and leatherback turtles.

To characterize sea turtle/fishery interactions, the SEFSC coordinates observer coverage for pelagic longline, shrimp trawl, coastal gillnet, reef fish, and shark fisheries in the southeast U.S. These observer programs are funded through fisheries programs as part of their obligation to reduce bycatch of protected species and as a result are not coordinated by the protected resources program. However, protected resources staff support the observer programs through training and data entry and management of protected species data. In addition, they analyze observer data to assess quarterly and annual bycatch rates and infer trends in turtle distribution and bycatch correlates. Sea surface temperature analyses and aerial surveys have been conducted to determine overlap between turtle distribution and fishing and military operations, guiding area closures to mitigate turtle mortality. The SEFSC is also part of the NMFS Atlantic Strategy for Sea Turtle Conservation and Recovery, an effort to reduce sea turtle bycatch by evaluating and prioritizing management of gear types, rather than individual fisheries (note: the Strategy's framework is currently being revised, but the SEFSC will continue to be a participant).

**Assessment Frequency and Quality** –The SEFSC has been involved in revising the loggerhead and Kemp's ridley recovery plans to allow incorporation of recent data and evaluation of population status. The SEFSC has also been integral to numerous TEWGs and biological reviews, regularly collaborating with NEFSC as well as with other domestic and international agencies, academic institutions, and NGOs, to assess population status for different species and identify data needs. The products of these efforts are extensively assessed by working group participants and have been disseminated as internally-reviewed technical memoranda and peer reviewed publications, with a recent move toward review of the technical memoranda by the Center for Independent Experts.

### **C. Pacific Islands Fisheries Science Center**

The Protected Species Division includes two programs that conduct sea turtle research and monitoring. Marine turtle assessments at the PIFSC are conducted by the Marine Turtle Assessment Program (MTAP). The Marine Turtle Research Program (MTRP) conducts sea turtle monitoring, research, and the stranding program within the Hawaiian archipelago. The Fisheries Research and Monitoring Division (FRMD) investigates fisheries interactions and conducts bycatch mitigation research and the Ecosystem and Oceanography Division looks at the overlay of environment, fisheries, and sea turtle habitat. The region's fisheries observer program is managed by PIRO and is not included in this report.

Within the region, PIFSC and PIRO coordinate closely to promote various activities in support of sea turtle population assessment. Since 2004, monetary support for sea turtle programs in the U.S. Pacific Flag Areas (American Samoa, Guam, and the Commonwealth of the Northern Mariana Islands), Palmyra, Hawaii, the Republic of the Marshall Islands, Federated States of Micronesia, and the Republic of Palau has been provided through competitive grants from the PIRO Protected Resources Division. Supported projects have included nesting beach monitoring, in-water research, genetic sampling, and stranding programs. Many supported projects focus not on research but applied management, education, and outreach objectives.

MTAP and MTRP conduct research on sea turtle populations across the Pacific Islands region (PIR; American Samoa, Guam, Hawaii, Northern Mariana Islands and Pacific Remote Island Areas) with some research conducted outside the U.S. areas. Presently 5 FTEs (2 MTAP, 3 MTRP) and 9 contractors (all MTRP, 3 part-time) work on monitoring, assessment, demographics, genetics, stranding program, and related areas of investigation (Appendix III, Table 1). In addition, the PIRO observer program employs

another 15 FTE and 40+ contractors, and the Fisheries Interaction and Conservation Program of FRMD employs 1 FTE and 1 contractor to research reducing fisheries interactions and increasing post-interaction survival. Involvement of the PIFSC Ecosystems and Oceanography Division in sea turtle research is integrated into its broader mandate and is not otherwise broken out in this document.

### ***PIFSC Sea Turtle Assessment Activities***

PIFSC is currently designing and implementing Tier II-equivalent and ecosystem-based standards for the North Pacific loggerhead and the Hawaiian green turtle populations. Additionally, in conjunction with colleagues at the SWFSC, MTAP is currently designing and implementing Tier II-equivalent and ecosystem-based standards for western Pacific leatherback populations. The remaining populations in the PIR are having Tier I-equivalent standards being developed and set in place by MTAP. Maintaining excellence in existing surveys, adaptively revising sampling methods, and expanding geographically across the PIR is uncertain given the limited current personnel levels and program support. Expansion of research and monitoring efforts to enable assessments of populations throughout the PIR will require additional financial support and some additional staff. Ongoing PIFSC sea turtle assessment activities are listed below. Regionally-relevant activities identified by the PIFSC that would make better use of existing data and survey efforts (Tier I-equivalent), better meet relevant mandates of the ESA (Tier II-equivalent), and to better incorporate ecosystem characteristics (Tier III-equivalent) are listed in Appendix II, and estimates of staffing, vessel, and aircraft requirements to achieve those tasks are available in Section V and Appendix III.

***Research*** – Annual research tasks include nesting surveys; strandings monitoring; demographic and life history investigations; fishery interactions; satellite biotelemetry; epidemiology; climatic forcing; skeletochronology, physiology and growth; long-term population trends; and threat analyses. Five species of Pacific sea turtles are included in this work: loggerhead, green, hawksbill, leatherback, and olive ridley. Significant collaborations occur with researchers within NMFS, with other government agencies, NGOs, U.S. territory governments, international partners, and with university scientists.

The North Pacific loggerhead DPS and Hawaiian green turtle populations have been the principal focus of MTAP and MTRP investigations to date. Other populations across the PIR have been monitored primarily by partner agencies due to programmatic, fiscal, and logistical constraints. However, significant advances by PIFSC are being made to provide greater research attention to western Pacific leatherback and Hawaiian hawksbill populations. The population structure, migrations, eco-physiology, population threats, and long-term nesting surveys of these populations are currently being researched to advance assessments. Emerging research and partnerships on green and hawksbill populations in American Samoa, Guam, Commonwealth of Northern Mariana Islands, Palau, Federated States of Micronesia, Republic of the Marshall Islands, and the Pacific Remote Island Area is also developing.

***Assessment Frequency and Quality*** – To date, PIFSC scientists have conducted formal assessments on North Pacific loggerheads and Western Pacific leatherbacks. Several additional formal assessments are currently in process on loggerheads, leatherbacks, greens, and hawksbills, and ecological studies in support of these assessments are maturing. The specific populations, geographic regions, and scientific issues mentioned here are designated as priorities in the 2010 NRC review document on sea turtle assessments.

## **D. Southwest Fisheries Science Center**

The marine turtle research programs, Marine Turtle Ecology and Assessment Program (MTEAP) and Marine Turtle Genetics Program (MTGP), within the Marine Mammal and Turtle Division of the SWFSC, have been working to increase scientific knowledge about threatened and endangered marine turtle populations in the Pacific Ocean and around the globe.

In FY11, the marine turtle programs consisted of nine FTEs, two full-time contractors, seasonal contractors hired as aerial observers, volunteer research interns, and graduate students (Appendix III, Table 1). Research activities are focused on Pacific leatherbacks, North Pacific loggerheads, and East Pacific green turtles. Lesser but consistent effort is given to Pacific olive ridley and hawksbill turtles. In addition, the SWFSC is designated as the NMFS National Marine Turtle Genetics Laboratory and conducts research on both Pacific and Atlantic marine turtle populations in collaboration with NMFS science centers, regional offices, and national and international collaborators. SWFSC also houses the Stable Isotope and Chemical Ecology Laboratory that serves as a primary marine turtle stable isotope research facility within NOAA. SWFSC has ongoing stable isotope research collaborations with SEFSC and PIFSC. In all cases, the U.S. Pacific sea turtle recovery plans serve as templates to help develop research and conservation priorities. The MTEAP and MTGP use a wide variety of technologies and survey/sampling methods for collecting and analyzing data, including genetic analysis, SIA, line-transect sampling, telemetry, nesting beach thermal profiling, and CMR sampling. These methods are used to provide information about stock (population) structure, stock origin identification of turtles incidentally captured in fisheries (Atlantic and Pacific), in-water ecology, movements and migrations, health, and demography. There are no nesting beaches along the Pacific coast of the U.S. However, leatherback, loggerhead, and green turtles occur within U.S. west coast EEZ waters. Abundance of these species in U.S. west coast waters are estimated through in-water CMR efforts and aerial surveys of key foraging sites along the Pacific coast, and counts of reproductively mature females are performed at western Pacific nesting sites by international colleagues. The SWFSC also provides scientific advice and consultation to colleagues in a number of countries in the Pacific where these turtles nest.

In addition to scientific research, the MTEAP and MTGP have worked to develop innovative approaches that build and promote diverse and dynamic partnerships among stakeholders including local communities, fisheries agencies and observer programs, governmental and nongovernmental organizations, and international organizations. Over the last decade, the SWFSC has built close collaborations with Pacific Rim countries to work toward nesting beach recovery and fisheries bycatch reduction and mitigation. This networking not only assists in enhancing the research capabilities of in-country biologists, but also leads to the SWFSC marine turtle programs' acquiring additional biological samples (e.g., genetic and stable isotope) for stock identification and demographic data for future population assessment analyses (e.g., counts of reproductive females at nesting beaches and CMR data through tagging). Further, in response to the growing concern about incidental bycatch of sea turtles in artisanal longline, drift-net, and set-net fisheries, the turtle programs provide training to observers in many of the aforementioned countries. Information exchange focuses on de-hooking, resuscitation, tissue sample collection, and data recording.

### ***SWFSC Sea Turtle Assessment Activities***

Ongoing SWFSC sea turtle assessment activities are listed below. Regionally-relevant activities identified by the SWFSC that would make better use of existing data and survey efforts (Tier I-equivalent), better meet relevant mandates of the ESA (Tier II-equivalent), and to better incorporate ecosystem



characteristics (Tier III-equivalent) are listed in Appendix II, and estimates of staffing, vessel, and aircraft requirements to achieve those tasks are available in Section V and Appendix III.

**Stock Identification** – The SWFSC conducts research projects to generate biological information on marine turtles to help define conservation/management units and provide input data needed to support current management needs and conduct assessments. This discipline is distinguished from the next section (*Life History and Vital Rates*) by focusing exclusively on molecular tools such as genetic and SIA to examine stock structure. The blueprint for the SWFSC’s stock identification activities is based largely on the goals outlined in the USFWS/NMFS Recovery Plans for U.S. Pacific Populations of Marine Turtles. These include defining stock boundaries, determining distribution, abundance, and status, and identifying important marine habitats. Most of the research in this discipline is also consistent with the NMFS mission to “identify stocks... of marine turtles in the marine environment.”

The SWFSC is able to determine a variety of aspects regarding foraging, nesting, bycaught, and stranded turtles’ population origin, trophic status, and prior foraging habitats through analysis of small amounts of tissue. These data are integrated with information gathered via satellite telemetry and demographic studies to provide a comprehensive understanding of sea turtle stock structure and habitat use. Tissue samples are currently collected through field-based capture efforts, during Eastern Pacific and Eastern Tropical Pacific scientific cruises, from turtles stranded along the U.S. west coast, and from turtles encountered via fisheries observer programs. Additional tissue samples and scientific data come from numerous collaborators worldwide. The NOAA National Center for Molecular Studies of Marine Turtles based at the SWFSC maintains the largest collection of marine turtle tissue and DNA samples in the world and serves the research needs of NMFS science centers and regional offices, academic and other international research institutions. In addition to providing information for current NOAA studies, the SWFSC maintains tissues that cover broad taxonomic, geographic, and temporal ranges. The collection currently holds over 84,800 tissue and 27,850 DNA samples collected from every species in nearly every ocean basin and receives, on average, approximately 4,500 samples annually. The SWFSC stable isotope tissue archive currently houses more than 7,000 tissue samples and nearly 2,000 habitat samples, adding roughly 1,000 turtle tissue and 300 habitat samples annually as additional research questions and collaborations are developed.

Management-related stock identification activities undertaken by the SWFSC include:

- Determining stock boundaries for marine turtle populations by using existing and developing new genetic and stable isotope techniques; and
- Identifying biologically meaningful management units to facilitate implementation of the ESA and the USFWS/NMFS Recovery Plans for U.S. Pacific populations of the five marine turtle species occurring in the area, utilizing genetic data in conjunction with movement and distribution information.

Genetic and other molecular techniques employed and/or under development by the SWFSC include:

- Standard molecular markers, such as mitochondrial DNA (mtDNA) and nuclear DNA (microsatellites), for population assessments and finer scale genetic stock assessment, respectively;
- Novel molecular markers, including single nucleotide polymorphisms (SNP), mitogenomics, and stable isotopes, to enhance capability to identify marine turtle management units, foraging stock structure, and fishery bycatch stock composition;
- “Next generation” sequencing, which allows the fast sequencing of whole mitochondrial genomes (approximately 16,700 base pairs) from hundreds of individuals for population studies and provides

a platform for rapid nuclear SNP discovery and genotyping, across the genome or from pre-selected genomic regions; and

- SIA, which allows for the determination of marine turtle trophic status, habitat use, habitat-specific residency durations, and has provided for greater resolution of marine turtle stock structure.

**Life History and Vital Rates** – A goal of the SWFSC is to have a thorough understanding of the linkages between Pacific nesting beaches and foraging areas for each ESA-listed marine turtle species listed. Providing information for assessment models requires estimating many demographic parameters such as ontogenic life stage durations, age at maturity, reproductive longevity, survival rates, and fecundity.

Data for this category are gathered from turtles in foraging areas and at nesting beaches. Demographic data gathered via CMR efforts include information on juvenile growth rates, fecundity, and survival rates - all of which are essential for developing population models, which are necessary for evaluating population status, impacts of anthropogenic mortality, and progress towards meeting recovery criteria. The SWFSC relies on long-term CMR data from foraging areas and nesting beaches for estimating survival rates and somatic growth. Data are collected at nesting beaches for determining and estimating sex ratios, hatching success rates, and effects of environmental variables on these demographic parameters.

**Abundance** – The current approach to assessment incorporates information on population abundance and trends, and anthropogenic and natural sources of mortality. Because of the migratory nature of marine turtles, individuals inhabiting U.S. Pacific waters originate from distant nesting beaches in both the eastern and western Pacific Ocean. As such, the data necessary for assessing marine turtle stocks come from a variety of regions and are facilitated through collaborations with governmental and non-governmental institutions. Data are collected from research vessels, fishing vessels, aircraft, and shore-based field efforts. Various types of analyses are employed, including mark-recapture analyses, line-transect and telemetry analyses, population-dynamics modeling, stable isotope mixing models, and simulation modeling.

Because of the importance of tagging data for determining spatial distributions of marine turtle stocks, the SWFSC Marine Turtle Programs' maintain a flipper-tagging database for the eastern Pacific Ocean and a passive integrated transponder (PIT) tag database for leatherbacks throughout the Pacific. As a government resource management agency, the SWFSC is able to maintain the continuity required to coordinate these flipper- and PIT-tagging programs, acting as a centralized distribution point for flipper and PIT tags and conducting tagging training and database management.

Abundance estimates are required under the ESA to evaluate the conservation status of a species. Typically these estimates are meant to describe the status of the population or at least a portion of the population observed in a specific area or at a specific time. The estimates can take various forms including, but not limited to, estimates of abundance based on aerial surveys corrected for individuals not available during the survey (requires information on how much time on average animals spend at water surface), estimates of the abundance of a certain stage of the population (e.g., nesting females), index counts of that stage of the population at selected sites, and estimates based on CMR analyses. For most populations, the data from single aircraft, vessel, or land-based surveys cannot be used to describe the year-round status of the population in a specific area. While such an approach is compatible with the requirements of ESA status reviews, it is inadequate to address other needs, such as fine-scale temporal or spatial estimates of species abundance or densities, which are frequently necessary for ESA Section 7 consultations. SWFSC marine turtle research programs conduct aerial surveys over neritic

waters along the U.S. west coast to determine occurrence, and distribution and estimate abundance of leatherback and loggerhead turtles. A long-term in-water CMR study has been ongoing within San Diego Bay for more than 20 years, and another capture-recapture study has been initiated for a foraging group of green turtles in the area near Long Beach, California, within the San Gabriel River and Seal Beach National Wildlife Refuge. Aerial surveys have also been conducted along the Baja California Peninsula and within the Southern California Bight (partial funding from the U.S. Navy) to estimate abundance of loggerhead turtles, along the Pacific coast of Mexico to determine the distribution of green turtle in nearshore and lagoonal foraging areas, and along western Pacific coastlines (e.g., Solomon Islands and Papua New Guinea) to determine nesting activities of leatherback turtles.

Additional data on movements, dive behavior, and habitat use are gathered using animal-borne data-recording devices such as satellite transmitters, GPS transmitters, acoustic transmitters, video recorders, and time-depth recorders. In addition to traditional methods, we have developed and continue to invent new telemetry attachment techniques that are less invasive to study animals and to collect high-resolution data. Data generated from these tools illuminate areas of high use for sea turtle stocks as well as fine-scale habitat use and, when integrated fisheries effort and molecular data can provide a better understanding of the susceptibility of each stock to fisheries interaction (applicable to *Anthropogenic Impacts*, below).

***Anthropogenic Impacts*** – Understanding the degree to which marine turtle stocks are affected by anthropogenic mortality can enable stock assessors to better understand the recovery potential of stocks. Quantification of the extent to which marine turtles are affected by marine debris, marine fisheries interactions, and harvest is paramount to accurate assessments. Monitoring the turtle take by fisheries is extremely important for two reasons. First, it allows us to gauge the extent of the problem, and by the very act of monitoring, tends to cause commercial and artisanal fishermen to be more aware of the concern over incidental take, and thereby encourage reduced take. Currently, the SWRO organizes observer programs for the fishery operations that are based on the west coast of the U.S. Bycatch data are communicated between the SWRO and SWFSC for further analyses. Additionally, integration of telemetry, genetic, and stable isotope data can elucidate what stocks are impacted by the various anthropogenic impacts (e.g., fisheries interactions, coastal habitat degradation, illegal harvest), and thus has relevance for assessments and recovery planning.

***Assessment Frequency and Quality*** – The SWFSC provides essential genetic information for defining stocks and developing recovery plans for all turtle species in the U.S. The SWFSC has also been involved in TEWGs and biological review teams for evaluating status of marine turtle species in the U.S. Further, the center's turtle research groups collaborate with domestic and international agencies, academic institutions, and NGOs to assess population status for different species and identify data needs.

## V. National Sea Turtle Assessment Needs

Implementation of sea turtle assessment improvement activities listed in this report will require integration with NOAA/NMFS budget and program planning initiatives. Under constrained budget environments, resource sharing with federal, state, territory, academic, and other partners and strategic use of available vessel and aerial platforms will be essential to continued and improved assessment of sea turtle populations. Additionally, follow-up to the recent Protected Resources Science Investment Plan workshop (Simpkins and Srinivasan 2013) and related future efforts should generate a prioritization scheme among different types of activities and/or species, stocks, populations, or life stages.

### A. Overarching Assessment Needs

Each science center identified regionally-relevant assessment activities that would meet the overarching goals of making better use of existing data and survey efforts (Tier I-equivalent) and better meeting relevant mandates of the ESA (Tier II-equivalent). These activities are listed in Appendix II. Each center's list is, as would be expected, dictated by species in the region, program expertise, and region- and species-specific assessment gaps, but common themes include increasing assessment quality and frequency by:

- Continuing, reinitiating, and expanding ongoing and past in-water surveys (on-water and aerial), sampling, and tagging;
- Conducting surveys and sampling at regular intervals suitable for assessing abundance and distribution patterns;
- Improving methods and using multidisciplinary approaches for stock determination and estimation of population- or stage-specific abundance, vital rates, and anthropogenic impacts;
- Increasing integration of habitat, ecosystem, environmental, and climatic data into analyses; and
- Improving coverage of lesser-studied species and/or life stages in a given region.

Staffing, vessels and aircraft, education and training, equipment, and facilities were identified as key resource areas in the protected species SAIP (2004), and these, as well as data management and computing, are discussed below in relation to sea turtle assessments and planning. Additionally, national-level needs for increasing efficiency, better tracking progress, and strategically addressing regional sea turtle assessment gaps include:

- Use of novel approaches, advanced technology, and integrated/multi-taxa surveys to reduce costs and increase efficiency;
- Increased interagency and international partnerships;
- Development, evaluation, and compilation of analysis tools to assess anthropogenic impacts;
- Improved administration and revision of performance metrics to better reflect data and analysis gaps;
- Development of a consistent reporting mechanism and schedule for compiling U.S. population abundance, demographic, anthropogenic impact, and status information (perhaps in concert with performance metric reporting); and
- Capacity building, recruitment, and training.

## B. Resource Needs

Staffing and survey platform estimates were developed by the centers such that Tier I and Tier II level assessment status would be achieved for appropriate regional sea turtle populations (see Appendix II for Tier I- and Tier-II equivalent activities), with the acknowledgement that the overall status of U.S. sea turtle assessment has declined since FY03 (i.e., since the SAIP) and that in some specific data categories, it has improved (e.g., recent Atlantic and Gulf of Mexico survey efforts). Thus, additional staff, vessel, and aerial resources were estimated to both achieve Tier I (better use of existing resources) and Tier II (achieving score Level 3 or higher for all data categories).

Several different approaches were taken by the Centers to estimate resource needs. The NEFSC and SEFSC generated aerial survey and vessel estimates based on continuing annual abundance surveys at the level funded by AMAPPS and NRDA in FY11. Tier II NEFSC and SEFSC aerial survey and vessel costs were estimated based on increasing the Atlantic (AMAPPS) effort from two to four surveys per year. These aerial and vessel-based survey estimates in turn affected estimated numbers of NEFSC and SEFSC staff necessary to collect, analyze, and synthesize the data. The PIFSC's assessment program is a unique, stand-alone turtle program and therefore relatively small by comparison to similar multi-species assessment programs in other science centers. Estimates were generated with the intention of scaling up the PIFSC program to better use existing staff and data under Tier I and achieving Level 3 for all data categories under Tier II. The SWFSC aimed to re-initiate basic surveys of juvenile loggerhead sea turtles along the west coast of the U.S. and Mexico under Tier I and to expand survey and *in situ* sampling efforts under Tier II.

### **Staffing**

This report projects a more than doubling of staff involved in NMFS sea turtle assessments. Total numbers of sea turtle science staff at the four centers are detailed by activity type for FY11 in Table 2, and a detailed, center-by-center breakdown is provided in Appendix III. The centers also estimated the additional full-time employees (FTEs, or equivalent part-time employees) and contractors needed to continue current data collection and assessment initiatives, fully use these data for assessments and related analyses, with full support coming from NOAA (Tier I), and to achieve at least Level 3 in all sea turtle assessment data categories (Tier II) (Table 2; activities detailed Appendix II). Substantial increases in numbers of both FTEs (90%) and contractors (175%) will be necessary to achieve the Tier I-equivalent activities identified by each center, including continuing recent externally-funded activities. The largest staffing gaps identified included: survey leaders, abundance survey observers, and individuals capable of collecting field data, analyzing bycatch and biological/health data, conducting assessments, and providing data management support. Increases in survey, field, and analytical staff were especially vital to achieving Tier II-equivalent assessments. As noted in the protected species SAIP (NMFS 2004), while additional new FTEs would be required to improve assessments and ultimately achieve Tier II for all species, this increase represents an important investment for NOAA/NMFS over the long term.

**Table 2. NMFS Science Center sea turtle staffing.** The numbers of staff (full time employees [FTEs] and contractors) paid from Northeast, Southeast, Pacific Islands, and Southwest Fisheries Science Centers' sea turtle funds in FY11 and the estimated additional staff that would be needed to continue and expand FY11 activities and fully utilize the assessment data (Tier I) and achieve adequate assessments for all sea turtle stocks (Tier II) are shown by activity. Detailed, center-by-center breakdowns of specific staff activities are presented in Appendix III, and specific Tier I- and Tier II-equivalent activities to be conducted by center staff are listed in Appendix II. NOTE: Fishery observers are not housed in the centers' turtle programs and are not included here.

	NEFSC		SEFSC		PIFSC		SWFSC		All Centers	
	FTE	Contract	FTE	Contract	FTE	Contract	FTE	Contract	FTE	Contract
<b>FY11</b>										
Field Programs	0.30	0.00	2.52	2.03	1.60	4.30	2.78	0.80	7.20	7.13
Fishery Observer Programs	0.85	0.50	1.30	0.00	0.00	0.00	0.30	0.20	2.45	0.70
Lab/Office Programs	0.30	0.50	2.25	1.05	2.30	1.00	4.20	1.20	9.05	3.75
Other Staff Activities	0.30	0.00	1.80	0.15	1.10	0.70	1.72	0.00	4.92	0.85
<i>FY11 Total</i>	<i>1.75</i>	<i>1.00</i>	<i>7.87</i>	<i>3.23</i>	<i>5.00</i>	<i>6.00</i>	<i>9.00</i>	<i>2.20</i>	<i>23.62</i>	<i>12.43</i>
<b>Additional for Tier I</b>										
Field Programs	1.25	1.10	2.07	9.00	1.00	1.50	1.00	0.20	5.32	11.80
Fishery Observer Programs	2.50	0.00	2.00	1.50	0.00	0.00	0.00	0.30	4.50	1.80
Lab/Office Programs	1.75	0.20	5.55	2.00	1.00	2.00	2.10	0.40	10.40	4.60
Other Staff Activities	0.00	1.10	0.00	2.00	0.00	0.50	1.00	0.00	1.00	3.60
<i>Total Additional for Tier I</i>	<i>5.50</i>	<i>2.40</i>	<i>9.62</i>	<i>14.50</i>	<i>2.00</i>	<i>4.00</i>	<i>4.10</i>	<i>0.90</i>	<i>21.22</i>	<i>21.80</i>
<b>Additional for Tier II</b>										
Field Programs	1.00	9.25	1.10	14.50	0.00	1.00	0.00	2.50	2.10	27.25
Fishery Observer Programs	1.00	0.00	1.00	0.00	0.00	0.00	0.70	0.00	2.70	0.00
Lab/Office Programs	2.25	0.00	3.15	1.00	1.00	1.00	2.30	0.00	8.70	2.00
Other Staff Activities	0.00	0.50	0.00	0.75	0.00	0.00	0.00	0.50	0.00	1.75
<i>Total Additional for Tier II</i>	<i>4.25</i>	<i>9.75</i>	<i>5.25</i>	<i>16.25</i>	<i>1.00</i>	<i>2.00</i>	<i>3.00</i>	<i>3.00</i>	<i>13.50</i>	<i>31.00</i>

### **Vessels and Aircraft**

The availability of appropriate research and monitoring platforms is necessary to carry out many of the data collection priorities and activities listed in this report, sea turtle recovery plans, ESA five-year reviews, and the NRC review (2010). Vessels and aircraft are currently the primary platforms to obtain basic information such as broad-scale in-water abundance and distribution. In-water and aerial surveys are complemented by nesting and stranding surveys and development of environmental proxies for demography, distribution, and abundance. However, NOAA boats, ships, and aircraft, as well as chartered vessels and aircraft, must be used annually to achieve improved assessment of all sea turtle stocks, as well incorporating ecosystem-based approaches into assessments. Observers, which are housed outside of the centers' turtle programs, also remain necessary to obtain information on the incidental bycatch of turtles, and they also represent a large expense.

Numbers of NMFS-funded aerial platform days, days at sea of vessels, and operational expenses (excluding labor and platform days) used by each center for FY11 sea turtle survey activities are summarized in Table 3, as are estimated ship and aerial requirements for achieving Tier I- and Tier II-equivalent sea turtle assessments. The SWFSC was the only one of the four centers that conducted any vessel-based or aerial sea turtle surveys using solely center turtle funds during FY11, and the Southeast

and Northeast Centers provided some operational funds in support of Atlantic and Gulf of Mexico surveys funded by BOEM and NRDA. The NEFSC and SEFSC relied on small to mid-sized boats, including charters, for their NMFS-staffed, but otherwise externally-funded in-water surveys, whereas the SWFSC used a variety of vessels, ranging from small boats to NOAA ships. Additionally, U.S. Pacific Flag Area programs funded by PIRO in FY11 utilized small boats for surveys (not reported in Table 3). Projected operational costs are consistent with this mix of vessel types for three centers, whereas estimated PIFSC vessel costs are composed primarily of NOAA ships, as necessitated by geography of the region. Daily costs for vessel platforms currently range from hundreds of dollars per day for NOAA-owned small boats to thousands of dollars per day for mid-size vessels to tens of thousands of dollars per day for scientific cruises on fully-crewed NOAA ships; aerial platforms typically cost about \$1,000/hour. Without substantial increases in permanent funding and consistent access to ship and aerial platforms, NMFS will fall short of achieving even Tier I-equivalent sea turtle assessments (compared to FY03) and will fail to meet most of the recommendations of the NRC panel.

NMFS must maintain and establish partnerships with other agencies (e.g., BOEM, Navy, States, U.S. territories) and across taxa (e.g., marine mammals), as appropriate, order to conduct surveys that provide sufficient assessment information to all partners. Such surveys contribute to the information and analysis necessary for NMFS and partner agencies to evaluate issues related to proposed projects, management activities, and permits under the ESA, while enhancing the overall quality of data available for sea turtle assessments. Additionally, innovations in abundance survey, analysis, and prioritization methods and strong collaborations with States, U.S. territory governments, and international partners must be developed and employed due to the geographic range of sea turtle movements, as well as the vast size of the Atlantic and Pacific Oceans.

**Table 3. NMFS Science Center platform days and operational expenses for sea turtle assessment activities.** Aerial survey days, days at sea, and operational expenses paid from Northeast, Southeast, Pacific Islands, and Southwest Fisheries Science Center sea turtle funds in FY11 and estimated days and operational funding needed to achieve Tier I and Tier II for all regional species are listed. Specific Tier I- and Tier II-equivalent activities are listed for each Center in Appendix II. \*Includes overtime, hazard pay, travel, excess platform fees, etc. (varies by platform/vessel type and center); excludes base salaries. NOTE: Values do not include external, non-NOAA funding sources; e.g., BOEM, Navy, and NRDA. Some operational expenses of externally-funded surveys were paid by SEFSC in FY11.

	NEFSC	SEFSC	PIFSC	SWFSC	All Centers
<b>FY11</b>					
Aerial platform (days)	0	0	0	52	<b>52</b>
Vessel platform (days at sea)	0	0	0	31	<b>31</b>
Operational expenses*	\$0	\$60,000	\$0	\$212,600	<b>\$272,600</b>
<b>Additional for Tier I</b>					
Aerial platform (days)	92	90	6	48	<b>236</b>
Vessel platform (days at sea)	14	49	13	19	<b>95</b>
Operational expenses*	\$594,000	\$2,176,200	\$167,000	\$147,400	<b>\$3,084,600</b>
<b>Additional for Tier II</b>					
Aerial platform (days)	70	120	12	65	<b>267</b>
Vessel platform (days at sea)	70	140	31	112	<b>353</b>
Operational expenses*	\$5,896,500	\$19,865,000	\$459,000	\$2,703,500	<b>\$28,924,000</b>

### ***Equipment***

The protected species SAIP (NMFS 2004) identified three relatively expensive sets of equipment that continue to be integral to improving sea turtle assessments. These are:

- Small boats (including engine(s) and trailer for each), plus additional operational costs (all four centers);
- Telemetry equipment, including satellite transmitters, plus associated data processing costs (all four centers); and
- Genetic analytic equipment used by the SWFSC's NMTGL.

Three other types of relatively expensive equipment have since been identified as relevant to improving sea turtle assessments because they can be used to relate foraging and movements to age and growth. These are:

- Skeletochronology equipment used by the SEFSC's NSTAL;
- Microsamplers used by the SEFSC and SWFSC for sub-sampling individual growth increments in bone for SIA; and
- Other equipment necessary for stable isotope analyses.

### ***Computing***

An additional set of equipment that should be included in budgeting and planning is the electronic equipment and software, beyond standard office resources, necessary to complete sea turtle surveys and conduct assessment-relevant analyses. This includes, but is not limited to, field laptops, digital cameras, video equipment, specialized software, computers, and data storage hardware.

### ***Data Management***

Improving sea turtle assessments will require collection of large amounts of data and subsequent secure storage of the data, analyses, model outputs, and other assessment materials over the long-term. The NRC report (2010) noted that there are "extensive data requirements for accurate assessments of sea-turtle populations," and sea turtle recovery plans and five-year reviews highlight the large gaps in such datasets. Given the need to continue data collection under current programs to document historical trends, as well as the need to collect new types of data to fill knowledge gaps, NMFS will be faced with an ever-increasing need for secure, long-term electronic data storage and back-up. The NRC panel recommended that a single facility permanently house and archive data "to ensure long term data management." However, at this time, the centers feel that local storage is more appropriate to accommodate data and information requests and allow researchers access to data related to their own projects. Each of the four centers has an ongoing effort to improve data storage and back-up, which will require additional permanent funding to ensure long-term security of NMFS sea turtle data files, both on- and off-site. The Office of Science and Technology has taken a first step towards collecting sea turtle metadata at a national level by requiring each project awarded under its sea turtle assessment RFP to upload metadata to the NMFS InPort Catalog.

### ***Facilities***

As noted in the protected species SAIP (NMFS 2004), most of the regional sea turtle programs, and the larger protected species groups of which they are a part, are space-limited at their respective centers and laboratories. Additional space will ultimately be necessary to house the increased numbers of staff necessary to improve sea turtle assessment quality and frequency and to house increased computing,



data storage, and tissue, bone, and DNA archive needs created by increases in surveys, monitoring, and sample collection.

### ***Education and Training***

A 2008 report to Congress (U.S. Departments of Commerce and Education 2008) highlights the clear shortage of scientific expertise necessary to complete adequate assessments of the living marine resources that fall under NOAA/NMFS jurisdiction. The NRC review (2010) also recognized the assessment expertise shortage and emphasized the need for sea turtle assessment scientists to have cross-cutting, multidisciplinary training and experience that go beyond traditional population dynamics and modeling. The panel recommended using current partnerships with universities and NGOs to enhance and complement assessment expertise, as well as establishing new partnerships, public outreach, and improved science infrastructure to assist in capacity building. Partnerships through Sea Grant and the NOAA Cooperative Institutes can provide a solid basis for working directly with academia to improve or establish curricula to provide the necessary skills for future assessments. However, assessment capacity in NMFS sea turtle programs is also related to limited ability to hire FTEs and overextending current employees, reducing their ability to participate in vital training to update skills.

### **C. Prioritization and Planning**

It is clear that increased staff and access to vessel and aircraft resources are necessary to improve sea turtle assessment quality and frequency, and long-term commitments to data collection, archival and preservation, training, capacity building, and partnerships are essential for providing the building blocks of assessments. Many of the regional research priorities contained in this document are already inherent in center planning documents and are related to broader agency initiatives on habitat, ecosystem, and climate. However, criteria and methods to prioritize informational gaps and survey and analysis needs among sea turtle stocks and across all NMFS-managed protected species still need to be developed. This is especially important under budget constraints, and a framework for prioritization of informational, survey, and analysis gaps is to be developed as a follow-up action to a recent NMFS workshop related to protected species science planning (Simpkins and Srinivasan 2013). An additional consideration for increased efficiency in use of sea turtle assessment resources is ongoing intra- and interagency coordination on data collection, sharing, and analysis at both the regional and national level (i.e., headquarters, centers, and regional offices, as well as USFWS, states, and territories).

Once NMFS protected species prioritization criteria are established, a sea turtle research implementation plan (or a sea turtle component of an overarching protected species plan) should be developed, with input from managers and other partners, to ensure that the most pressing stock assessment needs, as well as other protected species priorities, are met. Research and implementation planning documents should be updated, at a minimum, every 5 years to adapt to changes in listing status, recovery plan priorities, NOAA and NMFS strategic plans and budget processes, and informational priorities for interagency consultations, permitting, and bycatch mitigation. Ideally, regionally-specific sea turtle or protected species research plans should be revised more regularly to ensure available resources are allocated as effectively as possible to meet regional- and national-level assessment, monitoring, and management priorities.

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**Appendix I. Status of U.S. Sea Turtle Assessments.** Overview of U.S. sea turtle populations and available data (Table I-1), quantitative assessments (Table I-2), and status reviews and recovery plans (Table I-3). Given the variety of assessment types available for U.S. sea turtle stocks, the assessment frequency and assessment quality categories were not explicitly scored. Instead, the Team chose to present descriptions of the most recently available quantitative and Endangered Species Act (ESA) assessments conducted by or for the agency for each stock, including the most recent year of data and types of information and analyses included in each assessment (Tables I-2 and I-3). In some instances, a quantitative assessment was contained in an ESA document.

**Footnotes for all three tables:**

- <sup>1</sup> All sea turtle species except loggerhead are currently listed globally under the U.S. Endangered Species Act (ESA). Loggerhead distinct population segment (DPS) designations are defined in Conant et al. 2009 and NMFS and USFWS 2011. A status review has been initiated for green turtles, which may identify DPS designations applicable to new/revised green turtle listings (NMFS 2012).
- <sup>2</sup> Only two of the nine ESA-listed loggerhead DPSs have been documented in U.S. waters.
- <sup>3</sup> Assessment units included ESA-listed segments within the U.S., and global listings were divided by ocean basin. The status of assessments for populations that nest in the U.S., as well as those that enter U.S. waters and/or interact with U.S. fisheries but do not have U.S. nesting populations, were examined. "Northwest Atlantic Ocean" includes the Gulf of Mexico and Caribbean.
- <sup>4</sup> Data category scoring criteria are described in Table 1 (Section II).
- <sup>5</sup> For Atlantic stocks of all species, the nesting abundance category was interpreted to mean abundance of the number of females nesting, not a count of the number of nests.
- <sup>6</sup> Includes green turtles originating from South Caribbean nesting beaches, which do not typically enter U.S. waters, but interact with U.S. longline fleets in international waters.
- <sup>7</sup> Includes foraging individuals from East and West Pacific leatherback breeding colonies.
- <sup>8</sup> The Kemp's ridley is geographically-limited and comprised of one genetic stock.
- \* Population/assessment unit nests entirely outside of the U.S. (relevant to U.S. assessment efforts because individuals enter U.S. waters or interact with U.S. fisheries during one or more life stage).
- # The green turtle status review initiated in 2012 will ultimately provide assessments.
- ^ Also included a quantitative assessment (see Appendix I-Table 2 for more information).

Table I-1: Overview of U.S. sea turtle populations and availability of assessment-related data.

ESA Unit/ Population <sup>1</sup>	Current ESA Listing Status	Population/Assessment Unit Considered <sup>3</sup>	Current ESA Recovery Plan	NMFS Region	Assessment Data Categories and Levels <sup>4</sup>				
					Stock ID	Life History	Abundance		Anthropogenic Impacts
							Nesting <sup>5</sup>	in-Water	
<b>Loggerhead (<i>Caretta caretta</i>)<sup>2</sup></b>									
North Pacific Ocean DPS	Endangered	North Pacific Ocean (DPS)*	U.S. Pacific loggerhead (NMFS & USFWS 1998e)	PI, SW	2	2	3*	2	2
Northwest Atlantic Ocean DPS	Threatened	Northwest Atlantic Ocean (DPS)	NW Atlantic loggerhead (NMFS & USFWS 2008)	NE, SE	3	2	1	1	2
<b>Green (<i>Chelonia mydas</i>)</b>									
Florida breeding colonies	Endangered	Northwest Atlantic Ocean (Florida breeding colonies)	U.S. Atlantic green (NMFS & USFWS 1991)	NE, SE	3	1	0-1	1	1
Mexico's Pacific breeding colonies	Endangered	East Pacific Ocean*	U.S. East Pacific green (NMFS & USFWS 1998a)	SW	2	2	2*	2	2
Elsewhere (globally)	Threatened	Northwest Atlantic Ocean (Non-Florida breeding colonies) <sup>6</sup>	U.S. Atlantic green (NMFS & USFWS 1991)	SE	1-3	1	0-1	0-1	1-2
		North Central Pacific Ocean (U.S. Pacific Islands)	U.S. Pacific green (NMFS & USFWS 1998b)	PI	1	1	2	0-1	1-2
<b>Leatherback (<i>Dermochelys coriacea</i>)</b>									
Global	Endangered	Northwest Atlantic Ocean	U.S. Caribb./Atl. leatherback (NMFS & USFWS 1992)	NE, SE	3	1	1	0-1	1-2
		U.S. Pacific Ocean <sup>7*</sup>	U.S. Pacific leatherback (NMFS & USFWS 1998d)	PI, SW	2	1	2-3*	0	2
<b>Hawksbill (<i>Eretmochelys imbricata</i>)</b>									
Global	Endangered	Western Caribbean Sea/ United States	U.S. Caribb./Atl. hawksbill (NMFS & USFWS 1993)	SE	2	1	0-1	0	1-2
		North Central Pacific Ocean (U.S. Pacific Islands)	U.S. Pacific hawksbill (NMFS & USFWS 1998c)	PI	1	0	1	0	1
<b>Kemp's ridley (<i>Lepidochelys kempii</i>)</b>									
Global	Endangered	Global (Northwest Atlantic Ocean)	U.S./Mexico Kemp's ridley (NMFS et al. 2011)	NE, SE	N/A <sup>8</sup>	2	2	1	2
<b>Olive ridley (<i>Lepidochelys olivacea</i>)</b>									
Mexico's Pacific breeding colonies	Endangered	East Pacific (Mexico breeding colonies)*	U.S. Pacific olive ridley (NMFS & USFWS 1998f)	SW	1	1	1-2*	2	2
Elsewhere (globally)	Threatened	East Pacific (Non-Mexico breeding colonies)*		SW, PI	1	1	1-2*	2	2
		West Atlantic Ocean*		SE	2	1	0-1*	0	1



Table I-2: Overview of quantitative U.S. sea turtle assessments. (See Appendix I-Table 3 ESA status reviews and recovery plans.)

ESA Unit/ Population <sup>1</sup>	Population/Assessment Unit Considered <sup>3</sup>	NMFS Region	Most Recent Quantitative Assessment(s)	Most Recent Data Year(s) Included in Assessment	Analysis Method(s) and Survey/Data Types
<b>Loggerhead (<i>Caretta caretta</i>)<sup>2</sup></b>					
North Pacific Ocean DPS	North Pacific Ocean (DPS)*	PI, SW	Japan nesting population: Van Houtan 2011	2011	Population viability analyses to assess effects of changes in fishery mortality
			Contained in Status Review (Conant et al. 2009)	2007	Population modeling (plausible life history parameters), susceptibility to quasi-extinction (nesting time series), and threat matrix analysis (known biology, threats, and mortality)
Northwest Atlantic Ocean DPS	Northwest Atlantic Ocean (DPS)	NE, SE	SEFSC 2009	2004-2007 (varied by region) 2004-2008 (varied by region/data type)	Demographic matrix model to assess effects of changes and variability in vital rates (various data sources)
			TEWG 2009	2004-2007 (varied by region)	Nesting and in-water trends (various survey and capture projects)
<b>Green (<i>Chelonia mydas</i>)</b>					
Florida breeding colonies	Northwest Atlantic Ocean (Florida breeding colonies)	NE, SE	None	N/A <sup>#</sup>	N/A
Mexico's Pacific breeding colonies	East Pacific Ocean*	SW	San Diego Bay: Eguchi et al. 2010	2009 <sup>#</sup>	Mark-recapture modeling (entanglement netting data) to estimate survival and abundance
Elsewhere (globally)	Northwest Atlantic Ocean (Non-Florida breeding colonies) <sup>6</sup>	SE	None	N/A <sup>#</sup>	N/A
	North Central Pacific Ocean (U.S. Pacific Islands)	PI	None	N/A <sup>#</sup>	N/A
<b>Leatherback (<i>Dermochelys coriacea</i>)</b>					
Global	Northwest Atlantic Ocean	NE, SE	TEWG 2007	2004-2005 (varied by region)	Nesting trends and conceptual model
	U.S. Pacific Ocean <sup>7*</sup>	PI, SW	Offshore of California: Benson et al. 2007	2003	Population abundance and density estimation (aerial surveys)
			Indonesia nesting population: Van Houtan 2011	2011	Population viability analyses to assess effects of changes in fishery mortality
<b>Hawksbill (<i>Eretmochelys imbricata</i>)</b>					
Global	Western Caribbean Sea/ United States	SE	Cuba: Heppell et al. 1995	1990	Sensitivity analysis and stage-based modeling to examine a fisheries/harvest model for the Cuban tortoiseshell trade
	North Central Pacific Ocean (U.S. Pacific Islands)	PI	None	N/A	N/A
<b>Kemp's ridley (<i>Lepidochelys kempii</i>)</b>					
Global	Global (Northwest Atlantic Ocean)	NE, SE	Contained in Recovery Plan (NMFS et al. 2011)	2009	Population modeling (plausible life history parameters) and threat matrix analysis (known biology, threats, and mortality)
<b>Olive ridley (<i>Lepidochelys olivacea</i>)</b>					
Mexico's Pacific breeding colonies	East Pacific (Mexico breeding colonies)*	SW	Offshore of Central America/Mexico: Eguchi et al. 2007	2006	Population abundance and density estimation (shipboard surveys)
Elsewhere (globally)	East Pacific (Non-Mexico breeding colonies)*	SW, PI			
		West Atlantic Ocean*	SE	None	N/A

**Table I-3: Overview of U.S. sea turtle ESA status reviews and recovery plans. (See Appendix I-Table 2 for quantitative assessments.)**

ESA Unit/ Population <sup>1</sup>	Population/Assessment Unit Considered <sup>3</sup>	NMFS Region	Most Recent ESA Document	Most Recent Data Year(s) Included in Document	Document Format/Content
<b>Loggerhead (<i>Caretta caretta</i>)<sup>2</sup></b>					
North Pacific Ocean DPS	North Pacific Ocean (DPS)*	PI, SW	Status Review (Conant et al. 2009) <sup>^</sup>	2007	Review of species information and threats, proposed DPSs, and modeling and threats analyses
Northwest Atlantic Ocean DPS	Northwest Atlantic Ocean (DPS)	NE, SE		2004-2007 (varied by region)	
			Revised Recovery Plan (NMFS and USFWS 2008) <sup>^</sup>	2003-2008 (varied by region)	ESA Recovery Plan, including species status and threats, recovery criteria, recovery strategy, population modeling, and threats analyses
<b>Green (<i>Chelonia mydas</i>)</b>					
Florida breeding colonies	Northwest Atlantic Ocean (Florida breeding colonies)	NE, SE	Five-Year Review (NMFS and USFWS 2007a)	2005	Standard ESA 5-Year Review, including compilation of information from literature and personal communications
Mexico's Pacific breeding colonies	East Pacific Ocean*	SW		2006	
Elsewhere (globally)	Northwest Atlantic Ocean (Non-Florida breeding colonies) <sup>6</sup>	SE		2003-2006 (varied by region)	
	North Central Pacific Ocean (U.S. Pacific Islands)	PI		2006	
<b>Leatherback (<i>Dermochelys coriacea</i>)</b>					
Global	Northwest Atlantic Ocean	NE, SE	Five-Year Review (NMFS and USFWS 2007c)	2004-2006 (varied by region)	Standard ESA 5-Year Review, including compilation of information from literature and personal communications
		U.S. Pacific Ocean <sup>7*</sup>		PI, SW	
<b>Hawksbill (<i>Eretmochelys imbricata</i>)</b>					
Global	Western Caribbean Sea/ United States	SE	Five-Year Review (NMFS and USFWS 2007b)	2005-2006 (varied by region)	Standard ESA 5-Year Review, including compilation of information from literature and personal communications
		North Central Pacific Ocean (U.S. Pacific Islands)		PI	
<b>Kemp's ridley (<i>Lepidochelys kempii</i>)</b>					
Global	Global (Northwest Atlantic Ocean)	NE, SE	Revised Recovery Plan (NMFS et al. 2011) <sup>^</sup>	2009-2010 (varied by region)	ESA Recovery Plan, including species status and threats, recovery criteria, recovery strategy, population modeling, and threats analyses
<b>Olive ridley (<i>Lepidochelys olivacea</i>)</b>					
Mexico's Pacific breeding colonies	East Pacific (Mexico breeding colonies)*	SW	Five-Year Review (NMFS and USFWS 2007d)	2006	Standard ESA 5-Year Review, including compilation of information from literature and personal communications
Elsewhere (globally)	East Pacific (Non-Mexico breeding colonies)*	SW, PI		2006	
		West Atlantic Ocean*		SE	

## **Appendix II. Region-Specific Activities to Improve Sea Turtle Assessments**

Note: Several different approaches were taken by the centers in development of their proposed Tier I- and Tier-II equivalent activities. See Section V-B for further information.

### **A. Northeast Fisheries Science Center**

#### ***NEFSC Priority Activities under SAIP Tier I***

Under Tier I the NEFSC will improve assessments using existing data collection resources:

- Continue to collect and analyze biological, demographic, and health data (e.g., genetics, sex ratio, stock structure, health, and contaminants), and evaluate field methodology (e.g., tag retention, detectability);
- Maintain the externally-funded AMAPPS aerial survey efforts to obtain seasonal surveys and improve species identification during aerial surveys, use environmental data variables to describe distribution of species, and advance the methodology to combine aerial survey, telemetry, and environmental data;
- Continue to deploy satellite tags to obtain distribution, behavior, habitat use, stage- and size-specific survival rates, as well as surfacing interval data that can inform estimation of seasonal density and abundance from aerial survey data;
- Continue fishery observer program support to document sea turtle bycatch, serious injury determination, survival, and mortality, collect biopsy samples for genetics, as well as data entry and database management;
- Develop and improve analytic methods for bycatch estimation and sampling design for allocating observer coverage;
- Incorporate data yielded by these activities (e.g., bycatch, demographics, life history) into population models for improved assessments; and
- Develop and refine analytic assessment methodologies.

#### ***NEFSC Priority Activities under SAIP Tier II***

***Stock Identification*** – To allow inference of genetic structure through integrative analysis of at least two lines of evidence and evaluate spatial and temporal trends, the NEFSC proposes to:

- Support genetics expert working groups, as appropriate;
- Continue and expand standardized collection of genetics samples through all appropriate NEFSC programs, with particular attention to life stages and species/populations for which samples are lacking; and
- Include telemetry component to assess population-specific habitat use (seasonal) and movements (would coincide with use of telemetry to assess *Abundance*, *Anthropogenic Impacts*, and survival rates for *Life History*, as described below).

***Life History and Vital Rates*** – To collect demographic data over broad spatial scales, specify age/stage parameters, and characterize uncertainty and variance, the NEFSC proposes to:

- Expand satellite tagging to assess survival, emigration/immigration, habitat shifts for adults and juveniles, and nesting frequency and remigration intervals for adult females; and
- Expand collection of samples/data and development and application of techniques to assess life history, demographics, and health.

***Abundance*** – To obtain unbiased estimates of abundance with seasonally or geographically explicit density, evaluate spatial and temporal trends, and evaluate variability, the NEFSC proposes to:

- Continue sampling established and initiate new in-water population assessment sites sampled using standardized CMR methodology (both at “hotspots” [as identified using aerial survey, CPUE, and other available spatial data] and areas with lower capture rates for broader-scale measures) in the Atlantic;
- Obtain detectability estimates for sampling sites, and explore possibility of meta-analysis to detect population trends;
- Augment aerial survey effort to increase precision, and expand survey area to increase spatial coverage;
- Apply alternate survey methods and technologies, such as acoustic technologies (sidescan sonar, acoustic imaging, etc.) for in-water surveys and line-scan high definition imaging systems for aerial surveys; and
- Expand deployment of satellite tags and collection of telemetry and environmental data to assess migration, dispersal rates, vertical behavior, and environmental associations.

***Anthropogenic Impacts*** – To obtain unbiased estimates of anthropogenic impacts and investigate causes of and variability associated with anthropogenic injury, the NEFSC proposes to:

- Expand studies, including satellite tagging, to assess post- interaction effects (physiological, sub-lethal) and mortality;
- Standardize sample collection and analysis for stable isotope studies of diet and habitat use to assess anthropogenic influences;
- Develop and apply analytical methods to evaluate anthropogenic impacts (e.g., bycatch, strandings);
- As fishery and/or observer coverage increases, ensure appropriate analytical support for bycatch analysis;
- Improve analytic methods for bycatch estimation and sampling designs for allocation of observer coverage;
- Incorporate health assessment component into network of in-water sampling areas to characterize baseline health parameters for all species, to make it possible to evaluate role of anthropogenic factors in unusual stranding events; and
- Incorporate toxicological component into network of in-water sampling areas to assess contaminant loads for all species and analyze archived samples to allow characterization of temporal trends.

***Assessment Frequency and Quality*** – To ensure that assessments are recent, transparent, and incorporate advanced models that do not use defaults or proxies, the NEFSC proposes to:

- Improve open access to all major databases;
- Incorporate data yielded by recent research into population models for improved assessments (e.g., working groups); and
- Develop and refine analytic assessment methodologies, and conduct assessments with a minimum frequency of 5 years.

### ***NEFSC Priority Activities under SAIP Tier III***

Due to the extensive requirements remaining under Tier I and Tier II, the NEFSC did not specifically identify Tier-III-equivalent activities. However, aspects of the work proposed and/or conducted under Tiers I and II relate to Tier III goals. The center can identify specific Tier III activities as necessary for future planning and prioritization exercises.

## B. Southeast Fisheries Science Center

### **SEFSC Priority Activities under SAIP Tier I**

Under Tier I, the SEFSC will improve assessments using existing data collection resources:

- Continue to collect and analyze biological, demographic, and health data (e.g., genetics, sex ratio, stock structure, health, and contaminants), and evaluate field methodology (e.g., tag retention, detectability);
- Continue the STSSN to monitor stranding levels, respond to unusual stranding events, document anthropogenic impacts, and collect samples to facilitate stock structure and life history research (including database development and maintenance);
- Maintain AMAPPS and NRDA aerial survey efforts to obtain seasonal surveys and improve species ID during aerial surveys; use environmental data variables to describe distribution of species; advance the methodology to combine aerial survey, telemetry, and environmental data;
- Continue to deploy satellite tags to obtain distribution, behavior, habitat use, stage- and size-specific survival rates, as well as surfacing interval data that can inform estimation of seasonal density and abundance from aerial survey data;
- Continue fishery observer program support to document sea turtle bycatch, serious injury determination, survival, and mortality, collect biopsy samples for genetics, as well as data entry and database management;
- Develop and improve analytic methods for bycatch estimation and sampling design for allocating observer coverage;
- Refine and apply skeletochronological analysis to sea turtle skeletal elements to obtain growth rates, stage duration, and age data, incorporate the influence of covariates on growth rates, and assess variability;
- Incorporate data yielded by these activities (e.g., bycatch, demographics, life history) into population models for improved assessments;
- Develop and refine analytic assessment methodologies; and
- Continue to support and improve the Cooperative Marine Turtle Tagging Program at the national level.

### **SEFSC Priority Activities under SAIP Tier II**

**Stock Identification** – To allow inference of genetic structure through integrative analysis of at least two lines of evidence and evaluate spatial and temporal trends, the SEFSC proposes to:

- Support genetics expert working groups to compile all available genetic data and apply improved analytical techniques, including temporal trends in stock composition;
- Evaluate temporal trends in stock composition on foraging grounds relative to nesting activity/success for the different sea turtle populations/DPSs;
- Continue and expand standardized collection of genetics samples through observer effort, STSSN, and all SEFSC in-water capture programs, with particular attention to life stages and species/populations for which samples are lacking; and
- Include telemetry component to assess population-specific habitat use (seasonal) and movements (would coincide with use of telemetry to assess *Abundance*, *Anthropogenic Impacts*, and survival rates for *Life History*, as described below).

**Life History and Vital Rates** – To collect demographic data over broad spatial scales, specify age/stage parameters, and characterize uncertainty and variance, the SEFSC proposes to:

- Expand satellite tagging to assess survival, emigration/immigration, habitat shifts for adults and juveniles, and nesting frequency and remigration intervals for adult females;
- Expand collection of samples/data and development and application of techniques to assess life history, demographics, and health; and
- Expand standardized collection and archival of sea turtle skeletal elements and analysis (including skeletochronology, stable isotopes, and trace elements) to obtain population-specific estimates of mean values and variability for growth rates, stage durations, size-at-age, and age at maturation.

**Abundance** – To obtain unbiased estimates of abundance with seasonally or geographically explicit density, evaluate spatial and temporal trends, and evaluate variability, the SEFSC proposes to:

- Continue sampling established and initiate new in-water population assessment sites sampled using standardized CMR methodology (both at “hotspots” [as identified using aerial survey, CPUE, and other available spatial data] and areas with lower capture rates for broader-scale measures) in the Atlantic and Gulf of Mexico;
- Obtain detectability estimates for sampling sites, and explore possibility of meta-analysis to detect population trends;
- Augment aerial survey effort to increase precision, and expand survey area to increase spatial coverage;
- Apply alternate survey methods and technologies, such as acoustic technologies (sidescan sonar, acoustic imaging, etc.) for in-water surveys and line-scan high definition imaging systems for aerial surveys; and
- Expand deployment of satellite tags and collection of telemetry and environmental data to assess migration, dispersal rates, vertical behavior, and environmental associations.

**Anthropogenic Impacts** – To obtain unbiased estimates of anthropogenic impacts and investigate causes of and variability associated with anthropogenic injury, the SEFSC proposes to:

- Expand studies, including satellite tagging, to assess post- interaction effects (physiological, sub-lethal) and mortality;
- Optimize STSSN coverage and expand data collection to standardize documentation of anthropogenic impacts;
- Increase number of necropsies to provide additional information on turtle condition/cause of stranding (fishery interaction, boat strike, debris ingestion);
- Standardize sample collection and analysis for stable isotope studies of diet and habitat use to assess anthropogenic influences;
- Develop and apply analytical methods to evaluate anthropogenic impacts (e.g., bycatch, strandings);
- Ensure appropriate analytical support for bycatch analysis as fishery and/or observer coverage increases;
- Improve analytic methods for bycatch estimation and sampling designs for allocation of observer coverage;
- Incorporate health assessment component into network of in-water sampling areas to characterize baseline health parameters for all species, to make it possible to evaluate role of anthropogenic factors in unusual stranding events; and
- Incorporate toxicological component into network of in-water sampling areas to assess contaminant loads for all species and analyze archived samples to allow characterization of temporal trends.

**Assessment Quality and Frequency** – To ensure that assessments are recent, transparent, and incorporate advanced models that do not use defaults or proxies, the SEFSC proposes to:

- Improve open access to all major databases;
- Incorporate data yielded by recent research into population models for improved assessments (e.g., working groups); and
- Develop and refine analytic assessment methodologies, and conduct assessments with a minimum frequency of 5 years.

**SEFSC Priority Activities under SAIP Tier III**

Due to the extensive requirements remaining under Tier I and Tier II, the SEFSC did not specifically identify Tier-III-equivalent activities. However, aspects of the work proposed and/or conducted under Tiers I and II relate to Tier III goals. The center can identify specific Tier III activities as necessary for future planning and prioritization exercises.

**C. Pacific Islands Fisheries Science Center**

**PIFSC Priority Activities under SAIP Tier I**

Under Tier I requirements of basic monitoring, the PIFSC will:

- Conduct genetic studies to determine population distinctions and structure;
- Improve performance and efficiency in data gathering, processing, and staffing; and
- Conduct more extensive analyses on existing data streams.

**PIFSC Priority Activities under SAIP Tier II**

To achieve standards of Tier II, the PIFSC will need to:

- Extend assessment activities throughout the Hawaiian Archipelago and the Pacific Islands region, emphasizing; increasing collaborations and partnerships with local agency and university scientists;
- Adaptively revise monitoring techniques for appropriate spatiotemporal resolution; and
- Conduct investigations of historical baselines for population metrics and impacts.

**PIFSC Priority Activities under SAIP Tier III**

To achieve an ecosystem-based understanding, the PIFSC will need to:

- Develop physiological and resource research to determine habitat and growth rates for each species occurring in the Pacific Islands region (including on the high seas);
- Investigate physical oceanography, ecology, and climate effects on populations; and
- Integrate climate and physiology studies into investigations of population changes.

**D. Southwest Fisheries Science Center**

**SWFSC Priority Activities under SAIP Tier I**

***Stock Identification –***

- Continue to analyze genetic and stable isotope samples from nesting beaches, foraging areas, strandings, and fisheries observer programs.

***Life History and Vital Rates –***

- Continue in-water sampling of leatherback turtles within central California waters to collect tissue samples, attach transmitters, assess health, and collect CMR data;
- Continue nesting beach monitoring of leatherback turtles at various nesting beaches in the Western Pacific; and
- Continue in-water CMR study of green turtles along the Southern California coast to estimate juvenile and adult survival rates, abundance, and movement rates; monitor movements and habitat use via satellite and acoustic telemetry; and collect tissue samples to determine stock origins and food habit through genetic and stable isotope analyses.

***Abundance –***

- Restore and continue annual aerial surveys over neritic waters along the U.S. west coast to determine occurrence, distribution, and estimate abundance of leatherback turtles;
- Conduct aerial surveys of loggerhead turtles along the Southern California coast to estimate abundance;
- Re-initiate aerial surveys along the Pacific coast of the Baja Peninsula for estimating abundance of juvenile loggerhead turtles, which come from the same stock that occupy U.S. waters of the North Pacific; and
- Continue in-water CMR study of green turtles along the Southern California coast to estimate juvenile and adult abundance.

***Anthropogenic Impacts –***

- Establish onboard observer programs to quantify anthropogenic impacts of Peruvian and Chilean artisanal fisheries on ESA-listed marine turtles;
- Study the impact of using circle hooks and various bait types on marine turtle by-catch in Chilean swordfish fisheries;
- Continue to record injuries of turtles apparently caused by human activities, such as boat strike and fishing gear entanglements;
- Develop and maintain a U.S. west coast marine turtle stranding database that can be shared and accessed by the science center and the regional office;
- Conduct timely necropsies fresh stranded turtle carcasses to determine cause of death; and
- Conduct statistical analyses of spatial and temporal distributions of fishery operations using observer and logbook data.

***Assessment Frequency and Quality –***

- Incorporate new information on genetics, stable isotope ecology, movements, abundance, and demography into assessments of green, loggerhead, and leatherback turtles;
- Aim to conduct regular sampling and surveys of green, loggerhead, and leatherback turtles in their foraging areas; and
- Maintain updated nesting beach abundance database to provide trend information for NMFS management needs.

**SWFSC Priority Activities under SAIP Tier II**

***Stock Identification –***

- Continue to improve the SWFSC molecular sample archive and laboratory information management system;



- Increase sampling effort (genetics and stable isotopes) of leatherback, loggerhead, and green turtles at nesting beaches and in foraging areas, including waters along the U.S. west coast; and
- Develop new molecular markers to improve stock resolution.

***Life History and Vital Rates–***

- Improve our understanding of life history parameters (age at first reproduction, survival rates, abundance, sex ratios, fecundity, foraging destinations, and remigration intervals) through sampling at nesting beaches and foraging areas and using various laboratory and analytical techniques, including genetics, stable isotopes, nesting beach monitoring, and statistical modeling;
- Initiate nest and beach temperature monitoring combined with histological examination of hatchlings to determine cohort sex ratios at various nesting beaches;
- Initiate in-water sampling of leatherback turtles within Oregon/Washington waters in support of tagging, telemetry, CMR studies, health assessments, and morphometrics, and to obtain tissue samples for genetic and SIA; and
- Determine oceanic juvenile stage durations for North Pacific loggerheads and Eastern Pacific green turtles in the North Pacific and eastern Pacific via stable isotope and skeletochronological analyses.

***Abundance –***

- Increase the number of aerial survey days and area of spatial coverage for leatherback turtles within U.S. west coast EEZ waters;
- Continue annual aerial surveys of loggerhead turtles along the Southern California coast and along the Pacific coast of the Baja Peninsula to estimate abundance and identify oceanographic factors affecting their distribution; and
- Continue in-water CMR study of green turtles along the Southern California coast to estimate juvenile and adult abundance.

***Anthropogenic Impacts –***

- Analyze existing data on occurrence of turtles and fishery observer and logbook data to determine possible overlap between fishery distributions and turtle distributions as a function of environmental variables; and
- Compare data on vertical and horizontal habitat use of leatherback turtles and swordfish (the primary fishery target species) within the Leatherback Time Area Closure along the U.S. west coast to determine the areas and depths of greatest likelihood for leatherback-fisheries interactions.

***Assessment Frequency and Quality –***

- Ensure new information collected by research projects is incorporated into assessment, including definitions of management units;
- Aim to conduct assessments of each species every 5 years and determine areas that require more research;
- Develop methods to integrate stable isotope ecological data into future status assessments, including SIA data in the context of trophic structure, movements, and stage durations in component habitats; and
- Maintain an ongoing Pacific Leatherback Assessment Working Group (consisting of biologists from SWFSC, PIFSC, and external partners) to monitor biology, conservation status, and climate change impacts on leatherbacks.

**SWFSC priority activities under SAIP Tier III**

- Assess effects and exposure to threats to leatherback turtles at U.S. west coast foraging grounds by measurement of normal physiological parameters, baseline hematologic and plasma biochemistry values, and exposure to heavy metals, organochlorine contaminants, and domoic acid;
- Develop predictive models of occurrence of leatherback turtles with respect to environmental factors;
- Model ocean-current-mediated dispersal of hatchling turtles emerging from nesting beaches, with efforts focusing on green turtles in the eastern and central Pacific, loggerheads in the North Pacific, and leatherback turtles in the eastern and western Pacific;
- Conduct process-oriented ecosystem assessment of temperate foraging habitats of leatherback turtles off the U.S. west coast, integrating oceanographic and prey (jellyfish) sampling and real-time satellite oceanography with concurrent aerial surveys and telemetry studies of leatherback turtles;
- Assess leatherback turtle energetics in temperate foraging grounds through determination of caloric energy required for movement and metabolic heat in temperate waters via video imagery of leatherback foraging behavior (consumption rate) and caloric content of primary jelly prey to provide mechanistic data for refinement of habitat suitability models;
- Conduct process-oriented ecosystem assessment of temperate foraging habitats (overwintering sites) of green turtles in bays and estuaries along the U.S. west coast, integrating environmental variable and diet sampling, long-term seasonal changes in distribution and abundance of primary diet constituents, and monitoring of anthropogenic threats (heavy metal, boat collisions, and pollutants), with telemetry studies of green turtles within the study areas;
- Conduct process-oriented ecosystem assessment of foraging habitats of juvenile loggerhead turtles along the U.S. and Mexican west coasts, involving continuous monitoring of loggerhead distributions along the coast, *in situ* and remote-sensed oceanographic sampling, and fisheries observer program (incidental deaths);
- Assess potential impacts of climate change on behavior and demographic parameters of marine turtles, particularly as it relates to changes in habitat structure and food availability; and
- Develop stable isotope food-web models for green turtles, loggerheads, and leatherbacks along the U.S. west coast to determine the ecosystem role of marine turtles and clarify the impacts of anthropogenic-based habitat degradation.

**Appendix III. NMFS Science Center Sea Turtle Assessment Staffing Levels.** Numbers of staff (full time federal employees [FTEs] and contractors) paid from turtle funds in FY2011 (Table II-1), estimated additional staff needed above FY11 levels and total staff needed to achieve Tier I (Table II-2), and estimated additional staff needed above Tier I levels and total staff needed to achieve Tier II (Table III-3) are shown for each staff activity. Specific Tier I- and Tier II-equivalent activities to be conducted by center staff are listed in Appendix II.

Notes: 1) Several different approaches were taken by the centers in development of their proposed Tier I- and Tier-II equivalent activities, which in turn impacted staff estimation approaches. See Section V-B for further information. 2) Fishery observers are not housed in the centers' turtle programs and are not included here.

\*Staff may be split between activities in the tables.

**Table III-1.** NMFS Science Center sea turtle staffing levels. Numbers of staff paid from turtle funds in FY11 are shown for each staff activity.

Staff Activity*	NEFSC		SEFSC		PIFSC		SWFSC		Total FY11 Staff	
	FTE	Contract	FTE	Contract	FTE	Contract	FTE	Contract	FTE	Contract
<b>Field Programs</b>										
Survey leaders	0.10		0.50	0.20	0.50	1.45	0.40		<b>1.50</b>	<b>1.65</b>
Abundance survey observers			0.45	0.40	0.20	0.45	0.58	0.40	<b>1.23</b>	<b>1.25</b>
Biopsy, mark/recapture, and tagging studies				0.50	0.20	0.45	0.80		<b>1.00</b>	<b>0.95</b>
Field collection of biological and health data	0.20		0.25	0.10	0.20	0.25	0.95	0.20	<b>1.60</b>	<b>0.55</b>
Response to strandings			1.12	0.83	0.25	1.45	0.05		<b>1.42</b>	<b>2.28</b>
Processing of biological and health samples			0.20		0.25	0.25		0.20	<b>0.45</b>	<b>0.45</b>
<b>Fishery Observer Programs</b>										
Fishery Observers									<b>0.00</b>	<b>0.00</b>
Other observer staff (Observer program support)			0.85						<b>0.85</b>	<b>0.00</b>
Bycatch analyses	0.85	0.50	0.40				0.30		<b>1.55</b>	<b>0.50</b>
Processing of biological samples			0.05					0.20	<b>0.05</b>	<b>0.20</b>
<b>Lab/Office Programs</b>										
Stranding program			0.65	0.10	0.60		0.05		<b>1.30</b>	<b>0.10</b>
Stock identification						1.00	2.00	0.50	<b>2.00</b>	<b>1.50</b>
Analysis of biological and health data	0.10		0.60	0.80	0.40		0.80	0.70	<b>1.90</b>	<b>1.50</b>
Conduct assessments	0.10		0.40		0.35		0.25		<b>1.10</b>	<b>0.00</b>
Assessment research	0.10	0.50	0.05		0.65		0.25		<b>1.05</b>	<b>0.50</b>
Communication of results			0.55	0.15	0.30		0.85		<b>1.70</b>	<b>0.15</b>
<b>Other Staff Activities</b>										
Data management support				0.05	0.55	0.70	0.97		<b>1.52</b>	<b>0.75</b>
Program administration and management support	0.10		1.05	0.10	0.25		0.50		<b>1.90</b>	<b>0.10</b>
Permit management	0.10		0.60		0.20		0.25		<b>1.15</b>	<b>0.00</b>
Management support	0.10		0.15		0.10				<b>0.35</b>	<b>0.00</b>
Veterinarian									<b>0.00</b>	<b>0.00</b>
<b>Total People</b>	<b>1.75</b>	<b>1.00</b>	<b>7.87</b>	<b>3.23</b>	<b>5.00</b>	<b>6.00</b>	<b>9.00</b>	<b>2.20</b>	<b>23.62</b>	<b>12.43</b>

**Table III-2.** Estimated NMFS Science Center sea turtle Tier I staffing requirements. Additional numbers needed above FY11 levels and total staff needed to achieve Tier I are shown for each staff activity. The first four numerical columns show estimated numbers of new staff necessary beyond FY11 staffing levels (Table III-1) to continue FY11 activities and complete Tier I-equivalent activities (Appendix II). The fifth column sums the preceding four columns.

Staff Activity*	NEFSC		SEFSC		PIFSC		SWFSC		Total Additional for Tier I vs. FY11	
	FTE	Contract	FTE	Contract	FTE	Contract	FTE	Contract	FTE	Contract
<b>Field Programs</b>										
Survey leaders	0.25		0.50		0.25	0.00	0.50		1.50	0.00
Abundance survey observers			0.30	6.00	0.25	0.50			0.55	6.50
Biopsy, mark/recapture, and tagging studies					0.25	0.50			0.25	0.50
Field collection of biological and health data	1.00	1.00	0.50	2.00	0.25	0.50		0.20	1.75	3.70
Response to strandings			0.67	1.00					0.67	1.00
Processing of biological and health samples		0.10	0.10				0.50		0.60	0.10
<b>Fishery Observer Programs</b>										
Fishery Observers									0.00	0.00
Other observer staff (Observer program support)	0.50			1.50					0.50	1.50
Bycatch analyses	2.00		2.00						4.00	0.00
Processing of biological samples							0.30		0.00	0.30
<b>Lab/Office Programs</b>										
Stranding program			1.40	1.50					1.40	1.50
Stock identification						0.50	0.40	0.40	0.40	0.90
Analysis of biological and health data	0.25	0.20	2.35	0.50		1.00	0.70		3.30	1.70
Conduct assessments	0.75		1.00		0.20		0.50		2.45	0.00
Assessment research	0.75		0.75		0.80	0.50	0.50		2.80	0.50
Communication of results			0.05						0.05	0.00
<b>Other Staff Activities</b>										
Data management support		1.00		2.00		0.50	1.00		1.00	3.50
Program administration and management support									0.00	0.00
Permit management									0.00	0.00
Management support									0.00	0.00
Veterinarian		0.10							0.00	0.10
<b>Total People</b>	<b>5.50</b>	<b>2.40</b>	<b>9.62</b>	<b>14.50</b>	<b>2.00</b>	<b>4.00</b>	<b>4.10</b>	<b>0.90</b>	<b>21.22</b>	<b>21.80</b>

**Table III-3.** Estimated NMFS Science Center sea turtle Tier II staffing requirements. Additional numbers needed above estimated Tier I levels and total staff needed to achieve Tier II are shown for each staff activity. The first four numerical columns show estimated numbers of new staff necessary beyond Tier I staffing levels (Table III-2) to continue FY11 activities and complete Tier I- and Tier II-equivalent activities (Appendix II). The fifth column sums the preceding four columns.

Staff Activity*	NEFSC		SEFSC		PIFSC		SWFSC		Total Additional for Tier II vs. Tier I	
	FTE	Contract	FTE	Contract	FTE	Contract	FTE	Contract	FTE	Contract
<b>Field Programs</b>										
Survey leaders	1.00		1.00						2.00	0.00
Abundance survey observers				4.00				0.90	0.00	4.90
Biopsy, mark/recapture, and tagging studies						0.50		0.30	0.00	0.80
Field collection of biological and health data		9.00		10.00		0.50		0.90	0.00	20.40
Response to strandings			0.10						0.10	0.00
Processing of biological and health samples		0.25		0.50				0.40	0.00	1.15
<b>Fishery Observer Programs</b>										
Fishery Observers									0.00	0.00
Other observer staff (Observer program support)									0.00	0.00
Bycatch analyses	1.00		1.00				0.70		2.70	0.00
Processing of biological samples									0.00	0.00
<b>Lab/Office Programs</b>										
Stranding program			0.20						0.20	0.00
Stock identification									0.00	0.00
Analysis of biological and health data	1.00		1.70	1.00		0.50	1.00		3.70	1.50
Conduct assessments	0.50		0.50				0.50		1.50	0.00
Assessment research	0.75		0.75		0.80	0.50	0.40		2.70	0.50
Communication of results					0.20		0.40		0.60	0.00
<b>Other Staff Activities</b>										
Data management support		0.50		0.50				0.50	0.00	1.50
Program administration and management support									0.00	0.00
Permit management									0.00	0.00
Management support									0.00	0.00
Veterinarian				0.25					0.00	0.25
<b>Total People</b>	<b>4.25</b>	<b>9.75</b>	<b>5.25</b>	<b>16.25</b>	<b>1.00</b>	<b>2.00</b>	<b>3.00</b>	<b>3.00</b>	<b>13.50</b>	<b>31.00</b>