

Organization: University of Maryland Center for Environmental Science (UMCES)

Principal investigators:

Helen Bailey, Chesapeake Biological Laboratory, UMCES, P.O. Box 38, Solomons, MD 20688.
Email: hbailey@umces.edu, Tel: 410-326-7284

Larry Crowder, Hopkins Marine Station, Stanford University, 120 Oceanview Blvd, Pacific Grove CA 93050, Email: larry.crowder@stanford.edu, Tel: 831-333-2099

NOAA partners:

Jeffrey Seminoff, Tomo Eguchi and Scott Benson: NOAA Southwest Fisheries Science Center, 8901 La Jolla Shores Dr, La Jolla, CA 92037, E-mail: jeffrey.seminoff@noaa.gov, Tel: 858-546-7152

Toby Garfield and Cara Wilson: NOAA Southwest Fisheries Science Center, 99 Pacific Street Suite 255A, Monterey, CA 93940, E-mail: toby.garfield@noaa.gov, Tel: 858-546-5623.

Tina Fahy: NOAA West Coast Region, 501 West Ocean Boulevard, Suite 4200, Long Beach, CA 90802, E-mail: christina.fahy@noaa.gov, Tel: 562-980-4023

Area of interest: 1. b. Protected Species

Project title: El Niño Watch revised - An improved index for reducing Loggerhead Turtle bycatch in the California Current

Project objectives: 1) Develop a habitat model for loggerhead turtles in the California Current that incorporates the comprehensive suite of available loggerhead turtle datasets and environmental observations. 2) Use newly collected satellite telemetry and aerial survey data to validate the models. 3) Develop an improved closure rule, based on regional environmental data, which will be made available through a new web-based platform hosted by the NOAA CoastWatch Program and incorporated into existing efforts to inform the California drift gillnet fishery fleet of areas of high-bycatch risk.

Summary of work: 1 August 2016 – 31 July 2017. We propose to re-examine the DGN seasonal El Niño closure rule by developing a habitat-based model of loggerhead turtle occurrence and using regional oceanographic variables to develop an improved, spatially- and temporally-explicit closure rule.

Total funds requested: \$134,262

Ginger Steelman, Assistant Director	Date
University of Maryland Center For Environmental Science	
Office of Research Administration & Advancement	
Phone: 410-221-2014; E-Mail: gsteelman@umces.edu or oraa@umces.edu	

Project Description

Identification of the problem: Balancing ecological and economic objectives by reducing bycatch of protected species while maintaining vibrant U.S. commercial fisheries is one of the key challenges in fisheries management. As part of this process, managers may be required to implement fishery closures based on existing Federal legislation. The California Drift Gillnet Fishery (DGN) requires a seasonal closure to avoid potential interactions with loggerhead turtles (*Caretta caretta*), which follow warmer waters off California in search of their preferred prey, pelagic red crabs (*Pleuroncodes planipes*) (Nichols 2003). The California DGN fishery is a limited entry fishery that primarily targets broadbill swordfish (*Xiphias gladius*) in Federal waters off California. However, bycatch of endangered species such as the North Pacific loggerhead turtle has resulted in fishery closures and reduction in profitability for fishers. Since 2003, NMFS has been required by law to close an area in the Southern California Bight (approximately 25,000 sq. miles) termed the Pacific Loggerhead Conservation Area (Figure 1) when particular oceanographic conditions are present (50 CFR 660.713(c)(2)). NMFS employs the closure to protect the sea turtles during June, July and August when an El Niño event is occurring or forecast to occur (El Niño Watch). This closure rule was based on relatively scant information NMFS had available at the time of its analysis in 2000. Although this regulation is an encouraging example of accounting for current environmental conditions in the management of a fishery, the environmental metric, an El Niño event, may not accurately reflect conditions in the Conservation Area and has not been adequately tested to evaluate its efficacy in reducing loggerhead turtle bycatch.

As a result of the time-area closure and additional legislation, the productivity of the California DGN fishery has been reduced, and catches have dropped from 2,198 metric tons of

swordfish at the peak in 1985, to less than 200 metric tons of swordfish in recent years. The Pacific Fishery Management Council regulates the DGN fishery and the NOAA/NMFS West Coast Region enacts its regulations. Under consideration is whether the protected species mandates can be met with reduced DGN closures because of the negative economic impact closures are having on fishermen. However, the regulators lack information on loggerhead turtle habitat use and a tool to accurately inform them when coastal oceanic conditions may place loggerhead turtles at risk. The current closure metrics (El Niño indices) are calculated in the central tropical Pacific and may not adequately capture warming conditions in the Southern California Bight (SCB), as highlighted by the recent “blob” event that brought warm waters nearshore but was not tied oceanographically to the tropics (Bond *et al.* 2015). Whereas innovative tools are being developed to help manage other species (for example EcoCast, see http://www.westcoast.fisheries.noaa.gov/publications/fishery_management/hms_program/swordfish2015/ecocast_infosheet.pdf), no such development is currently underway for loggerhead turtles. Consequently, the goal of this project is to develop a more complete understanding of loggerhead habitat use in U.S. waters to inform a decision-support tool that would serve to reduce bycatch of protected species while maintaining or even improving target catch at sustainable and commercially viable levels (BREP Priorities 1b and 1c).

Project objectives: Here we propose to re-examine the DGN seasonal El Niño closure rule by developing a habitat-based model of loggerhead turtle occurrence and using regional oceanographic variables to develop an improved, spatially- and temporally-explicit closure rule. This analysis will help to more effectively target the time-area closure to periods when loggerhead turtles are most likely to be present. The goal is to minimize the risk of loggerhead

turtle bycatch in the DGN fishery whilst also having a reduced impact on target catch. This may also benefit two other gillnet fisheries that operate in the area (smaller mesh gear targeting species such as barracuda and white sea bass). Our proposed objectives are:

1. Develop a habitat model for loggerhead turtles in the California Current that incorporates the comprehensive suite of available loggerhead turtle datasets (aerial surveys, telemetry data, bycatch, and shipboard) and environmental observations.
2. Use newly collected data (aerial surveys and satellite telemetry) to validate the models.
3. Develop an improved closure rule, based on regional environmental data, which provides a more direct correspondence to loggerhead turtle bycatch risk. This closure rule metric will be made available through a new web-based platform hosted by the NOAA CoastWatch Program and incorporated into existing efforts (e.g. EcoCast) to inform the DGN fleet of areas of high-bycatch risk.

Through the proposed project, we will improve and update the existing El Niño Watch tool to consider and/or improve current regulations that will ensure the fishery is closed when and where certain environmental triggers are met. This will provide important information directly to fishers and managers, and offers a flexible framework that could lead to improved rules for maximizing profitability while minimizing bycatch. This project directly addresses BREP Priorities 1b and 1c (Developing innovative practices to reduce bycatch of protected species and highly migratory species), and specifically addresses BREP's goals of developing technological solutions and changes to fishing practices that will result in reductions in bycatch.

Project narrative: In collaboration with the NMFS West Coast Region and Southwest Fisheries Science Center (SWFSC), we will use available data as well as new data collection to better

understand the oceanographic drivers of loggerhead turtle distributions within the southern California Current. We will use approaches similar to those we successfully developed for “WhaleWatch” for the NMFS West Coast Region (<http://www.westcoast.fisheries.noaa.gov/whalewatch>). Our efforts will be in direct partnership with the Pacific Fishery Management Council and NMFS West Coast Region as both have been integrally involved in the management of this fishery. Our approach will follow a multi-step process:

- 1) **Habitat modeling:** Combine fisheries dependent and independent data (bycatch, satellite telemetry, aerial and shipboard survey data) with environmental information (e.g., bathymetry and satellite-derived sea surface temperature and upwelling indices) to improve our understanding of the habitat preferences of loggerhead turtles and predict their likelihood of occupying the Southern California Bight.
- 2) **Field Data Collection:** We will leverage on-going data collection as well as conduct new aerial surveys and satellite telemetry to test and further refine our loggerhead turtle habitat model.
- 3) **Improve El Niño Watch tool and closure rule:** We will utilize remotely-sensed and modeled oceanographic data to develop a more effective closure threshold that reflects warm waters in the southern California Current no matter what the underlying cause (e.g. El Niño or other ocean anomalies). We will integrate our findings and models with ongoing efforts of bycatch reduction (e.g. EcoCast) to create a one-stop product for reduction of bycatch in the DGN fishery that can be used directly by the NMFS West Coast Region and fishers.

Loggerhead Turtle Data and Habitat modeling

Scientists have known that juvenile loggerhead turtles originating from Japanese nesting beaches cross the Pacific Ocean to access the productive waters off the Baja California

Peninsula, Mexico (Peckham *et al.* 2007). Less understood are the movements of these loggerhead turtles into U.S. waters off California. An aerial line-transect survey of loggerhead turtles in the SCB was conducted during September and October 2015 with 4866 km surveyed and a total of 215 loggerhead turtles sighted (Figure 1).

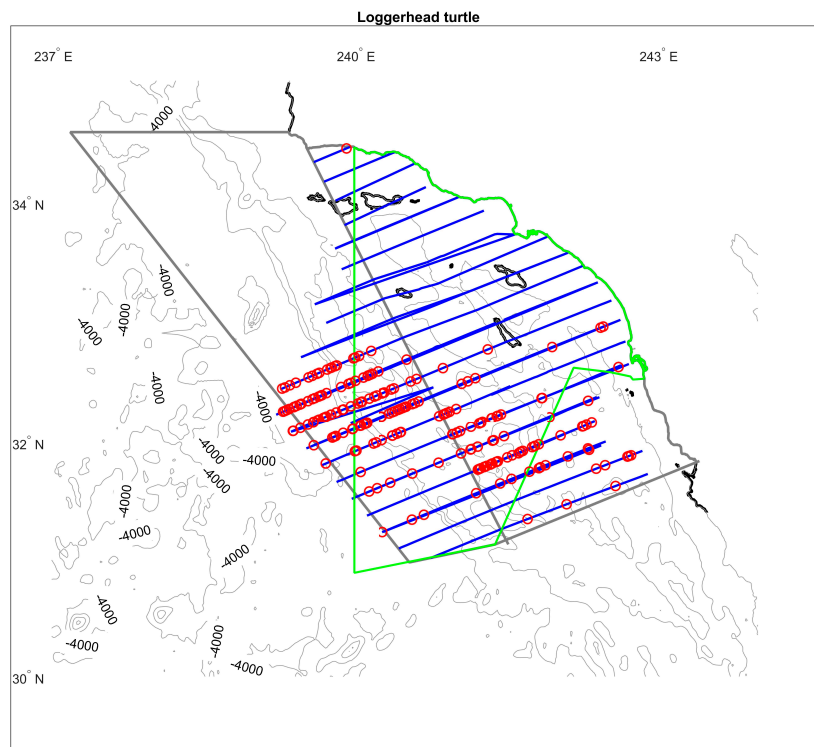


Figure 1: A map of the aerial survey in 2015 with the track lines (blue lines), sightings of loggerhead turtles (red circles), survey study area (gray lines) and the Pacific Loggerhead Conservation Area (green line).

In addition to the aerial surveys, the SWFSC is conducting a satellite telemetry study: three loggerhead turtles were tagged and tracked in the SCB in 2015, with an additional 17 tags to be deployed in 2016. The turtles ranged from 29 to 54 cm curved carapace length, with tracking durations ranging from 44 to 99 days, and total displacement from release point ranging from 399 to 730 km (Figure 2).



Figure 2: Satellite tracks of three loggerhead turtles (stars indicate the last known position).

Bycatch data of loggerhead turtles ($n=16$) in the DGN fishery have been collected since 1990 through the observer program managed by the NMFS West Coast Region. Shipboard sightings of loggerhead turtles have also been recorded during the SWFSC marine mammal surveys that are conducted during the summer and fall off the U.S. west coast every 3-4 years on average (Forney *et al.* 2012), as well as hundreds of sightings through the SWFSC ‘hotline email’ (see Field Data Collection section) which will be quality checked before use in the habitat analysis.

Data on loggerhead turtles from multiple platforms (aerial, satellite telemetry, bycatch, and shipboard) will be combined to maximize the available sample size. These data will be correlated with environmental data to predict the likelihood of loggerhead turtle presence in the SCB. We will develop a three-tiered approach:

- 1) **Sea Surface Temperature (SST) index:** For many species, such as loggerheads, thermal

sensitivity is an important aspect of their fundamental niche (Hawkes *et al.* 2007). Recognizing this, current closures are based on a forecast or existing El Niño event as a proxy for temperature conditions in the California Current. However, ENSO indices highlight changing oceanographic conditions in the Eastern Tropical Pacific, which do not consistently impact temperature conditions in the California Current in the same way (Di Lorenzo *et al.* 2010) and do not account for anomalously warm events unrelated to El Niño (e.g. Bond *et al.* 2015). Therefore, a more thorough understanding of thermal dynamics in the SCB would help refine this adaptive management tool. To address this need, we will create an SST index using a spatially-averaged time series of SSTs within the SCB (121°W -117°W, 32°N -35°N). We will look for such indicators as changes in absolute temperatures, SST gradients by month, maximum temperatures and running averages of anomalously warm SSTs.

2) **Oceanographic niche space of loggerhead turtles:** Niche-based modeling is a useful tool for investigating species distribution patterns and the environmental limitations affecting them (Costa *et al.* 2008). We propose development of an integrated and dynamic niche-based model of loggerhead turtle occurrence using regional oceanographic variables (e.g., bathymetry, SST, upwelling indices) to generate an improved spatially- and temporally-explicit fisheries closure rule. Niche-based models have been successful with relatively small sample sizes and in bycatch reduction tools such as TurtleWatch in the central North Pacific (Howell *et al.* 2008).

3) **Ensemble approaches to data-poor models:** Estimating rare events, such as bycatch, can be challenging. The effects of sample size, combined with sparse observer coverage, may lead to reduced precision and increased bias in bycatch estimates (Martin *et al.* 2015). Methodologies for modeling rare occurrences and bycatch probabilities have been explored for several protected species, including within the SCB region (Martin *et al.* 2015). However, there

is a trade-off between model complexity and model precision, and this becomes increasingly critical in near real-time approaches as data availability becomes more limited (Howell *et al.* 2008). Ensemble-based approaches that combine multiple models can reduce the unpredictability of rare events, such as bycatch estimates, and provide more efficient predictor variables, model selection, and model diagnostics. We will explore ensemble-modeling approaches to predict loggerhead turtle occurrence to see if they enhance the efficacy and precision of the oceanographic niche as compared to single algorithm models. We will validate and refine our models using new aerial survey and telemetry data collected in 2016-17 (see section below).

Field Data Collection

We propose to advance our understanding of loggerhead distribution and movements in southern Californian waters through aerial surveys and at-sea capture of loggerheads in the SCB to apply satellite transmitters. In the past two years, hundreds of loggerhead sightings have been reported on the SWFSC ‘hotline email’ (swfsc.turtle-sightings@noaa.gov) and have gained significant real-time information on turtle whereabouts from a network of sport fishers that frequent offshore waters. During a pilot study in 2015, use of this type of information enabled us to successfully capture two loggerheads at sea using a sport fisheries platform (M/V Outer Limits). Thus, our proposed field program is two-fold: First, because of the large study area, we will conduct well-established aerial survey techniques that have been used previously to monitor sea turtle abundance and distribution in the eastern North Pacific (Benson *et al.* 2007, Seminoff *et al.* 2014) to determine the timing and locations of loggerhead turtles. A parallel-line pattern of transect lines will be laid from Point Conception to the Mexican border to efficiently cover the study area. We will use a high-wing, twin-engine Partenavia ‘Observer’ airplane contracted from Aspen Helicopters (Oxnard, CA) for the survey because it is the most cost-effective platform.

Transect lines will be determined based on sightings data from previous aerial surveys, although they may be adjusted due to available flight time and weather. If areas of high loggerhead abundance are encountered during the survey, we will attempt to modify the plan to include finer-scale survey effort in these areas. Second, we will partner with commercial drift gillnet fishing vessels and sport fishing boats in the southern California region to conduct at-sea captures of loggerhead turtles using dip nets or hand capture using the aerial survey information and from our sighting hotline and real-time fisher observations. We will leverage funds from an existing award for these boat costs. We will equip up to 17 loggerheads with satellite transmitters to track their movements. We are leveraging existing resources for 11 of these and request funds for the remaining 6 transmitters in this proposal. To date, three turtles have been tracked with satellite telemetry in the SCB (Figure 2); however, an increased number of transmitter deployments are needed to characterize loggerhead movements in the region. The existing satellite tracks coupled with tags to be deployed in 2016 will yield a total of 20 satellite tracked loggerheads.

Our project depends on getting on the water to access loggerhead foraging grounds in the SCB. Whereas SWFSC does have research vessels available, these platforms are either too small (e.g. Boston Whalers) to safely access waters upwards of 100 nautical miles offshore, or too large (e.g. R/V *Ruben Lasker*) to economically or effectively conduct loggerhead captures in the region. With our previous capture success from the fishing vessel M/V *Outer Limits*, we have determined that small (<100 ft) commercial and/or sport fishing vessels are the optimal platforms for our research needs. Many of the drift gillnet skippers fishing out of San Diego have over 30 years of experience, have participated in NMFS research exploring new technology to reduce bycatch of sea turtles and other protected species (e.g., buoy-gear research using the F/V

Goldcoast; longline fishing research off central California using the F/V *Ventura II*), and have the motivation to help our efforts to understand loggerhead movement and how it may relate to swordfish movements and habitat use. The commercial and sport fishing fleets based out of southern California ports in the SCB are close communities, in which sightings of turtles can be shared among vessels. Consequently, the chance of finding turtles in the SCB is greatly increased by using the commercial and sport fishing fleets.

Improve El Niño Watch tool and closure rule

Improvements to the El Niño Watch will occur over a series of steps. The first step is to create a website that hosts the El Niño status so closures could be enacted more quickly (see Project Impacts section). Second, the SST indices developed will be used to refine the rule such that El Niños with minimal effect on the California Current would not result in the same closure as those with a strong signal. Finally, niche-based models will be used to create stoplight-based closures, such that areas could be deemed green (low-risk of loggerhead presence), yellow (medium-risk), and red (high-risk of loggerhead presence), similar to efforts underway for bluefin tuna off Australia (Hobday *et al.* 2011). The thresholds for each category (green, yellow, red) can be informed by management risk, e.g. population status of loggerhead turtles and number of turtles caught in US fisheries to date.

Timeline of milestones and deliverables

Task	Months 1-3	Months 4-6	Months 7-9	Months 10-12
Compile existing loggerhead turtle datasets	X			

Task	Months 1-3	Months 4-6	Months 7-9	Months 10-12
Obtain remotely-sensed oceanographic data	X			
New data collection by satellite tagging and aerial surveys for loggerhead turtles	X	X	X	
Develop thermal index	X	X		
Develop niche-based model and evaluate ensemble modeling approach		X	X	
Validate models with new data collected			X	X
Improve El Niño Watch based on model results and host new tool on publicly available website			X	X
Monthly conference calls between the PIs and NOAA partners involved in the project	X	X	X	X
Meetings at the NMFS West Coast Region to discuss needs, progress and results	X		X	
Presentation of results at scientific conference			X	
Manuscript preparation for peer-reviewed publication			X	X
Semiannual progress report and final report		X		X

Permitting: At-sea capture and attachment of satellite transmitters to loggerhead turtles will be conducted under permit number NMFS#14097.

Impacts, benefits or results expected: Determining the movement patterns and environmental

influences of loggerhead turtles off the U.S. West Coast is of major importance for fisheries and endangered species management in this region. The Assistant Administrator for NMFS Protected Resources at the West Coast Region Office has determined that a thorough re-examination of the loggerhead time-area closure is a top priority; therefore, a thorough understanding of loggerhead movements in this area is warranted for better informing future implementation of the southern time-area closure and/or determining that a refinement of the rule is appropriate.

Need for government financial assistance: Government financial assistance would support this project's prompt achievement by greatly facilitating collaboration with NMFS West Coast Region, SWFSC, the Pacific Fishery Management Council and the fishermen themselves. In addition to this proposal request, this project has received \$52K in support from the Cooperative Fisheries Research Program (NMFS) for boat support, and \$35K in satellite transmitter and Service ARGOS support from NMFS SWFSC base funding.

Federal, state and local government activities: The NMFS West Coast Region manages and oversees the observer program, which collects information on bycatch and sightings data in the DGN fishery, along with other fisheries, as resources allow. The goal for the DGN fishery is to attain 20% to 30% coverage, and observers are debriefed regularly throughout the season following each trip. Therefore, NMFS shall be able to use information on loggerhead distribution on a near real-time basis to help inform aerial surveys and at-sea captures. The California Department of Fish and Wildlife is responsible for issuing permits to the DGN fleet, as well as the transfer and management of latent permits. Because the number of participants in this fishery is low and regulations carry consequences, fishermen continuously share information with one another about areas to avoid (i.e., to reduce protected species bycatch). In addition, tools for dynamic closures are being developed for other species in the SCB, although they

currently rely on larger datasets to fit the models. Our approach for this relatively data-poor species would fill an important gap in the ongoing modeling efforts of EcoCast.

Project management: Dr. Helen Bailey will be responsible for the coordination and management of the project. Dr. Elliott Hazen and Dr. Steven Bograd will oversee the habitat modeling analysis conducted by Drs. Dana Briscoe, Kylie Scales and Michael Jacox. Dr. Bailey will coordinate the field data collection with Drs. Jeffrey Seminoff (leader of the Marine Turtle Ecology and Assessment Program at SWFSC) and Tomo Eguchi who are conducting the on-going aerial survey and satellite telemetry study. The PIs will work closely with Tina Fahy at the NMFS West Coast Region to apply the habitat model to improving the El Niño Watch tool and closure rule. Dr. Dale Robinson will create the website hosted by the NOAA CoastWatch Program and make the project data available on CoastWatch data servers. DGN fishermen have expressed support for the use of their vessels as platforms for conducting boat-based surveys and supporting the capture of loggerhead turtles. Given their many years of experience fishing in the SCB, they are uniquely qualified to assist with observations and facilitating the captures. Some of these fishermen also participate in a harpoon fishery, where they rely on spotter planes to assist them in searching for basking swordfish.

Results from prior NOAA/NMFS support: NOAA award RA133F-11SE-2873, \$40,972, 09/12/11-09/11/12, “Identifying hot-spot indices of Pacific bluefin tuna (*Thunnus orientalis*) using movement models, foraging events, and environmental data”. Whitlock *et al.* 2015. Direct quantification of energy intake in an apex marine predator suggests physiology is a key driver of migrations. Science Advances, 1:e1400270. doi:10.1126/sciadv.1400270.

Project impacts: The online management support tool will be made available through a web-based platform that leverages the responsive front-end web interface, content management

system, and ERDDAP data services already in place at the NOAA CoastWatch Program's West Coast website (<http://coastwatch.pfeg.noaa.gov>). This flexible framework can easily incorporate updated closure thresholds and regulations as they are adopted as well as improvements requested by the user community via an online feedback form. The design will target fishers and managers as the primary users, and the management support tool will include the following major elements:

- A prominent closure indicator showing the present status of the closure metric
- An overview of the fishery, the bycatch problem and description of the criteria for closure with links to pertinent regulatory and fisheries science information
- Map-based graphics showing the latest environmental data within the Pacific Loggerhead Conservation Area
- Access to historical closure metrics and environmental data
- Responsive web design that adapts automatically to a user's viewing device, from smartphone to desktop

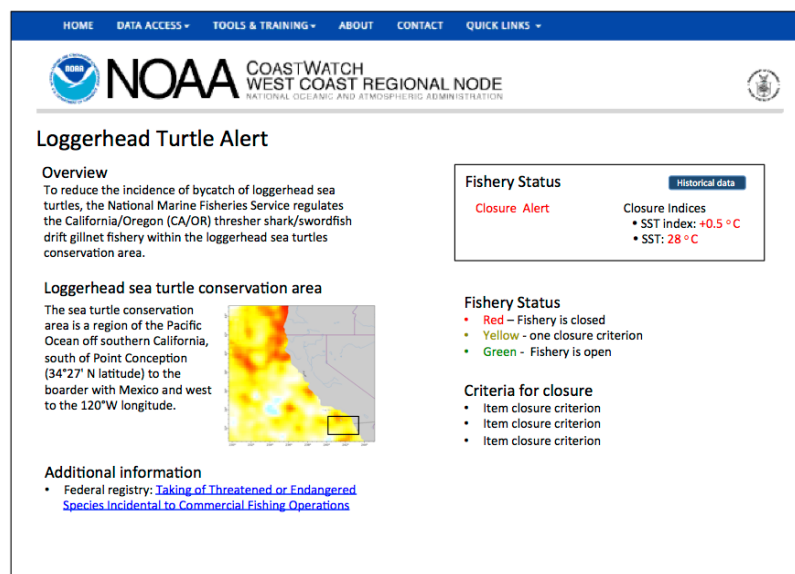


Figure 3: Mock-up website design for making the tool readily available to fishers and managers.

Education and outreach: Tina Fahy at the NMFS West Coast Regional Office regularly communicates with the DGN fleet through mandatory and/or voluntary skipper workshops. The office also holds annual (or more, if needed) meetings, both in-person and/or via webinar, with the Pacific Offshore Cetacean Take Reduction Team, which is comprised of federal and state agencies, Pacific Fishery Management Council representatives, scientists and fishermen. While the team and its associated Take Reduction Plan is primarily focused on reducing marine mammal bycatch, when pertinent, discussions may focus on other management measures affecting the fishery, such as closures to protect sea turtles. In addition, the NMFS West Coast Region provides briefing materials regularly to the Council to inform them on the latest research and management measures considered by the agency with respect to highly migratory species.

Evaluation of project: Based on historic takes, with the current El Niño closure rule, we anticipated an 85% reduction in loggerhead turtle mortalities. This is a bit confounded by the reduced effort in the fishery, but based on calculated anticipated takes with the reduced effort (contained in a NMFS 2013 biological opinion), it has realized a 90% reduction in interactions and a 73% reduction in mortalities. We will use this calculation method to quantify the effect changes to the closure rule resulting from this project have on the reduction in interactions and mortalities, and are aiming to achieve the initial goal of an 85% reduction in mortalities. We will also count the number of page views of our new website to determine the frequency of use and keep a log of meetings with fishermen, the Pacific Fishery Management Council and other stakeholders to further refine our approach to meet their needs.

Data sharing plan: See appendix.

Appendix

Data Sharing Plan

Types of environmental information created during the course of the project

In this project, we envision collecting or generating four main types of environmental data and information.

1. Loggerhead turtle movements tracked by satellite telemetry. This will be made visible and accessible to general users through the freely available [seaturtle.org](http://www.seaturtle.org) website and is where the tracks of the three previously satellite tagged loggerhead turtles are displayed (http://www.seaturtle.org/tracking/index.shtml?project_id=1090&dyn=1460389465).
2. Loggerhead turtle occurrence and transect lines from the aerial surveys. This will be made available through peer-reviewed publications.
3. Habitat preference models for loggerhead turtles. These models and products will be made available through peer-reviewed publications and their associated data repositories.
4. Oceanographic indices based on loggerhead turtle habitat use to assist with assessing bycatch risk. These indices will be displayed on the new website hosted by the NOAA CoastWatch Program.

Tentative date by which data will be shared

Data and information collected and created during the project will be reviewed by the PIs and NOAA partners for quality control before being shared publicly. The information will be made available within two years of the data collection or creation.

Standards to be used for data/metadata format and content

All e-data would be cataloged using conventional metadata standards and portability (e.g. EML, XML). Moreover, all original or raw data will be saved and any derivatives (e.g. filtered data) will be referenced back to the raw data along with metadata describing the methods used in the filtering. Any programs or codes written for such tasks will also be documented and saved. Where applicable (i.e., maps and models), we will use Open Geospatial Consortium OpenGIS® standards now adopted by many industrial and public sector organizations such as the Group on Earth Observation (GEO) and Google Earth®. We anticipate using both R and ArcGIS, which can produce OpenGIS data products and has exceptional interoperability and capability for data management. In all cases, we will seek out the most common standards for data formats that are relevant to the data we collect in this project.

Policies addressing data stewardship and preservation

UMCES, UCSC and NMFS/SWFSC will house and maintain data collected as part of the project. Data will be archived for at least 5 years and back-ups made on and off site. The CoastWatch program will also archive data on the website for at least 3 years.

Procedures for providing access, sharing, and security

Data will be shared amongst the team collaborators and co-authorship given on publications to those contributing resources or to the analysis or writing of the manuscript. Access to the telemetry data will be via seaturtle.org and to the derived indices via the NOAA CoastWatch website. Sharing of bycatch data will be dictated via NOAA's confidentiality agreements with fishermen.

Prior experience in publishing such data

All of the investigators on this project have extensive collaborations and are accustomed to sharing data amongst themselves and with outside investigators. Many of the investigators were part of a large multi-institutional research program called the Tagging of Pacific Predators (TOPP; see Block *et al.* 2011), which required an advanced data management system. We will therefore honor any reasonable request for data from this project in a timely manner, as long as confidentiality agreements are not violated. We will require that requestors provide opportunities for input on interpretation of results and conclusions before dissemination. We would also request a brief synopsis of planned activities with the data so that we can evaluate any competing or duplicative activities.

Literature cited

- Benson, S. R., K. A. Forney, J. T. Harvey, J. V. Carretta, and P. H. Dutton. 2007. Abundance, distribution, and habitat of leatherback turtles (*Dermochelys coriacea*) off California, 1990-2003. *Fishery Bulletin* 105: 337-347.
- Block, B. A., I. D. Jonsen, S. J. Jorgensen, A. J. Winship, S. A. Shaffer, S. J. Bograd, E. L. Hazen, D. G. Foley, G. A. Breed, A. L. Harrison, J. E. Ganong, A. Swithenbank, M. Castleton, H. Dewar, B. R. Mate, G. L. Shillinger, K. M. Schaefer, S. R. Benson, M. J. Weise, R. W. Henry, and D. P. Costa. 2011. Tracking apex marine predator movements in a dynamic ocean. *Nature* 475: 86-90.
- Bond, N. A., M. F. Cronin, H. Freeland, and N. Mantua. 2015. Causes and impacts of the 2014 warm anomaly in the NE Pacific. *Geophysical Research Letters* 42: 3414-3420.
- Costa, G. C., C. Wolfe, D. B. Shepard, J. P. Caldwell, and L. J. Vitt. 2008. Detecting the influence of climatic variables on species distributions: a test using GIS niche-based models along a steep longitudinal environmental gradient. *Journal of Biogeography* 35: 637-646.
- Di Lorenzo, E., K. Cobb, J. Furtado, N. Schneider, B. Anderson, A. Bracco, M. Alexander, and D. Vimont. 2010. Central Pacific El Niño and decadal climate change in the North Pacific Ocean. *Nature Geoscience* 3: 762-765.
- Forney, K. A., M. C. Ferguson, E. A. Becker, P. C. Fiedler, J. V. Redfern, J. Barlow, I. L. Vilchis, and L. T. Ballance. 2012. Habitat-based spatial models of cetacean density in the eastern Pacific Ocean. *Endangered Species Research* 16: 113-133.
- Hawkes, L. A., A. C. Broderick, M. S. Coyne, M. H. Godfrey, and B. J. Godley. 2007. Only some like it hot - quantifying the environmental niche of the loggerhead sea turtle. *Diversity and Distributions* 13: 447-457.
- Hobday, A. J., J. R. Hartog, C. M. Spillman, and O. Alves. 2011. Seasonal forecasting of tuna habitat for dynamic spatial management. *Canadian Journal of Fisheries and Aquatic Sciences* 68: 898-911.
- Howell, E. A., D. R. Kobayashi, D. M. Parker, G. H. Balazs, and a. Polovina. 2008. TurtleWatch: a tool to aid in the bycatch reduction of loggerhead turtles *Caretta caretta* in the Hawaii-based pelagic longline fishery. *Endangered Species Research* 5: 267-278.
- Martin, S. L., S. M. Stohs, and J. E. Moore. 2015. Bayesian inference and assessment for rare-event bycatch in marine fisheries: a drift gillnet fishery case study. *Ecological Applications* 25: 416-429.
- Nichols, W. J. 2003. Biology and conservation of sea turtles in Baja California, Mexico, PhD dissertation, The University of Arizona, Tucson, AZ.
- Peckham, S. H., D. M. Diaz, A. Walli, G. Ruiz, L. B. Crowder, and W. J. Nichols. 2007. Small-scale fisheries bycatch jeopardizes endangered Pacific loggerhead turtles. *PLoS ONE* 2: e1041.
- Seminoff, J. A., T. Eguchi, J. Carretta, C. D. Allen, D. Prosperi, R. Rangel, J. W. Gilpatrick, K. Forney, and S. H. Peckham. 2014. Loggerhead sea turtle abundance at a foraging hotspot in the eastern Pacific Ocean: implications for at-sea conservation. *Endangered Species Research* 24: 207-220.

Resumes

HELEN BAILEY
Research Assistant Professor
Chesapeake Biological Laboratory
University of Maryland Center for Environmental Science
Solomons, MD 20688 U.S.A.
Tel: (1) 410-326-7284, E-mail: hbailey@umces.edu

Education

2001 University of Oxford, St. Hilda's College, U.K. B.A. Hons. (Biological Sciences).
2002 University of Southampton, U.K. M.Sc. (Oceanography).
2006 University of Aberdeen, U.K. Ph.D. (Biological Sciences).
2006 University of Aberdeen, U.K. Postdoctoral Research Assistant.
2007-10 National Research Council Postdoctoral Research Associate, NOAA/NMFS
Southwest Fisheries Science Center, Environmental Research Division.

Professional Positions

2010-Present Research Assistant Professor, Chesapeake Biological Laboratory, University of
Maryland Center for Environmental Science (UMCES).
2009-10 Visiting Scientist, Chesapeake Biological Laboratory, UMCES.
2007-10 National Research Council Postdoctoral Research Associate, NOAA/NMFS
Southwest Fisheries Science Center, Environmental Research Division. Advisor:
Dr. Steven Bograd
2006 University of Aberdeen, U.K. Postdoctoral Research Assistant. Advisor: Prof. P.
Thompson.

Relevant Publications

Howell, E.A., Hoover, A., Benson, S.R., Bailey, H., Polovina, J.J., Seminoff, J.A., and Dutton,
P.H. (2015) Enhancing the TurtleWatch product for leatherback sea turtles, a dynamic habitat
model for ecosystem-based management. *Fisheries Oceanography*, 24: 57-68.
Lewison, R., Hobday, A.J., Maxwell, S., Hazen, E. Hartog, J.R., Dunn, D.C., Briscoe, D.,
Fossette, S., O'Keefe, C.E., Barnes-Mauthe, M., Abecassi M., Bograd, S., Bethoney, N.D.,
Bailey, H., Wiley, D., Andrews S., Hazen, L., Crowder L.B. (2015) Dynamic Ocean
Management: Identifying the critical ingredients of dynamic approaches to ocean resource
management. *BioScience*, 65: 486-498.
Roe, J. H., Morreale, S. J., Paladino, F. V., Shillinger, G. L., Benson S. R., Eckert, S. A., Bailey,
H., Santidrián Tomillo, P., Bograd, S. J., Eguchi, T., Dutton, P. H., Seminoff, J. A., Block, B.
A. and Spotila, J. R. (2014) Hotspots for bycatch of endangered leatherback turtles on
longlines in the Pacific Ocean. *Proceedings of the Royal Society B*, 281: 20132559.
Bailey, H., Benson, S.R., Shillinger, G.L., Bograd, S.J., Dutton, P.H., Eckert, S.A., Morreale,
S.J., Paladino, F.V., Eguchi, T., Foley, D.G., Block, B.A., Piedra, R., Hitipeuw, C., Tapilatu,
R.F. and Spotila J.R. (2012) Identification of Distinct Movement Patterns in Pacific
Leatherback Turtle Populations Influenced by Ocean Conditions. *Ecological Applications*,
22: 735 – 747.

- Bailey, H., Fossette, S., Bograd, S.J., Shillinger, G.L., Swithenbank, A.M., Georges, J.Y., Gaspar, P., Strömberg, K.H.P., Paladino, F.V., Spotila, J.R., Block, B.A. and Hays, G.C. (2012) Movement Patterns for a Critically Endangered Species, the Leatherback Turtle (*Dermochelys coriacea*), Linked to Foraging Success and Population Status. *PLoS ONE*, 7: e36401, doi: 10.1371/journal.pone.0036401.
- Blanco, G.S., Morreale, S.J., Bailey, H., Seminoff, J.A., Paladino, F.V. and Spotila, J.R. (2012) Post-nesting movements and feeding grounds of a resident East Pacific (*Chelonia mydas*) population from Costa Rica. *Endangered Species Research*, 18: 233-245.
- Maxwell, S.M., Hazen, E.L., Morgan, L.E., Bailey, H. and Lewison, R. (2012) Finding balance in fisheries management. *Science*, 336: 413.
- Benson, S.R., Eguchi, T., Foley, D.G., Forney, K.A., Bailey, H., Hitipeuw, C., Samber, B.P., Tapilatu, R.F., Rei, V., Ramohia, P., Pita, J., Dutton, P.H. (2011) Large-scale movements and high-use areas of western Pacific leatherback turtles, *Dermochelys coriacea*. *Ecosphere*, 2: art84.
- Shillinger, G.L., Swithenbank, A.M., Bailey, H., Bograd, S.J., Castleton, M.R., Wallace, B.P., Spotila, J.R., Paladino, F.V., Piedra, R. and Block, B.A. (2011) Vertical and horizontal habitat preferences of post-nesting leatherback turtles in the South Pacific Ocean. *Marine Ecology Progress Series*, 422: 275-289.
- Howell, E.A., Dutton, P.H., Polovina, J.J., Bailey, H., Parker, D.M. and Balazs, G.H. (2010) Oceanographic influences on the dive behavior of juvenile loggerhead turtles (*Caretta caretta*) in the North Pacific Ocean. *Marine Biology*, 157: 1011-1026.
- Shillinger, G.L., Swithenbank, A.M., Bograd, S.J., Bailey, H., Castleton, M.R., Wallace, B.P., Spotila, J.R., Paladino, F.V., Piedra, R. and Block, B.A. (2010) Identification of high-use interesting habitats for eastern Pacific leatherback turtles: role of the environment and implications for conservation. *Endangered Species Research*, 10: 215-232.
- Bailey, H., Shillinger, G., Palacios, D., Bograd, S., Spotila, J., Paladino, F. and Block B. (2008) Identifying and comparing phases of movement by leatherback turtles using state-space models. *Journal of Experimental Marine Biology and Ecology*, 356: 128-135.
- Shillinger, G., Palacios, D., Bailey, H., Bograd, S., Swithenbank, A., Gaspar, P., Wallace, B., Spotila, J., Paladino, F., Piedra, R., Eckert, S. and Block, B. (2008) Persistent leatherback turtle migrations present opportunities for conservation. *PLoS Biology*, 6: e171, doi: 10.1371/journal.pbio.0060171.

Synergistic Activities

1. Member of National Research Council (NRC) Committee on the Assessment of the Cumulative Effects of Anthropogenic Stressors on Marine Mammals.
2. Instructed graduate courses on “Quantitative Methods in Environmental Science” and “Spatial Ecology”.
3. Co-editor of a Marine Ecology Progress Series Theme Section on Tagging Through The Stages: Ontogeny in Biologging published in volume 457, June 2012. Guest editor for a Special Issue on Fronts, Fish, and Predators published in volume 107, September 2014, Deep-Sea Research II: Topical Studies in Oceanography.
4. Reviewer for 17 journals including Conservation Biology, Journal of Applied Ecology, Marine Ecology Progress Series, and Proceedings of the Royal Society B.
5. Contributing scientist to the Leatherback Trust.

Larry B. Crowder

Ed Ricketts Professor and Science Director
Center for Ocean Solutions and Hopkins Marine Station
Stanford University
99 Pacific St., Suite 155a
Monterey, CA 93940, USA

PROFESSIONAL PREPARATION

<u>College/University</u>	<u>Major</u>	<u>Degree & Year</u>
California State University-Fresno	Biology and Mathematics	B.S. & B.A. 1973.
Michigan State University	Zoology	M.S. 1975.
Michigan State University	Zoology	Ph.D. 1978.

PUBLICATIONS

- Žydelis R., R.L. Lewison, S.A. Shaffer, J.E. Moore, A.M. Boustany, J.J. Roberts, M. Sims, D.C. Dunn, B.D. Best, Y. Tremblay, M.A. Kappes, P.N. Halpin, D.P. Costa and L.B. Crowder. 2011. Dynamic habitat models: Using telemetry data to project fisheries bycatch. *Proceedings of the Royal Society B* 278:3191-3200.
- Hazen, E.L., S. Jorgensen, R.R. Rykaczewski, S. J. Bograd, D.G. Foley, I.D. Jonsen, S.A. Shaffer, J.P. Dunne, D.P. Costa, L.B. Crowder, and B.A. Block. 2012. Predicted habitat shifts of Pacific top predators in a changing climate. *Nature Climate Change* 3: 234-238 doi:10.1038/nclimate1686.
- Lewison, R.L., L.B. Crowder, B. Wallace, J. Moore, T. Cox, R. Žydelis, S. McDonald, A. DiMatteo, D. Dunn, C.Y. Kot, R. Bjorkland, S. Kelez, C. Soykan, K.R. Stewart, M. Sims, A. Boustany, A.J. Read, P. Halpin, W.J. Nichols, and C. Safina. 2014. Global patterns of marine megafauna bycatch. *Proceedings of the National Academy of Sciences* 111:5271-5276, doi:10.1073/pnas.1318960111.
- Hobday, A. J., S.M. Maxwell, J. Forgie, J. McDonald, M. Darby, K. Seto, H. Bailey, S.J. Bograd, D.K. Briscoe, D.P. Costa, L.B. Crowder, D.C. Dunn, S. Fossette, P.N. Halpin, J.R. Hartog, E.L. Hazen, B.G. Lascelles, R.L. Lewison, G. Poulos and A. Powers. 2014. Dynamic ocean management: Integrating scientific and technological capacity with law, policy and management. *Stanford Environmental Law Journal* 33 (2):125-165.
- Maxwell, S.M., E.L. Hazen, R.L. Lewison, D.C. Dunn, H. Bailey, S.J. Bograd, D.K. Briscoe, S. Fossette, A.J. Hobday, M. Bennett, S. Benson, M.R. Caldwell, D.P. Costa, H. Dewar, T. Eguchi, L. Hazen, S. Kohin, T. Sippel, and L.B. Crowder. 2015. Dynamic oceans need dynamic management. *Marine Policy* 58:42-50.
- Crowder, L.B. and W.E. Cooper. 1982. Habitat structural complexity and the interaction between bluegills and their prey. *Ecology* 63:1802-1813.
- Crouse, D.T., L.B. Crowder, and H. Caswell. 1987. A stage-based population model for loggerhead sea turtles and implications for conservation. *Ecology* 68:1412-1423.
- Miller, T.J., L.B. Crowder, J.A. Rice, and E.A. Marschall. 1988. Larval size and recruitment mechanisms in fishes: Toward a conceptual framework. *Can. J. Fish. Aquat. Sci.* 45:1657-1670.
- Coleman, F.C., W.F. Figueira, J. Ueland and L.B. Crowder. 2004. The impact of United States recreational fisheries on marine fish populations. *Science* 305(24 September 2004):1958-1960.
- Crowder, L.B., G. Osherenko, O.R. Young, S. Aïramé, E.A. Norse, N. Baron, J.C. Day, F. Douvère, C.N. Ehler, B.S. Halpern, S.J. Langdon, K.L. McLeod, J.C. Ogden, R.E. Peach, A.A. Rosenberg, and J.A. Wilson. 2006. Resolving mismatches in U.S. ocean governance. *Science* 313:617-618.

Professional Preparation

- | | | |
|--------------------------------------|-------------------------------------|------------|
| • University of Arizona, Tucson | Ecology & Evolutionary Biology B.S. | 1989 |
| • University of Arizona, Tucson | Ecology & Evolutionary Biology M.S. | 1994 |
| • University of Arizona, Tucson | Wildlife and Fisheries Science | Ph.D. 2000 |
| • University of Florida, Gainesville | Zoology Postdoctoral Fellowship | thru 2002 |

Professional Appointments

- Leader, Marine Turtle Ecology & Assessment Program
 - NOAA – Southwest Fisheries Science Center; 2009 – present
- Adjunct Assistant Professor / Faculty
 - Indiana - Purdue University; 2001 – present
 - University of Florida; 2003 – present
 - University of Central Florida; 2014 – present
- Sea Turtle Management Roles
 - Leader, NMFS/USFWS US Endangered Species Act Assessment of the Green Sea Turtle; 2012 – present
 - Leader, Loggerhead Turtle MSRA Technical Advisory Team for comparability evaluation for US and Mexico fisheries that interact with N. Pac loggerhead turtles (2015-present)
 - U.S. Delegate, Scientific Committee for the Inter-American Convention for the Protection and Conservation of Sea Turtles; 2010 - present
 - Member, Advisory Committee, USFWS Marine Turtle Conservation Act Fund, Arlington, VA; 2006-present
- Editorial Roles
 - Executive Editor, *Chelonian Conservation and Biology*, 2006 – present
 - Editor, *Endangered Species Research*, 2007 – present,

Five Most Relevant Publications

- Seminoff, J.A., T. Eguchi, J. Carretta, D. Prosperi, C. Allen. R. Rangel, J. Gilpatrick, K. Forney, and S.H. Peckham. 2014. Loggerhead sea turtle abundance at an offshore foraging hotspot in the eastern Pacific Ocean: implications for at-sea conservation. *Endangered Species Research* 24: 207–220
- Seminoff, J.A. and B.P. Wallace (editors). 2012. *Sea Turtles of the Eastern Pacific Ocean: Advances in Research and Conservation*. University of Arizona Press, Tucson, Arizona. 376 pp. ISBN: 978-0-8165-1158-7
- Seminoff, J.A., S.R. Benson, K.E. Arthur, P.H. Dutton, R. Tapilatu, B.N. Popp. 2012. Stable isotope tracking of endangered sea turtles: validation with satellite telemetry and $\delta^{15}\text{N}$ analysis of amino acids. *PLoS ONE*. 7(5): e37403. doi:10.1371/journal.pone.0037403
- Seminoff, J.A., P. Zárata, M. Coyne, D. Foley, D. Parker, B.N. Lyon, and P.H. Dutton. 2008. Post-nesting migrations of Galapagos green turtles, *Chelonia mydas*, in relation to oceanographic conditions: integrating satellite telemetry with remotely-sensed ocean data. *Endangered Species Research* 4:57-72
- Seminoff, J.A., A. Resendiz, and W.J. Nichols. 2002. Home range of the green turtle (*Chelonia mydas*) at a coastal foraging ground in the Gulf of California, México. *Marine Ecology Progress Series* 242:253-265

Tomoharu Eguchi, Ph.D.

Marine Turtle Ecology and Assessment Program
Southwest Fisheries Science Center
National Marine Fisheries Service
8901 La Jolla Shores Drive
La Jolla, CA 92037
858.546.5615 voice
858.546.7003 fax
tomo.eguchi@noaa.gov

Education

B.S. Marine Science, University of the Ryukyus, Okinawa, Japan. (March 1990).
M.S. Marine Biology, Moss Landing Marine Laboratories, California State University, Fresno, CA. (May 1998)
M.S. Thesis: Morphology, movements, and diving behavior of the Pacific harbor seal (*Phoca vitulina richardii*) in the Monterey Bay area (Adviser: James T. Harvey)
Ph.D. Biological Sciences, Montana State University, Bozeman, MT (May 2003)
Ph.D. Dissertation: A hierarchical Bayes approach to capture-recapture abundance estimation (Adviser: Daniel Goodman)
M.S. Statistics, Montana State University, Bozeman, MT (December 2003)

Recent Research Experience

2011, 2015: Aerial surveys in the Southern California Bight for protected species
2014-current: Evaluation of statistical tools for predicting bycatch. Co-investigators: Eric Ward (NWFSC), Brice Semmens (Scripps Institution of Oceanography), Sam McClatchie (SWFSC)
2013-2015: Developing assessment tools for marine turtle species. Co-investigators: Eli Holmes (NWFSC), Eric Ward (NWFSC)

Recent Publications

Schakner, Z.A., Lunsford, C., Straley, J., **Eguchi**, T., Mesnick, S.L. (2014) Using Models of social transmission to examine the spread of longline depredation behavior among sperm whales in the Gulf of Alaska. PLoS ONE 9(10): e109079.
Maxwell, S.M., Hazen, E.L., Lewison, R.L., Dunn, D.C., Bailey, H., Bograd, S.J., Briscoe, D.K., Fossette, S., Hobday, A.J., Bennett, M., Benson, S., Caldwell, M.R., Costa, D.P., Dewar, H., **Eguchi**, T., Hazen, L., Kohin, S., Sippel, T., Crowder, L.B. (2015) Dynamic ocean management: defining and conceptualizing real-time management of the ocean. Marine Policy 58:42-50.
Allen, C. D., Robbins, M. N., Owens, D. W., Meylan, A., Meylan, P., Kellar, N. M., **Eguchi**, T., Schwenter, J., Nollens, H., Dutton, P. H., and Seminoff, J. A. (2015) First assessment of the sex ratio for an East Pacific green sea turtle foraging aggregation: validation and application of a testosterone ELISA. PloS ONE 0138861.

CURRICULUM VITAE

NAME: **Scott Robert Benson**

ORGANIZATION: National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Southwest Fisheries Science Center
8604 La Jolla Shores Drive,
La Jolla, California 92037-1508

CONTACT INFORMATION: Marine Turtle Ecology and Assessment Program
Marine Mammal and Turtle Division, SWFSC
c/o MLML Norte
7544 Sandholdt Rd, Moss Landing, CA 95039
Phone: 831-771-4154; FAX: 831-633-0805
e-mail: Scott.Benson@noaa.gov
Profile : <https://swfsc.noaa.gov/staff.aspx?id=5618>

PRESENT POSITION:

2002-present, Research Fishery Biologist (ZP-III), NMFS, Southwest Fisheries Science Center.
Perform research on the ecology of leatherback turtles, primarily at U.S. west coast foraging grounds and at western Pacific nesting beaches. Includes the design and implementation of research projects; extensive field work conducting aerial surveys, satellite telemetry studies, and nesting beach monitoring; training western Pacific collaborators; quantitative analyses of data and synthesis to meet management objectives; and publication of results in peer-reviewed journals, technical reports and at international conferences.

DISCIPLINE:

Applied Marine Ecology

EDUCATION:

- 2002 M. S. in Marine Science, Moss Landing Marine Laboratories, San Jose State University.
Thesis Title: " Ecosystem Studies of Marine Mammals and Seabirds in Monterey Bay, CA, 1996-99"
- 1981 B. A. in Journalism, San Diego State University.

PROFESSIONAL AFFILIATIONS:

- Research Affiliate, Moss Landing Marine Laboratories, California State Universities
- Co-investigator, Tagging of Pacific Pelagics Project (Sea Turtle Group)
- Member, International Sea Turtle Society
- Co-investigator, California Whale Rescue

Biographical Sketch for **Newell (Toby) Garfield**

Director, Environmental Research Division
NOAA/NMFS/SWFSC
8901 La Jolla Shores Rd
La Jolla, CA, 82037
toby.garfield@noaa.gov

Professional Preparation:

William College	Geology	B.A., 1973
University of Delaware	Marine Science	M.S., 1977
University of Rhode Island	Physical Oceanography	Ph.D., 1990

Appointments:

10.13-present	Director, Environmental Research Division, NOAA/NMFS/SWFSC, La Jolla, CA
8.98-10.13	Professor of Geosciences (Oceanography), SFSU, San Francisco, CA
6.06-10.13	Director, Romberg Tiburon Center, SFSU, San Francisco, CA
8.89-8.98	Research Assistant Professor, Naval Postgraduate School, Monterey, CA
9.83-9.89	Grad. Res. Assist., Graduate School of Oceanography, URI
7.76-9.83	Res. Associate, Bigelow Laboratory for Ocean Sciences, W. Boothbay Harbor, ME

Relevant Publications (student co-authors have “*”)

Maxwell Hubbard*, Donald Barrick, Newell Garfield, Jim Pettigrew, Carter Ohlmann, and Matthew Gough, (2013), A new method for estimating high-frequency radar error using data from Central San Francisco Bay. *Ocean Science Journal* 48 (1): 105-116. <http://dx.doi.org/10.1007/s12601-013-0009-y>,

Gough*, M. K., N. Garfield, and E. McPhee-Shaw (2010), An analysis of HF radar measured surface currents to determine tidal, wind-forced, and seasonal circulation in the Gulf of the Farallones, California, United States, *J. Geophys. Res.*, 115, C04019, doi:10.1029/2009JC005644.

Long, R.M., D. Barrick, J.L. Largier and N. Garfield, (2011), Wave Observations from Central California: SeaSonde Systems and In Situ Wave Buoys, *Journal of Sensors*, vol. 2011, Article ID 728936, 18 pages. doi:10.1155/2011/728936.

Young, Sung Y., Eric J. Terrill, Bruce D. Cornuelle, Burt Jones, Libe Washburn, Mark A. Moline, Jeffrey D. Paduan, Newell Garfield, John L. Largier, Greg Crawford, and P. Michael Kosro, 2011, Mapping the U.S. West Coast surface circulation: A multi-year analysis of high-frequency radar observations, *J. geophys. Res.*, **116** C03011, doi:10.1029/2010JC006669.

Belinda Lipa, Donald Barrick, Sei-Ichi Saitoh, Yoichi Ishikawa, Toshiuki Awaji, John Largier, Newell Garfield, 2011, Japan Tsunami Current Flows Observed by HF Radars on Two Continents. *Remote Sens.* **3**(8): 1663-1679.

Synergistic Activities:

Co-lead, California Current Integrated Ecosystem Assessment (CCIEA), with Chris Harvey, NWFSC (2014-present). The CCIEA is providing integrated ecosystem indices and evaluating environmental pressures and risks associated with fishery management issues.

The NOAA Southwest Fisheries Science Center's Environmental Research Division (ERD) consists of two groups: the Climate & Ecosystems Program and the Data Integration & Analysis Program. The Climate & Ecosystems Program focuses on environmental research pertinent to fishery science and meeting the Center's mandates. The Data Integration & Analysis Program assists with these studies and provides efficient and powerful web access to hundreds of marine related data sets. The West Coast Node of the CoastWatch program, NOAA's satellite data serving web presence, is directly integrated into the Division and works closely with both Programs.

Dr. Cara Wilson

EDUCATION

Ph.D., 1997, Oceanography, College of Oceanic and Atmospheric Sciences (COAS), Oregon State University (OSU). “Hydrography and heat flux in hydrothermal areas”, advisor: Gary P. Klinkhammer.
B.Sc. (cum laude), 1989, Ocean. & Atmos. Sciences, College of Engineering, University of Michigan, Ann Arbor.

PROFESSIONAL EXPERIENCE

Sept. 2002 – present, Research Oceanographer, NOAA (National Oceanic and Atmospheric Administration)/NMFS (National Marine Fisheries Service)/SWFSC (Southwest Fisheries Science Center) ERD (Environmental Research Division)
Dec. 1999 – Aug 2002, Postdoctoral Fellow, NASA/Goddard

PUBLICATIONS

Last three years

Wilson, C, A. V. Sastre, M. Hoffmeyer, V. J. Rowntree, S. Fire, N.H. Santinelli, S.D. Ovejero, V. D’Agostino, C.F. Marón, G. Doucette, M.H. Broadwater, Z. Wang, N. Montoya, M.M. Uhart (2016) Southern right whale (*Eubalaena australis*) calf mortality at Península Valdés, Argentina: Are harmful algal blooms to blame? Marine Mammal Science, doi:10.1111/mms.12263
Villareal, T.A. and C. Wilson (2014). A comparison of the Pac-X trans-Pacific Wave Glider data and satellite data (MODIS, Aquarius, TRMM and VIIRS), PlosOne, 9(3) e92280. doi:10.1371/journal.pone.0092280.
Fernandez, D. and C. Wilson (2013), User Engagement and Requirements, Chapter 3 in U.S. Integrated Ocean Observing System (IOOS) 2012 Summit Report.
Wilson, C., T.A. Villareal, L. Adornato, M. Brzezinski, and A. Shcherbina (2013). Chlorophyll dynamics associated with the Northern Subtropical Front, J. Geophys. Res., 118, doi:10.1029/2012JC008489

Five other relevant publications

Wilson, C (2011). The rocky road from research to operations for satellite ocean-colour data in fishery management. ICES J. Mar Sci, 68, doi:10.1093/icesjms/fsq168.
Yoder, J.A., S.C. Doney, D.A. Siegel, and C. Wilson (2010). Study of Marine Ecosystems and Biogeochemistry Now and in the Future. Oceanography, 23(4), 128-141.
Wilson, C. et al. (2009). Remote Sensing Applications to Fisheries Management in Remote Sensing in Fisheries and Aquaculture. pp 43-56, IOCCG report #8, Dartmouth, Canada.
Bundy, A. G. Borstad, J. Field, S. Groom, N. Hoepffner, C. Hu, V. Lutz, C. Wilson (2009). Building Links with the Fishing, Aquaculture and Management Communities Management in Remote Sensing in Fisheries and Aquaculture, pg 89-102, IOCCG report #8, Dartmouth, Canada.
Wilson, C., J. Morales, S. Nayak, I. Asanuma and G. Feldman (2008). Ocean Colour Radiometry and Fisheries in Why Ocean Colour? The Societal Benefits of Ocean-Colour Technology, pp 47-58, IOCCG report #7, Dartmouth, Canada.

Christina C. Fahy

Contact Information

Protected Resources Division
West Coast Regional Office
NOAA-National Marine Fisheries Service
501 W. Ocean Blvd.; Suite 4200
Long Beach, California 90802

office: (562) 980-4023
cell: (562) 537-9140
e-mail: Christina.Fahy@noaa.gov

Education

1995 M.M.A. Marine Affairs, University of Washington, Seattle, WA
1987 B.S. Fisheries Science and Technology, University of Rhode Island, Kingston, RI

Relevant Professional Appointments

National Marine Fisheries Service, Southwest Region, Long Beach, CA

2006-present Lead, Marine Mammal and Sea Turtle Program, Long Beach Branch
2004-present Sea Turtle Recovery Coordinator, U.S. West Coast
1998-2004 Marine Mammal Biologist

Anchor Environmental, Seattle, WA

1997-1998 Consulting Fish Biologist

Saltwater, Inc., Anchorage, AK /Washington Dept. of Fish and Wildlife, Seattle, WA

1994-1997 Fisheries Observer, Bering Sea/Aleutian Islands (groundfish trawl/pot, halibut/sablefish longline), Pacific Northwest (salmon gillnet/purse seine)

Relevant Publications/Presentations

Allen, C.D., G.E. Lemmons, T. Eguchi, R.A. LeRoux, **C.C. Fahy**, P.H. Dutton, S.H. Peckham, J.A. Seminoff. 2013. Stable isotope analysis reveals migratory origin of loggerhead turtles in the Southern California Bight. *Marine Ecology Progress Series*. Vol. 472: 275-285.

Helvey, M. and **C.C. Fahy**. 2012. U. S. fisheries management: A progressive model for sea turtle conservation. *In* Marine turtles of the Eastern Pacific: Conservation Challenges and Signs of Success. Seminoff, J.A. and B. Wallace (Eds.).

Fahy, C.C. 2011. Fisheries impacts on sea turtles in the Pacific. *In* Conservation of Pacific Sea Turtles. Dutton, P. H., D. Squires, and M. Ahmed (Eds.) University of Hawaii Press (2011).

Benson, S., H. Dewar, P. Dutton, **C. Fahy**, C. Heberer, D. Squires, and S. Stohs. 2009. Swordfish and leatherback use of temperate habitat (SLUTH). Administrative Report. LJ-09-06



UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Southwest Fisheries Science Center
8901 La Jolla Shores Dr.
La Jolla, CA 92037

11 April 2016

Derek Orner
NOAA/NMFS
Office of Sustainable Fisheries
1315 East-West Highway
Silver Spring, MD 20910Dear Dr. Wallace:

Dear Mr. Orner,

This letter is to convey my program's support for the proposal submitted by Principal Investigator Dr. Helen Bailey (University of Maryland) entitled **El Niño Watch revised - An improved index for reducing Loggerhead Turtle bycatch in the California Current** to be considered under NOAA's Bycatch Reduction Engineering Program. I am a NOAA Partner on this project and the current permit holder for the field component of the research outlined in this proposal.

Our current NMFS Permit is #14097 and is listed as "NMFS Southwest Fisheries Science Center Pinniped, Cetacean, and Sea Turtle Studies." This permit will be replaced in a few months with an updated permit (NOAA Permit #19091). The Marine Turtle Ecology & Assessment Program at the NOAA-Southwest Fisheries Science Center has been involved in sea turtle research and conservation in the waters off the U.S. West Coast for nearly two decades and has conducted field research on loggerhead sea turtles in the area since 2011. We continue to conduct aerial surveys, in-water capture, and satellite telemetry of loggerhead sea turtles (*Caretta caretta*) and look forward to supporting this BREP proposal to the fullest extent possible.

Please contact me at Jeffrey.Seminoff@noaa.gov for any additional information. We look forward to working on this project and interacting with all the project partners.

Kind regards,

Jeffrey A. Seminoff, Ph.D.
Leader, Marine Turtle Ecology and Assessment Program
Southwest Fisheries Science Center, La Jolla, California





UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
501 West Ocean Boulevard, Suite 4200
Long Beach, California 90802-4213

April 12, 2016

Derek Orner
NOAA/NMFS
Office of Sustainable Fisheries
1315 East-West Highway
Silver Spring, Maryland 20910

Dear Mr. Orner:

I am writing in support of the proposal, "El Niño Watch revisited – an improved index for reducing loggerhead turtle bycatch in the California Current," proposed to the NOAA's National Marine Fisheries Service's (NMFS) Bycatch Reduction Engineering Program (BREP). This project has great potential to enhance fisheries sustainability in California through contributing to measures to reduce the bycatch of North Pacific loggerhead sea turtles (*Caretta caretta*), a species listed as endangered under the Endangered Species Act.

The Assistant Administrator for NMFS Protected Resources Division at the West Coast Regional Office has determined that a thorough re-examination of the loggerhead time-area closure is a top priority. At present, NMFS is legally required to close a 25,000-square-mile area (the Pacific Loggerhead Conservation Area) to all fisheries activity during June – August in an El Niño year. This coarse-scale, broad-brush approach is pre-cautionary based on the scant information that was available at the time of its development in 2000, but is leading to fisheries closures that may detrimentally affect the economic viability of California's valuable fisheries. Moreover, this rule is based on oceanographic conditions in the Eastern Tropical Pacific, not the Southern California Bight, in which the closures take effect.

Improved indicators of loggerhead turtle presence in the Southern California Bight are essential to determine bycatch risk. This project seeks to develop an improved, spatially- and temporally-explicit indicator of loggerhead turtle presence, based on satellite remote sensing of actual oceanographic conditions in the Southern California Bight, available in near real-time. This will enable fishers to maximize catch of target species while minimizing bycatch of protected species, and so is an important step towards optimizing the ecological and economic sustainability of California's fisheries.

I provide my strong support for this innovative project.

Sincerely,

Christina C. Fahy
Fishery Biologist

