Tracking Great Shearwaters Leads Down Many Paths

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The great shearwater (GS) is a numerous, long-lived species of seabird that breeds in the South Atlantic's remote Tristan da Cunha Island group and spends the austral winter foraging throughout the western North Atlantic, including the Gulf of Maine (see figure). While the general annual migration pattern of the birds is well known, little fine-scale information exists relative to habitat use and interaction with human activities. This is a management concern for the U.S. Fish & Wildlife Service and U.S. National Marine Fisheries Service, since GS are subject to high levels of bycatch in commercial fisheries, at least in the northern parts of its range.

Great shearwater. Photo by Rob MacDonald

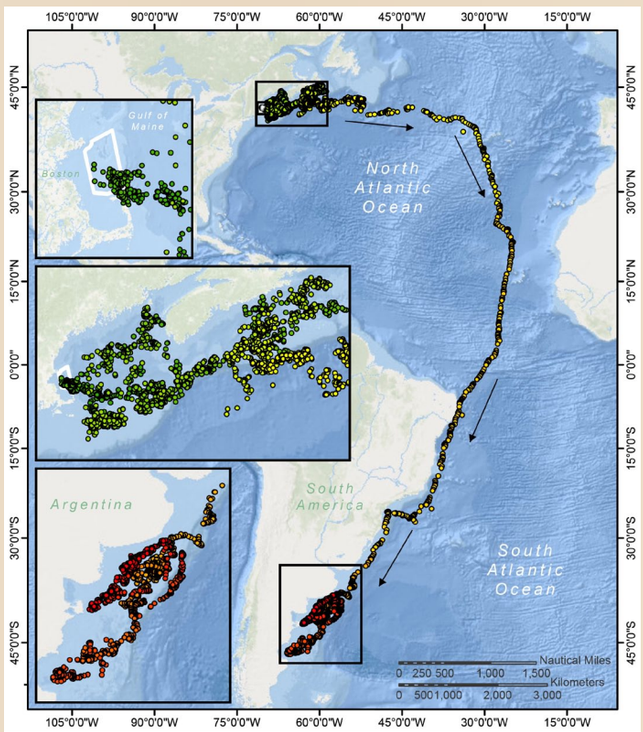
The U.S. National Oceanic and Atmospheric Administration's Stellwagen Bank National Marine Sanctuary is a 2181 km^2 marine protected area located in the southern Gulf of Maine (see figure; top insert, white polygon). Ecosystem-based management of the sanctuary requires extensive knowledge about species using the sanctuary, how those species fit into the Gulf of Maine ecosystem, and potential interactions with human uses such as commercial fishing. Complete ecosystem-based management also requires an understanding of habitat use and threats occurring away from the sanctuary, such as GS activity throughout the Northern and Southern Hemispheres.

While GS are seasonally abundant in the sanctuary, little information exists relative to habitat use and threats. Since 2012, each July we have been attaching 12g solar-powered PTT tags to 10 GS (n=50 tags) and tracking their movements in the sanctuary, Gulf of Maine, and beyond (see figure; top, middle, and bottom inserts). Because our goal is identifying fine-scale habitat use rather than migratory paths, we chose not to duty cycle our tags, but allow them to constantly transmit locations. As a result, we have been receiving ~18 locations per day and applying those data to understand GS habitat use (Powers et al., Marine Ecology Progress Series, In Press). However, as location data began flowing, so did ideas as to their interpretation and how we could combine the locations with other data to truly understand GS. What are they doing in the Stellwagen Sanctuary? Combining GS location data with our ongoing research into the abundance and distribution of sand lance (a key forage fish) suggests that GS only use the sanctuary when and where sand lance are abundant, such as the southern part of the sanctuary in 2016 (see figure; top insert). To further investigate food habits, we are collaborating with Les Kaufman (Boston University) and Kent Hatch (Long Island University Post) for stable isotope analysis of exhaled gas, blood, and feather samples from captured birds. Understanding the importance of sand lance to GS and other seabirds is significant since there is no management or protection for these forage fish in the Gulf of Maine.

Since GS are a species of high bycatch concern, we collaborated with Josh Hatch and Kimberly Murray (U.S. National Marine Fisheries Service) to search for areas of interaction. Combining GS locations with gillnet activity and fishery observer data, we were able to identify a small area constituting only 1% of the Gulf of Maine that accounted for 50% of observed GS bycatch (Hatch et al., 2015; Conservation Letters), along with identifying the ports of interacting fishing vessels. What about bycatch in other areas? Our birds, which are primarily juveniles and subadults, spend the November–March period on the Patagonia Shelf (see figure; bottom insert). Global Fishing Watch (*http://globalfishingwatch.org*) indicates high levels of fishing activity co-occurs with GS in that area, which could expose them to substantial bycatch risk.

Can highly mobile, satellite-tracked seabirds provide indications of bycatch in other species? Dynamic ocean management is an emerging paradigm that uses near real-time data for management decisions. We are collaborating with Jooke Robbins (Center for Coastal Studies; humpback whales) and Moria Brown (New England Aquarium; right whales) to investigate the ability of GS locations to predict the presence/absence of these species, each of which suffers from entanglement in commercial fisheries. If a correlation exists, tagged GS could remotely and inexpensively identify offshore whale aggregations in need of short-term management.

Our decision not to duty cycle our tags has also led to other emerging research opportunities. Whereas duty-cycled satellite-tagged birds provide only a few locations per day, our higher-resolution data provide an unusual opportunity to investigate bird navigation relative to large-scale influences (e.g., magnetism) and short-term occurrences (e.g., shifting wind and storms). Incredibly, some of our birds wearing continuously transmitting tags have traveled the entire migration route, the longest remaining active for over 300 days (see figure).



A 267-day satellite track of GS "Everglades" from 2016 showing use of southern portion of the Stellwagen Bank National Marine Sanctuary (white polygon), top insert; use of the Gulf of Maine and Scotian Shelf, middle insert; and use of the Patagonia Shelf, bottom insert. Map by Mike Thompson, SBNMS

Long-term data sets such as ours (five years and hopefully continuing) will become increasingly important as we attempt to understand the impacts of climate change at local and global scales. Our focal study area in the Gulf of Maine is experiencing one of the marine world's most rapid increases in temperature. Our data set that includes movement, food habits, and bird condition (e.g., body weight and measurements) will allow us to use GS as a barometer for the entire system. Additionally, since GS travel between hemispheres and are highly dependent on winds for travel, our birds can be used as a large-scale indicator of environmental change and how species react.

Anyone interested in following our birds can find them at *http://stellwagen.noaa.gov/seabirds.html*. Starting in 2017, our birds will have their own Twitter account: @Trackseabirds