



Maine Coastal Islands National Wildlife Refuge

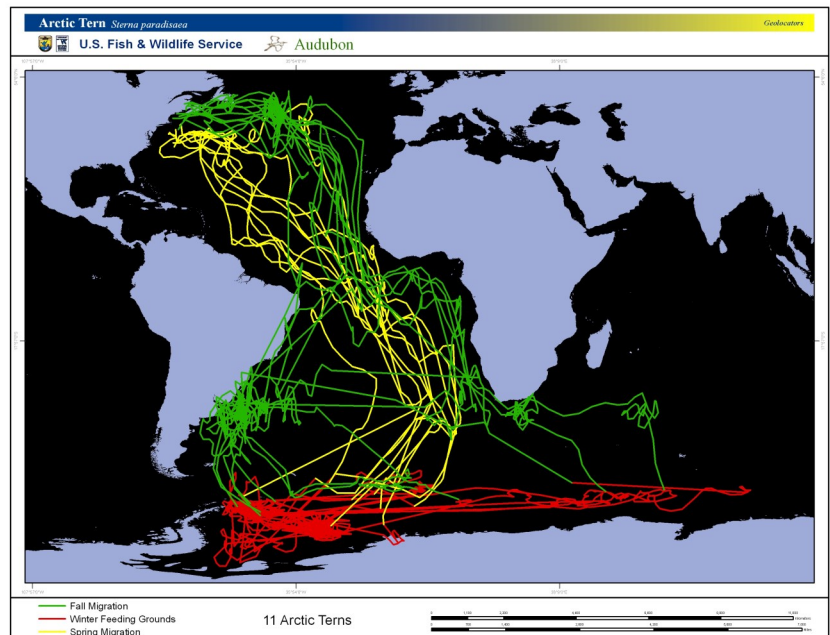
Biological Highlights: 2008-2012

Arctic Tern Geocator Project

Seabird biologists at Maine Coastal Islands National Wildlife Refuge Complex (MCINWR) have longed for opportunities to track Arctic tern migration to better understand how to protect the terns when they make their annual migration between breeding colonies in Maine and their wintering grounds in the Southern Hemisphere. Due to their small size, Arctic terns cannot carry heavy tracking devices. But now, "geolocators" that weigh just 1.6 grams are available. Geolocators determine the location of a bird based on the length of daylight and the time of sunrise and sunset. Researchers in Greenland recently used geolocators and documented Arctic terns fly more than 40,000 miles during migration. In 2010, USFWS Migratory Birds Program provided 30 geolocators to MCINWR and National Audubon Society for deployment on Arctic terns breeding in Maine. In June, researchers trapped incubating Arctic terns on Metinic Island and Eastern Egg Rock and equipped them with geolocators. Biologists attached these small, lightweight devices, to a band on the terns' leg. In 2011, biologists recaptured the terns, when they returned to the breeding colonies. This allowed us to retrieve the units and recover the data stored on the geolocators. We were able to recover 11 units in 2011 and two additional units in 2012 (containing two years of data!). These terns traveled an average of 59,400km in one year.

MCINWR supports 98% of the Arctic terns nesting in the lower 48 states

Annual Migration Pathway of Arctic Terns Breeding in Maine



All birds were tagged on breeding colonies in Maine. Green lines represent FALL migration, red lines represent WINTERING grounds, and yellow lines represent SPRING migration. This research confirmed that Arctic terns have the longest annual migration of any wildlife species (59,400km/yr). This is an amazing feat for a bird that can live more than 30 years.

	Fall	Winter	Spring
Average Distance Traveled	29,849 (19,219-42,038)	13,642 (9,834-17,455)	16,770 (13,734-19,124)
Average Length of Travel	92 days (33-128)	152 days (132-218)	30 days (24-39)
Average Distance Traveled / Day	323 km	89 km	552 km

Tracking Great Shearwater habitat use in the Gulf of Maine, and beyond...

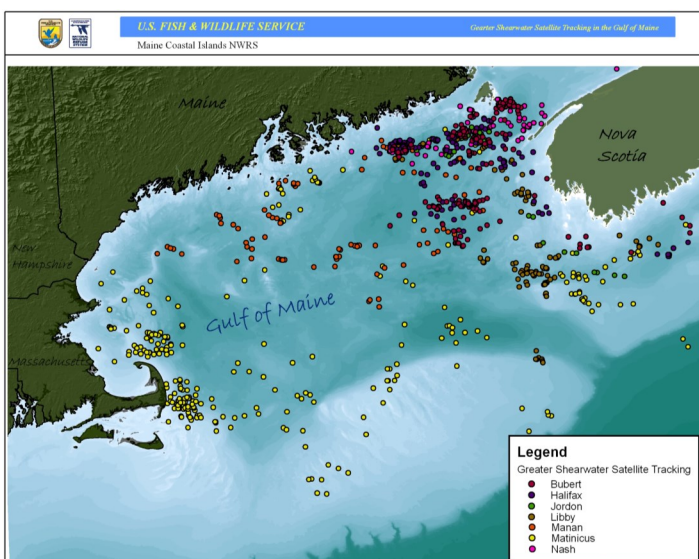


Great shearwater with satellite transmitter

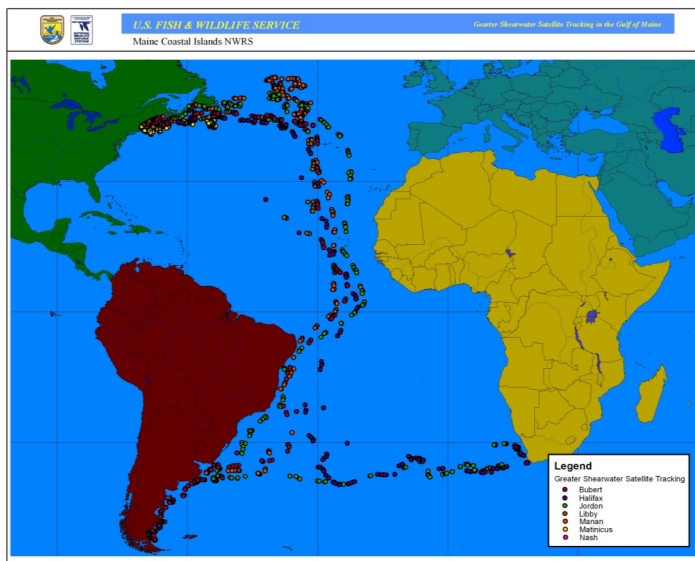
Shearwater Facts:

- Breed on Tristan da Cunha Island group, remote islands halfway between South America and South Africa
- While still abundant, the location of the entire world's population on a single island group makes these birds susceptible to environmental changes.
- Great shearwater are considered a focal species in the Mid-Atlantic New England Maritime (MANEM) Plan, and are listed as species of greatest conservation concern
- They spend their wintering / staging period foraging in the productive waters of the Gulf of Maine, George's and Grand Banks, Bay of Fundy, Greenland and Europe

Maine Coastal Islands NWR deployed 20 SirTrack Kiwisat satellite transmitters on great shearwaters in the Gulf of Maine from 2010 and 2012. We have partnered with researchers in Canada to tag a total of 75 shearwaters during the past 5 years. A PhD student at UMASS is analyzing the data and looking for correlations with primary productivity, sea surface temperature and bathymetry. The US Fish and Wildlife Service will utilize this information to predict the potential effects of climate change on pelagic seabirds and during offshore wind energy development consultations. While shearwaters are non-breeding visitors to the Gulf of Maine, their behavior and movements likely represent foraging hotspots and migratory pathways used by seabirds that breed in Maine (i.e. Atlantic puffins and razorbills). Great shearwaters are one of the few seabirds in this region large enough to carry a satellite transmitter. This shearwater data has documented repeated use of specific upwellings and the dynamic nature of pelagic seabirds in the Gulf of Maine. We now know shearwater residency time in the Gulf of Maine; some shearwaters remained in the Gulf of Maine long after others had returned to their breeding grounds in the South Atlantic. On average, shearwaters are traveling 1,800km within the Gulf of Maine and have an annual migration of more than 44,000km.



Locations of 7 shearwater throughout the Gulf of Maine



Migration pathway of shearwaters between Gulf of Maine and breeding colonies in South Atlantic

Atlantic Puffin Diving Behavior Study



Atlantic puffin—MCINWR supports 90% of the Atlantic puffins nesting in the US

In 2008, MCINWR biologists worked to secure funding to support a former seabird island technician and STEP student to conduct research on Atlantic puffins nesting on the Refuge. The student conducted her thesis work on the foraging ecology of Atlantic puffins breeding on Petit Manan Island in 2008-2010. This project was a collaborative effort between the US Fish and Wildlife Service, the UMass Amherst Department of Environmental Conservation, and the USGS Massachusetts Cooperative Fish and Wildlife Research Unit. Temperature Depth Recorders (TDR) were attached to metal leg bands using gorilla tape, and birds were recaptured within a week or two after TDR deployment. The data collected on these units was used to characterize diving activities of breeding puffins. This data will also help identify potential foraging habitat using TDR data and oceanographic conditions.

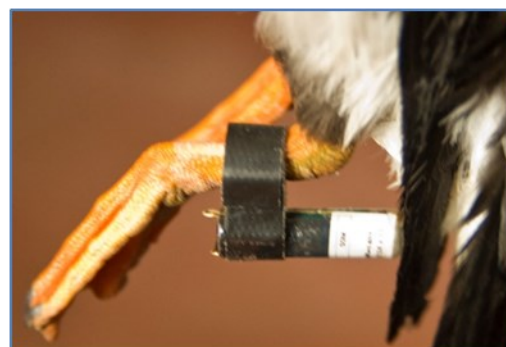
Puffin Sex Determination

Another part of the research involved developing a predictive model for identifying sex of breeding puffins on Petit Manan Island using morphometrics (body measurements). We found puffin sex was best predicted by culmen length and bill depth. For example, male puffins typically have larger bill measurements than females.

	Dives per day	Dives per bout	Maximum depth (m)	Dive depth (m)	Dive duration (s)	Proportion of time spent diving (%)
Mean	276	8.9	27.9	9.9	49	13.5
Range	131-430	5.1-18.7	18-40.7	3-40.7	43-56	5.4-23.7

SUMMARY:

- Puffins made nearly 60% of dives between 4:00-8:00AM and 4:00-8:00PM and averaged 276 dives per day.
- Puffins foraged within 25 km of the colony during 2009.
- There was no effect of the TDR on adult body mass or chick success.
- Peak diving activity was in the morning and evening, which suggests puffins are taking advantage of diurnal vertical migrations of fish such as juvenile Atlantic herring.
- Most dives were < 15 m and lasted less than one minute.
- Females performed more bouts and made more midday dives.
- Males made more deep dives.
- Puffins are not regularly diving to the depths they are capable of
- We are able to identify discrete foraging locations of some puffins.



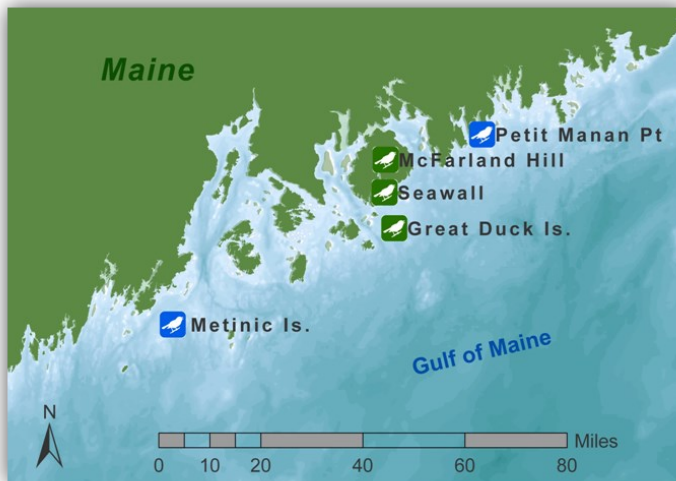
Atlantic puffin with temperature depth recorder

Passerine Migration Monitoring

In 2010, partners came together to form a Northeast Regional Migration Monitoring Network. The Network's first project was to document passerine migration across the landscape. This information is critical to help inform land management decisions, predict the impacts of climate change, and inform offshore wind energy development. Using standardized protocols, the Refuge, the University of Maine, Acadia University in Nova Scotia, and the National Park Service operated 5 migration monitoring stations in 2010 and 2011 and 4 stations in 2012. In addition to mist netting, crews conducted visual surveys, collected habitat data, and recorded birds acoustically at night.



This dataset is the first of its kind for the region. We will be able to start characterizing food availability and habitats used by migrants as well as broad-scale migration patterns and movements made by individuals. The Refuge has contributed mist-netting data to Network partners collected at Seal Island from 2007-2009 and 3 Refuge island 2009. The Refuge's Metinic Island (2009-2011) and Petit Manan Point (2010-2012) collected 3 successive years of migration data, as well as multiple acoustic recording sites each year.

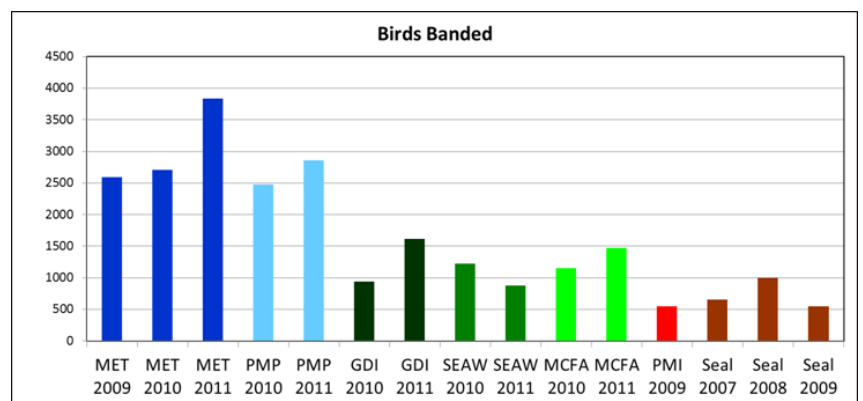


2010–2011 Monitoring Stations

Stable isotope analysis of feathers collected from

passerines on Metinic Island documented that birds migrating through Maine breed across nearly every Canadian province. Using nanotags and radar, Acadia University documented northern waterthrush and red-eyed vireos use the coast of Maine during migration, rather than crossing the Gulf of Maine from Nova Scotia. We have collectively banded nearly 30,000 birds over the last 6 years during fall migration, representing 130 species. Over 80% of passerines banded in the Gulf of Maine during the fall were hatch year birds making their first migration. The most common species captured at all sites are yellow-rumped warbler, golden crowned kinglet, red-eyed vireo, dark-eyed junco, common yellowthroat, white-throated sparrow.

Net Hours	39,152
# Banded Birds	24,521
Birds/Net Hour	0.63
# Species	130

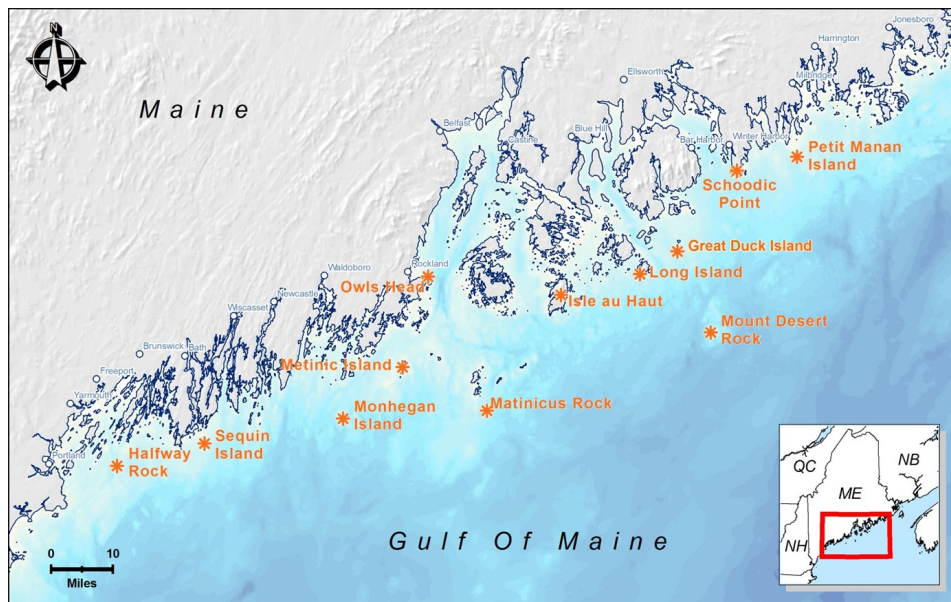


Bat Migration Monitoring

White nosed syndrome, a disease caused by the *Geomyces destructans* fungus, has killed more than 5.5 million bats in the Northeast and Canada since 2006, threatening our once most common species with extinction. Baseline population data collected before white-nosed syndrome affects an area are invaluable for documenting the spread and impact of the disease. White-nosed syndrome was recently confirmed in Maine and New Brunswick, Canada the spring of 2011. Although no caves or bunkers for bat hibernacula are found on Maine Coastal Islands NWR, the Refuge may support an abundance of solitary tree-roosting bats during the summer and bats from other regions during spring and fall migration.

In 2009, the Refuge partnered with Stantec Consulting to collect baseline data on bat migration, focusing on offshore Refuge islands where little information had been previously been gathered. Stantec acoustic units collected bat migration data at 12 sites in 2009 and 2012, including 3 Refuge islands (Petit Manan, Metinic, and Matinicus Rock). Maine Coastal Islands NWR deployed 4 units at various mainland properties from 2011-2012 (Petit Manan Point and Cross Island and private properties in Cherryfield, Thomaston, and Falmouth). Our studies documented a significant number of bats migrating over coastal islands, much farther from the mainland than expected (>20miles).

	2009	2010
Geographic Area	~125 miles	~170 miles
Number of Survey Locations	13	9
Number of Detectors	19	18
Distance From Shore	0 - 26 miles	0 -26 miles
Survey Period	July 28 through Nov 30	July 13 through Nov 30**
Survey Effort	1368 detector nights	923 detector nights**
Results	36001 bat call sequences	50267 bat call sequences**



Species Composition

In 2011, many more bat echolocation sequences were recorded at Petit Manan Point (10,422) than at our Cherryfield, Falmouth, and Thomaston sites (range of 100-566 sequences). Bats were most active the first few hours after sunset. Bat activity was positively correlated with air temperature and negatively correlated with wind speed at all sites except for Petit Manan. The 2011 results indicate Petit Manan may be located on a significant bat migration corridor, especially for *Myotis* species (nearly 7,000 sequences). Overall, *Myotis* species calls were the most commonly recorded call sequence in 2011 and represented 63 percent (n=7,235) of calls recorded by all four mainland detectors combined, followed by high-frequency unknown calls (28%, n=3,245), and calls from the red bat/tri-colored bat guild (6%, n=731).

Using Nanotags to Document Seabird Foraging Behavior

In recent years, many of the seabirds breeding on islands in Maine have been unable to locate forage fish to feed their chicks. This decline in prey availability has resulted in a 50-70% reduction in tern productivity rates. Managers are concerned that climate change and off-shore energy development may influence the abundance, distribution, and accessibility of forage fish. We hope that by documenting the location and habitat characteristics of productive seabird foraging habitat we may be able to manage and protect seabird colonies in the future.

Objectives:

Try to identify foraging areas utilized by seabirds breeding on Petit Manan Island

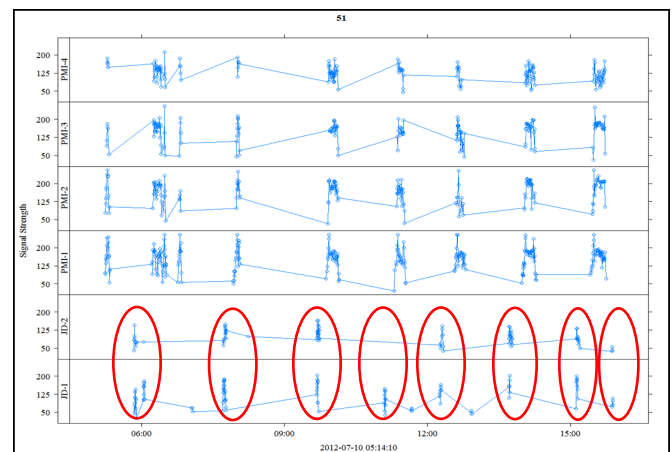
- Document daily activity patterns
- Document the number of foraging trips/day and duration of foraging trips
- Document differences in colony attendance and foraging behavior between incubation and chick rearing

Methods:

As part of a pilot project to test this technology, we tagged 21 incubating seabirds (Arctic and common terns and black guillemots) with 1.25 gm nanotags on Petit Manan Island (PMI). We established automated receiving stations on PMI, and two nearby islands: Jordan's Delight and Stanley Ledge. Nanotags are coded radio tags that allow you to automatically track hundreds of birds at one time, have much longer battery life than traditional radio tags (5 months), and allow for 24 hour monitoring of the tagged individuals.



Data for Common Tern Foraging Trips (10 hrs)



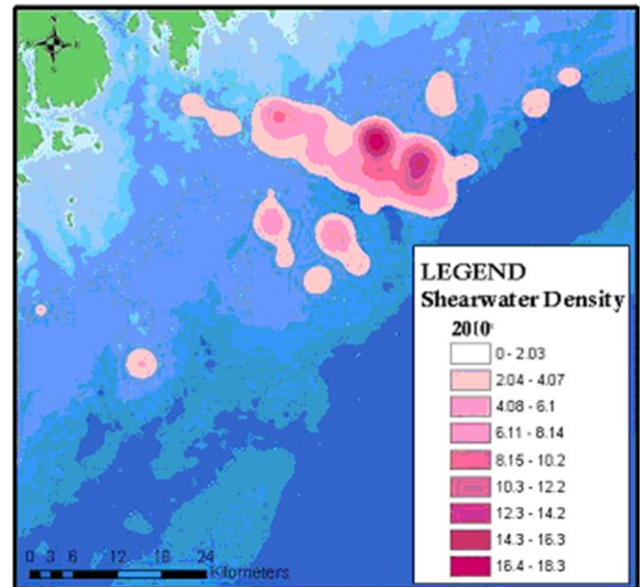
Data from the automated receivers on PMI indicates that common tern (#51) made 8 foraging trips (red circles) to the Jordan's Delight region in a 10 hour period. This bird was feeding two 4-5 day old chicks. Based on average flight speeds, the bird may have traveled an average of 40km on each foraging trip.

Results:

- Nanotags are an effective tool to document seabird foraging behavior and colony attendance rates
- Average flight time of common tern foraging trips was 83 min (48km /foraging trip)
- Arctic terns tended to fly offshore to forage (pelagic habitat), and had an average foraging time of 138 min (80km/trip).
- On average, terns made 7 foraging trips /day during chick rearing
- Estimated that common terns spent 9.5 hr/day foraging, while Arctic terns spent 14 hr/day foraging.
- Black guillemots exhibited 24 hour on / 24 hour off incubation pattern, but once chicks hatched they only visited the burrow one time per day for 2-3 hours each morning

Pelagic Bird Monitoring Effort

The last comprehensive pelagic bird survey in the Gulf of Maine occurred in the late 1970's , and with the growing interest in offshore energy development MCINWR needed to gather current information on the distribution and abundance of pelagic seabirds. We partnered with a commercial tourboat operator that made daily trips to a MCINWR managed seabird colony before heading out to a highly productive offshore feeding area for whales and seabirds. This allowed us to gather data on a daily basis for a small fraction of the coast typically associated with pelagic surveys.



Density map for Shearwaters in 2010

Project Objectives:

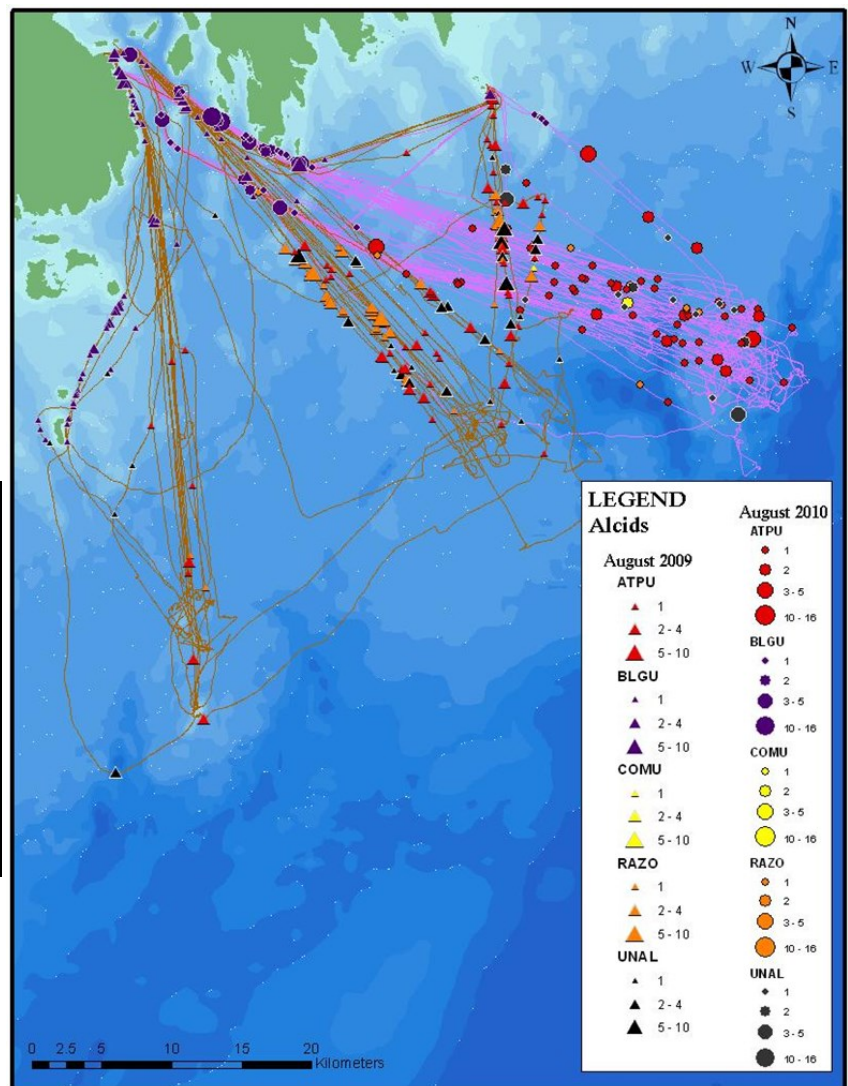
- Document abundance and diversity of pelagic seabirds (surveys covered 600 – 1400 km²)
- Identify significant foraging areas for seabirds nesting on Petit Manan Island,
- Develop standardized techniques for combining ecotourism operations with pelagic surveys

Results:

- Over 108,000 individuals were recorded
- Completed 10,000 km of transects in two years
- 59 species of birds and 7 species of whales were observed

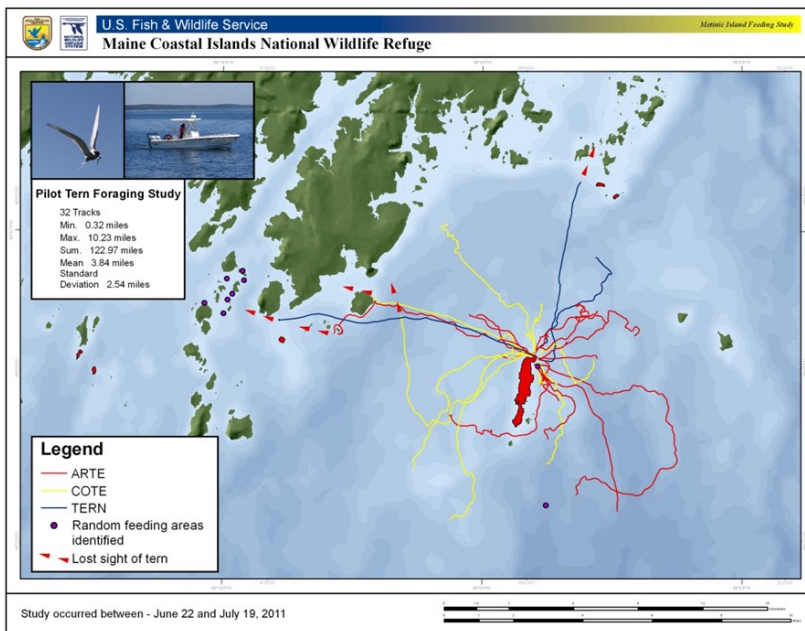
Species	birds/km 2009	birds/km 2010
Guillemot	0.3	0.31
Puffin	0.24	0.19
Razorbill	0.18	0.07
Murre	0.02	0.01

This figure demonstrates survey track lines and shows where alcids (puffins, razorbills, murre, & guillemots) were observed during 2009 and 2010



Using More Traditional Methods to Document Foraging Behavior....

MCINWR needs information on the foraging behavior (flight direction, duration of flights, location of foraging habitat, and characteristics of foraging habitat) for 7 of the seabird colonies we manage along the coast of Maine. We don't have the resources to use satellite or nanotags on all the colonies, so we must try to generate this information with more traditional "low tech" approaches.



Boat Based Tracking of Foraging Seabirds

Refuge staff manually tracked seabirds as they departed the breeding colonies and searched for food. Staff recorded the location of foraging areas, associated water depth, and any other species observed foraging with the terns. Surveys were conducted near Matinicus Rock, Seal and Metinic Islands.

Petit Manan Island Seabird Foraging Observations

Use Ground Based Observations to Document Patterns of Seabird Foraging

Seasonal technicians conducted feeding watches to document the flight direction of foraging seabirds (leaving and returning) the managed colonies. Crews collected 3,103 records of 2,238 seabird foraging flights. We are currently analyzing the data, however the following chart indicates the direction of tern foraging flights recorded on Petit Manan Island. We have separated flights made during incubation and chick rearing portions of the breeding season, and the length of the line represents the number of birds that flew in that direction. The breeding colony represents the center of the plot.

