Tracking the Intercontinental Migrations of Small Falcons

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The Eurasian Hobby (*Falco subbuteo*) and the Amur Falcon (*Falco amurensis*) are small slim raptors and complete long-distance, trans-equatorial migrants. The Eurasian Hobby breeds across Europe and Asia. European birds apparently winter in central and southern Africa.Very little is known about Hobby migration. Only a small number of birds are observed at the well-known bottlenecks such as Gibraltar. A total of 5,720 Hobbies have been ringed in 10 European countries from 1909-1998 of which 203 (3.5%) were subsequently recovered. We know only of two ring recoveries from Africa south of the Sahara.

A prototype of the smallest satellite transmitter produced so far weighing just 5g (1.9% of the bird's body mass) was fitted for the first time to a raptor, an adult female Hobby on 8 August 2008 in Germany near Berlin and has successfully recorded two autumn and spring migrations, respectively. We could not detect any effect of the transmitter on the Hobbies' behaviour. This smallest and lightest satellite transmitter delivered astoundingly high numbers of good Argos Doppler fixes. The complete dataset comprised slightly over 2,000 positions, of which 49% were high-quality locations (class 1–3). There were less fixes in Europe (65 on average per month) than in Africa (80 per month), the lowest number being recorded in the Mediterranean region, which is explained by interference in this area. The percentage of high quality fixes in Europe (22%) was lower than in Africa. Signal transmission lasted for 21½ months.

The route fidelity was low in the first Hobby, but high with respect to the wintering area. All migration routes of this bird were to the west of the shortest and most direct line between breeding site and wintering area (see Fig. 1). The distance migrated from the breeding site, not including regional movement in Angola, to the southernmost point in Zimbabwe was 10,065 km in the first recorded migration. The highest flight speeds during migration were recorded in spring 2010 in Mali and Morocco with 1,243 km covered in two days (a daily average of 621 km). During migration from Morocco to the South of France (1,032 km in two days) the falcon also migrated at night when a fix was made over the Mediterranean in the vicinity of Gibraltar. Daily flight distances recorded were up to 481 km on individual migration days. Migration across the Sahara took some 4 to 4½ days on each occasion. During both wintering periods the falcon spent the majority of its time in the Angolan Miombo woodlands. In its wintering area the small falcon showed an eagerness for travel. In the wintering period from 16 October 2008 to 7 April 2009, the bird covered a total distance of at least 9,025 km between identified night roosts. In 2009 the bird spent half of the year in the wintering area, a third at the breeding site and the remaining 18% of the time on migration, some 65% in Africa and 35% in Europe.

Photo by Bernd Meyburg

An adult female Eurasian Hobby, the first raptor ever fitted with a 5g PTT, on 8 August 2008.

Twelve more Hobbies were fitted with these tiny 5g PTTs, eight in 2009 and four in 2010. Thus we were able to track the spring migration of several falcons in 2010 (see Fig. 1). Almost no similar records are available from any other small falcon species.

If one species can claim the title for undertaking the most arduous of all raptor migrations, it is the Amur Falcon. The principal breeding and wintering ranges in northeastern Asia and southern Africa are separated by both 70° of latitude and longitude. This species is believed to undertake the longest regular overwater passage of any raptor as it crosses the Indian Ocean between India and tropical East Africa in autumn. According to the literature this species is an "elliptical migrant", and its return route back to its breeding area is largely over land and to the north and west of its southbound route.

Photo by Bernd Meyburg

Adult female Amur Falcon, January 2010.

In a joint effort the World Working Group on Birds of Prey (WWGBP), Microwave Telemetry, Inc., BirdLife Northern Natal and the Migrating Kestrel Group of the Endangered Wildlife Trust in South Africa started a satellite tracking program to study the almost unknown migration routes and other aspects of the biology of this little known raptor species. Ten adult birds were fitted with 5g PTTs in Natal, South Africa. Five falcons were tracked up to their breeding grounds in north-eastern China on their 14,500 km trip. In one case, almost 6,000 km were covered non-stop in five days, indeed an extreme endurance migration.

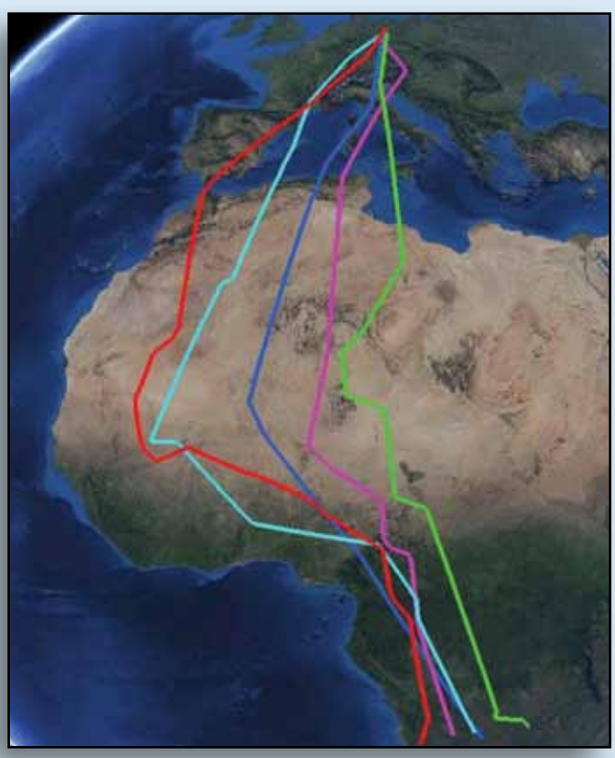

Fig. 1: The 2010 spring migration routes of five Eurasian Hobbies from their wintering grounds to their breeding area in Germany. The red line shows the track of the first bird marked in 2008.

5g PTTs Improve Tracking of the Burrowing Owl

By Geoff Holroyd and Helen Trefry - Environment Canada, Edmonton, Alberta, Canada
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Satellite telemetry provides a window into tracking the movements of birds and other species that was impossible when the author started his career. Bird banding as a teenager seemed like a dream; imagine, someone might find the bird with the band and tell us where it went. Fast forward 40 years and we get hourly locations with GPS accuracy on Peregrine Falcons that travel from Canada to South America.

Photo by Gordon Court

An adult male Burrowing Owl at the nest after delivering a deer mouse.

Since the late 1980's we have researched the movements of Burrowing Owls. Through the 1990's this species declined in Canada at the rate of 20% per year. By 2000 the population was only 5% of its numbers a decade earlier and was listed as Endangered. How can a species decline so quickly, what was causing such a rapid decline? We were lacking key information such as where do Burrowing Owls from the northern edge of their range in prairie Canada go for the winter?

Weighing only 150g, Burrowing Owls have been difficult to track. We have used leg bands, stable isotopes, geolocators, and VHF telemetry from small fixed wing aircraft to try to find their winter destinations. All these techniques have severe limitations and strong biases. Now, Microwave Telemetry has provided a better alternative due to the development of the new 5g PTT.

We trapped a female Burrowing Owl at her nest with young on June 24, 2010 and attached a 5g solar PTT using a Teflon harness. She stayed in the vicinity of her nest in southeastern Alberta until early July, when she began to make forays further from her nest site. On July 15, she began flying 5 km south, across the U.S. border in northern Montana but still returned to her nest. Starting August 3 she stayed at the Montana staging site two months in a vast area of cultivated fields adjacent to native prairie. One major advantage of these micro-PTTs over geolocators is that we get locations in near real time so we were able to visit her new roosting and foraging site. We found she was roosting in a fallow field with numerous scattered badger holes and feeding on thousands of grasshoppers within sight of the U.S. Homeland Security Border Patrol.

With shortening days and the sun dropping lower in the horizon, the PTT struggled to get signals to the Argos satellite. (Sensor data confirmed that the battery voltage was remaining low, potentially limiting the length of time the PTT could transmit.) On October 10 the owl was still in Montana. By October 21 she was in northeastern New Mexico, 1400 km from her Montana roost. Six days later she was 470 km south in the southeast corner of New Mexico just 17 km south of Carlsbad Caverns awaiting a favorable wind into Mexico. Her rate of travel was 110 km per night assuming she left Montana on October 10. A new message received from the PTT on November 10 yielded a Class 2 location placing this bird in Baja California, 1046 km from her last location in New Mexico. As this goes to press, the latest message on November 20 indicates a location in the same vicinity. The voltage readings continue to be low, which could be indicative of feathers over the solar array.

Photo by Geoff Holroyd

First Burrowing Owl ever to receive a 5g Microwave PTT.

This Burrowing Owl is following a new migration route previously not described. All the band recoveries from prairie Canada have followed the Great Plains. This bird has followed the foothills of the Rockies then headed west to a totally new location for Canadian Burrowing Owls. We eagerly await the next transmission and learning where she will spend the winter.

2010 Migration route of a female BUOW that nested in Alberta, Canada.

Big Returns from a Small Package: Tracking Kittlitz's Murrelet with the 5.5g Solar Powered PTT

John Piatt, Erica Madison, Mayumi Arimitsu, and David Douglas, USGS Alaska Science Center, Anchorage, Alaska and Michelle Kissling, U.S. Fish and Wildlife Service, Juneau, Alaska

Kittlitz's Murrelet (*Brachyramphus brevirostris*) is a small (220-260g) member of the Auk family of diving seabirds, and is one of the rarest and least-studied seabirds in the North Pacific. It is generally found in glaciated regions of Alaska and its natural history reflects adaptation to life in glacially influenced habitats. Populations appear to have declined during the past 20 years, and so the U.S. Fish and Wildlife Service (FWS) added Kittlitz's Murrelet to its roster of candidate species for listing under the Endangered Species Act. It is difficult to gather information on the biology of this species. Adults generally nest solitarily, inland within 30 km of the coast, and at high elevations (up to 2000 m). Kittlitz's Murrelets tend to forage in coastal fjords heavily influenced by glacial rivers. The winter range of the species is poorly known. There are occasional winter sightings in coastal and shelf waters of the northern Gulf of Alaska and Bering Sea. Lack of knowledge about the wintering grounds remains a critical data gap because we essentially have no information about factors influencing populations for 2/3rds of the year.

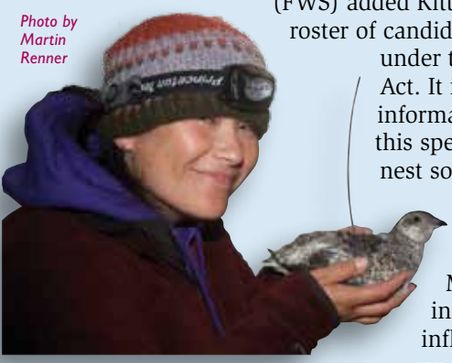
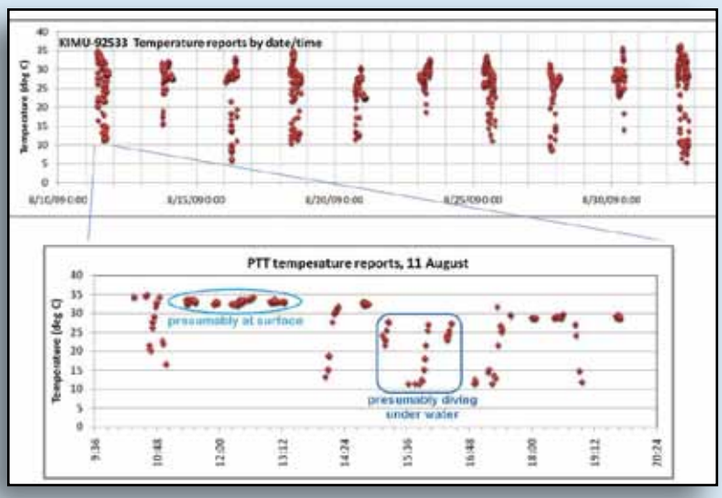


Photo by Martin Renner

Mayumi Arimitsu prepares to release a Kittlitz's Murrelet with a 5.5g PTT attached.

By late 2007, MTI had developed a 5.5g version of their solar-powered PTT. Fantastic! A unit small enough to be carried by a murrelet! In 2008, MTI sent us a prototype model to test on a Marbled Murrelet (*B. marmoratus*), a close relative to the Kittlitz's Murrelet. With the help of USDA Forest Service biologists Marty Raphael and Tom Bloxton in Washington, we captured a Marbled Murrelet in Puget Sound by stalking it at night from a small boat, and capturing it with a dip-net. We attached the PTT using a subcutaneous anchor and subsequent visual observations of this murrelet wearing the PTT provided confidence that it was not detrimental to the well-being of the bird.



Temperature data recorded by a 5.5g PTT attached to a Kittlitz's Murrelet. Upper graph shows averaged temperature reports on each satellite pass during each 10 hr reporting cycle (10 hr on/48 hr off). Bottom graph shows temperatures recorded on individual messages received on each satellite pass throughout one 10 hr cycle.

Following a few modifications in attachment design, we deployed 18 PTTs in 2009 and 2010 on Kittlitz's Murrelets in several locations with the help of colleagues Marc Romano (FWS), Ellen Lance (FWS) and Josh Adams (USGS). We tested a variety of attachment methods (single-prong and double-prong subcutaneous anchors; four-channel sutures). We

examined performance under different light and temperature regimes, and tested for submersion to depths to 40 m. In addition to reporting location, these PTTs also report temperature and battery voltage. Thus far the PTTs have performed well under the extreme conditions under which they must operate. For example, riding on the backs of murrelets, the PTTs routinely reach temperatures of 30-35° C, but may plummet to temperatures of < 5° C when birds dive in ice-filled seawater found in glacial fjords to depths of about 30 m (and pressure of 45 psi).

Post-breeding season (August-October) migration of two Kittlitz's Murrelets from the NE Gulf of Alaska about 1000 km westward to the Alaska Peninsula and Bering Sea.

Preliminary results from tagging have been exciting. For example, birds tagged during the breeding season in glacial fjords of the northeastern Gulf of Alaska (Icy Bay) and Prince William Sound migrated in late summer to the southwest corner of Cook Inlet, which is also strongly influenced by large glacial rivers that flow into the head of the inlet. From there they moved in a southwesterly direction along the coast of the Alaska Peninsula, apparently staging at selected bays, many of which have large glacial rivers that feed into them. Some of our tagged birds crossed over the Alaska Peninsula into the Bering Sea, where they may reside during winter. All of our tags stopped transmitting in early fall, presumably because they fell off during migration and molt. In the future, we plan on deploying PTTs from more locations including the Aleutians and Bering Sea, and we may try to catch birds after fall molt to gain further insights into winter migration patterns.

In addition to location data, we are obtaining interesting data on diving behavior. Kittlitz's Murrelets forage by "flying underwater" and capturing schooling fish. Temperature data collected during each reporting cycle (generally 10 hr on a 10/48 on/off cycle) revealed dramatic changes in temperature that we believe corresponds to when they are resting at the surface (warmer, steady temperatures) or diving (colder, variable temperatures). Kittlitz's Murrelets need to obtain more than half their body mass in prey every day, and the PTT temperature profiles are consistent with frequent diving activity. Presumed diving is highest during the day and virtually absent at night. We are beginning to contrast foraging activity patterns among birds, areas, and seasons to see how these factors may influence foraging behavior. It is possible that temperature data may provide a proxy for food availability, and enhance our understanding of how food supplies may affect choice of foraging habitat, migration routes, and breeding success.

Tracking Tiny Sea Turtles

Kate L. Mansfield, National Academies Research Associateship Program and Florida Atlantic University, Department of Biological Sciences, and Jeanette Wyneken, Florida Atlantic University, Department of Biological Sciences

Despite decades of research, very little is known about most sea turtle species from the time they emerge from their nests as hatchlings through the first years they spend at sea. Very few in-water movement and behavior data exist for these sea turtle "lost years". Understanding where these threatened and endangered species go, and identifying their nursery areas and habitat use is necessary for species conservation and management. However, historically, the small size, rapid growth and oceanic lifestyle of these young turtles made tracking their long-term in-water behavior and movements difficult, if not impossible. Available technology was not suitable for tracking oceanic-stage sea turtles; traditional sea turtle satellite tags are typically larger and heavier than these young animals.

Photo by J. Abernethy

Jeanette Wyneken (left), Kate Mansfield (right) and the rest of the team.

In 2007, we began a collaboration to address these glaring data and technology gaps. Our goals were to extend in-water observations of young oceanic-stage sea turtles to two months or longer and to develop the methods that would allow us to describe the early dispersal and habitat utilization of these turtles' "lost years". Initially, with the assistance of a Large Pelagics Research Center grant, this collaboration resulted in a fun few years of creative scientific problem solving.

Using slightly modified Microwave Telemetry PTT-100 9.5g solar powered bird tags we first lab-tested a variety of different tag attachment methods including harnesses and traditional epoxy attachments before settling on a flexible silicone-based attachment. Including a unique combination of wetsuit material, aquarium silicone, manicure acrylic, and glue used to attach hair extensions or toupees, we developed a novel approach to remotely track small loggerhead (*Caretta caretta*) sea turtles. Despite rapid growth of lab-reared turtles, the attachment method we developed resulted in tags remaining attached to the turtles in excess of two months before being cleanly shed from the turtles' shells. We also worked with Dr. Dan Rittschof of Duke University to test clear anti-foulants with the goal of protecting the tags' solar cells from biofouling while in a marine environment.

In 2009, this method was field-tested on 6-8 month old lab-reared neonate loggerheads released off southeast Florida, resulting in track durations of approximately two to three months (for example, Fig. 1). We expect to release an additional 10 tagged turtles in 2010 with track data posted publically online at www.seaturtle.org/tracking late November 2010. The data generated from this research represent the first successful long-term satellite tracks for any oceanic-stage sea turtle.

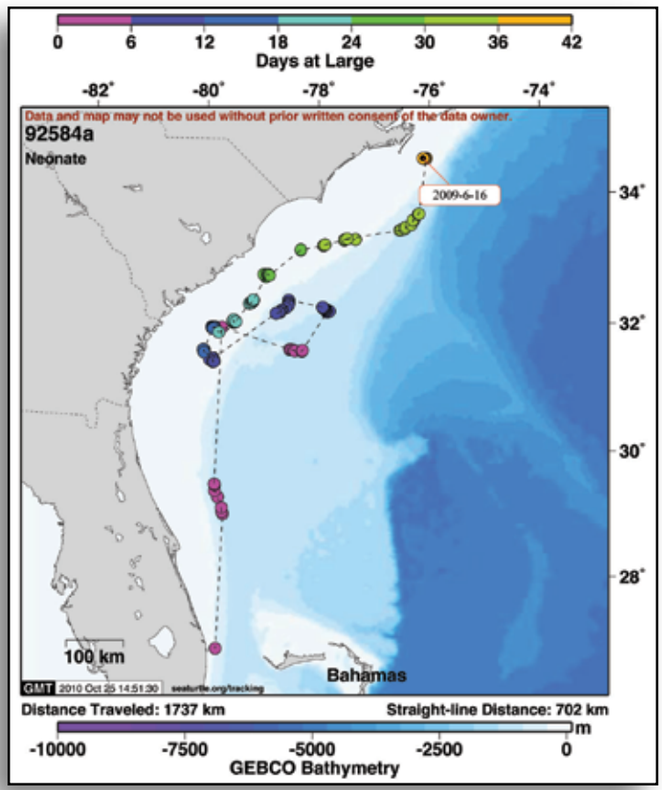


Fig. 1: Track of a lab-reared oceanic-stage loggerhead sea turtle released from southeast Florida in 2009.

Through 2011, we plan to lab-test the methods we developed for loggerheads on other sea turtle species and are continuing to work with Microwave Telemetry to develop and test different tag bases for a better fit on turtles' shells. Our preliminary track data have provided insight to how oceanic-stage loggerheads move through their environment and how they interact with large oceanographic features. We expect these results and our methods to be particularly valuable in addressing data gaps identified in sea turtle stock assessments, population models and management plans. This research will help identify how nearshore and offshore habitat is used by the early sea turtle age classes and should expand our understanding of sea turtle nursery areas and early dispersal patterns.

Photo by J. Abernethy

Loggerhead sea turtle in Gulf Stream.

Small Sharks - Deep Water: Understanding Behavior of Overexploited Sharks in The Bahamas

Edd Brooks (Program Manager, Shark Research and Conservation Program, Cape Eleuthera Institute) and Sean Williams (Field Manager for the Deep Water Shark Project, Cape Eleuthera Institute)

The Shark Research and Conservation Program at the Cape Eleuthera Institute in collaboration with Dr. Dean Grubbs of Florida State University, Dr. Demian Chapman of Stony Brook University, and Lucy Howey-Jordan of Microwave Telemetry, Inc. initiated a new research program aimed at investigating the diversity and abundance of deep ocean sharks living in The Bahamas. This project is also providing a unique educational experience for fall semester students from The Island School who, alongside staff from the Shark Research and Conservation Program, will continue to gather data on deep ocean sharks.

Photo by Annabelle Oronti

A gulper shark fitted with a X-Tag is about to be released back into the North Exuma Sound near Eleuthera, The Bahamas.

Humans know virtually nothing about the species that inhabit the deep ocean realm and this is especially true of deep ocean sharks. Of all the currently described shark species, 56% live their entire lives below 200 m of water. Of these species, basic information about life history is available for only a few species, and information relating to movement patterns is available for fewer still. Until recently deepwater environments acted as refuge from human exploitation. However, as stocks of fish closer to the ocean surface are subjected to overfishing, commercial interests have turned their attention to the deep. Many deepwater sharks are being exploited without any understanding of their biology and ecology on which to base management decisions.

In addition to monitoring the diversity and abundance of the animals encountered, our research team will be utilizing some of newest electronic tracking technology available to monitor these animals' movements. So far three pop-up satellite archival transmitters (PSATs) have been deployed on bluntnose sixgill sharks, *Hexanchus griseus*, to compliment the 10 already deployed on this species by Dr. Grubbs in Hawaii, the eastern United States and the Gulf of Mexico.

Perhaps the most exciting news has been the deployment of PSATs on gulper shark *Centrophorous granulosus* and Taiwan gulper shark *Centrophorous niaukang* providing the first movement and habitat-use data for these animals. Until the recent development of the X-Tag by Microwave Telemetry no PSAT was small enough to deploy on these smaller species.

C. granulosus is relatively widespread in the Gulf of Mexico, western and eastern Atlantic, west Indian, west and central Pacific Oceans. It is a small species with a maximum size just over 100 cm. The gulper shark is taken as bycatch in many deep ocean fisheries as well as a limited directed fishery mainly for its large livers which are high in oil content. The IUCN lists the gulper shark as "Vulnerable". *C. niaukang* reaches a maximum size of 170 cm and is found in the Atlantic and Indo-Pacific. The IUCN lists the Taiwan gulper shark as "Near Threatened".

To date, 22 surveys have resulted in 61 animals from eight different species. This includes 17 individual gulper sharks, ranging from 52–105 cm and four Taiwan gulper sharks ranging in size from 130–156 cm in total length. Fourteen X-Tags are planned for deployment on the gulper sharks throughout the duration of this project.

Photo by Lance Jordan

The team attaches an X-Tag to a bluntnose sixgill shark.

This is an incredibly exciting project for the Shark Research and Conservation Program. We have been working on the more easily accessible sharks such as the Caribbean reef, tiger and nurse sharks for over three years, yet we had no idea of the treasure trove of new species that were right on our door step. The first phase of this project has been a huge success and we cannot wait to see the rest of the data that are gathered over the course of the fall semester with the Island School students. These students are incredibly lucky as there are very few people who have ever seen most of the species they will be working with this semester - it's a truly unique opportunity for them.

Photo by Lance Jordan

As part of the shark ecology course, students survey the juvenile lemon shark population in nearby mangrove habitat.

The Island School is a three-month semester leadership program for high school students from the US and The Bahamas. Participants have come from over 300 schools to study the tropical marine environment and take place-based courses in math, history, English, and art. *www.islandschool.org*

Cape Eleuthera Institute is a marine field station situated on Cape Eleuthera, Eleuthera, The Bahamas. It undertakes research on local environmental issues as well as acting as a host facility for marine and terrestrial scientists and visiting education groups of all ages. Cape Eleuthera Institute has especially focussed on developing new methods of resource use and management applicable to the Caribbean, such as effective use of solar energy and local recycling of waste organic and other materials. The Cape Eleuthera Institute also provides hands-on research experience for the students of The Island School through their in-house research programs. These programs include shark research, flats ecology and conservation, patch reef ecology and sustainable offshore aquaculture. *www.ceibahamas.org*