Spring 2003
Volume 4, Issue 1

Microwave Telemetry, Inc.

From the ends of the earth to our own backyard...

Dear Customers and Friends,

We hope that you will be as thrilled as we are to read about tracking Southern giant petrels in beautiful, pristine Antarctica, this distant continent most of us dream of visiting one day. We thank Donna Patterson and William Fraser for sharing their work in Antarctica with us.

Next we travel to Venezuela where John Graves, Andrij Horodysky and David Kerstetter take us on the underwater odyssey of the white marlin. We thank them for their fascinating article on post-release survival and habitat preferences of the white marlin.

We next hop to New Zealand where John Holland takes us along on the journey of Icarus, the New Zealand falcon, tracked by the students of Palmerston North Girls High School. We hope that the girls will be inspired to become biologists and one day carry on from where we leave off.

We end our journey here in our own backyard, the Chesapeake Bay, where the impact of the mute swan population has become a controversial issue. We thank Larry Hindman for his informative article.

Photo courtesy of US Antarctic Program

An aerial view of Norsel Point and Humble Island, Anvers Island, Antarctic Peninsula. Over 150 Southern giant petrels nest in the areas pictured above.

Your success urges us on. We are pleased to bring you several innovative, new products encompassing the features and capabilities you asked for. We hope you enjoy reading about them below and on the next page.

As always, it is a pleasure to work with you and we wish you a great 2003 field season.

Sincerely,
Paul and the staff at MTI

Product Update

New Products Introduced

Over the last twelve years, as satellite tracking of birds has become an accepted technique, we have been asked many times for new features and capabilities. This spring we are pleased to announce four new products that will be available in the fall. All of these products were developed in direct response to requests from you!

The 45g Argos/GPS Solar PTT and its cousin the 50g Argos/GPS Solar PTT for patagial mounting are designed to bring GPS location accuracy to more of you. The GPS positions together with speed, heading and altitude are recorded at hourly intervals and then transmitted to Argos every third day.

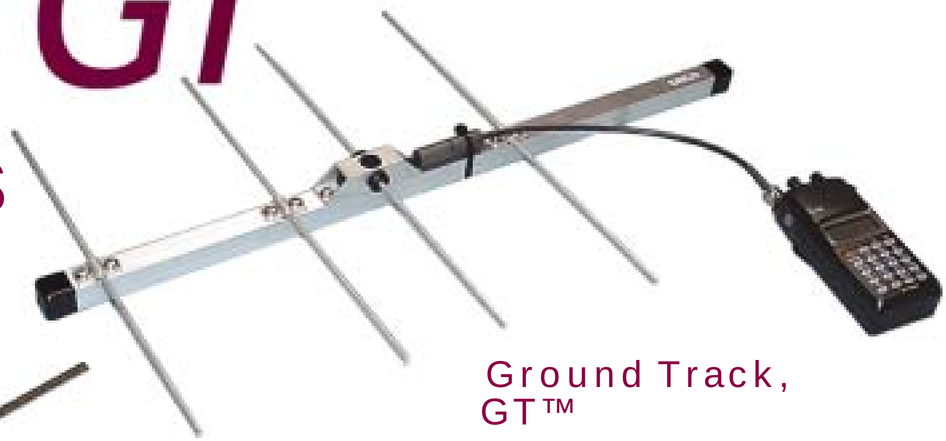
Ground Track, GT™, is a new feature that will soon be available on most of our PTTs. GT™ incorporates a UHF pulsed tracking transmitter into the PTT. This transmitter shares the PTT's antenna and has some unique features.

Our implantable PTTs will soon be available with a pressure sensor to measure dive depth, time at each depth, number of dives, mean dive duration and interdive duration.

For more information on our new products, please see pg. 2 and look us up on our recently updated website at *www.microwavetelemetry.com.* ❖

New products mean new capabilities

In our ongoing commitment to offer you state-of-the-art animal tracking devices, we are pleased to offer these new products.



Can you find your PTT? We can—with GT™!

Ground Track, GT™

If you have ever searched for a lost PTT on a tagged dead bird you know how difficult this can be. The Argos positions, at best, may tell you where it is to within 150 m; however, locations from dead birds are rarely location class 3! Even then, in typical field conditions, it is like looking for a needle in a haystack. Our new Ground Track, GT™, feature switches your PTT into a conventional tracking transmitter when mortality is sensed.

GT™ will be available soon on most of our PTTs. Now there is no need to glue a separate VHF transmitter to your PTT or have a separate antenna dangling from it. GT™ combines a UHF pulsed tracking transmitter, that sounds like the VHF units you are accustomed to, into the PTT. This transmitter shares the PTT's antenna and has some unique features.

GT™ has its own programmable duty cycle and the option to be activated in a mortality mode when activity ceases. It also transmits at two power levels making it exceedingly easy to find when you are right "on top" of it. Now if you are within a few miles of the unit, you can quickly find it.

Pressure Sensing Implantable PTT

Our implantable PTTs are now available with a pressure sensor to sense dive depth. By adopting the techniques used in our Archival Pop-up Tags, the microcomputer within the PTT can record the sensed pressure at three-second intervals and analyze the measurements for later transmission to Argos.

Dive depths, recorded in five depth bins, the number of dives, mean dive duration and inter-dive duration are recorded in four hour blocks. Every third day the records from the previous three days are transmitted to Argos.

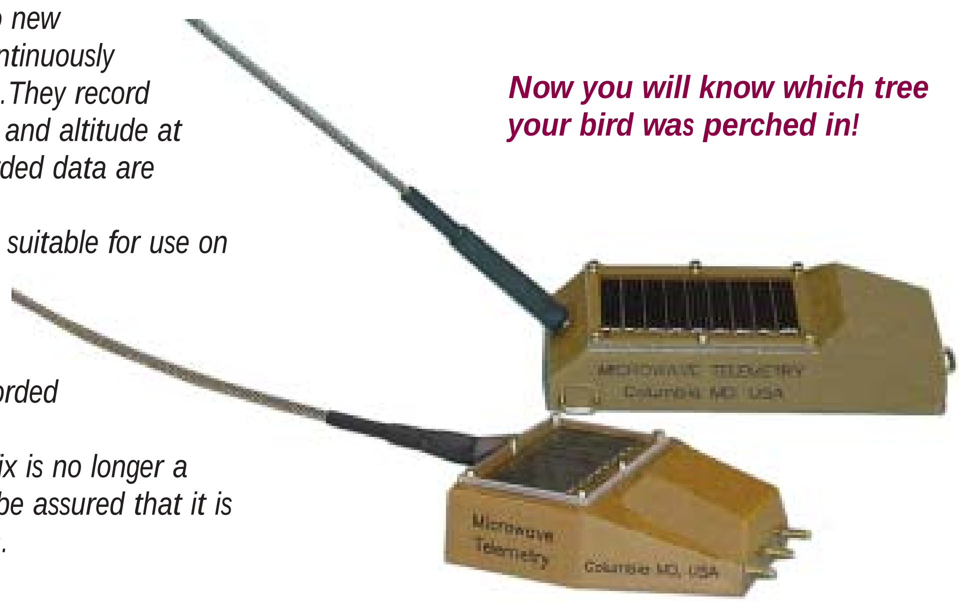
50g Argos/GPS Solar PTT for Patagial Mounting and 45g Argos/GPS Solar PTT

We are pleased to bring you these two new PTTs—the result of our commitment to continuously develop smaller, more sophisticated devices. They record GPS positions together with speed, heading and altitude at hourly intervals. Every third day these recorded data are transmitted to Argos on an SiV™ schedule.

These second generation GPS units are suitable for use on many species in both home range and long range studies. We can even program them to take as few as one GPS position a day and every few days transmit these recorded positions to Argos.

With GPS accuracy, the grade of your fix is no longer a concern. If you get a GPS location you can be assured that it is within 30 m of where the PTT actually was.

Now you will know which tree your bird was perched in!



Be sure to visit our updated website at www.microwavetelemetry.com

Eighth in a series of ***Feature Articles***
(Printed with permission)

Satellite Tracking Southern Giant Petrels at Palmer Station, Antarctica

Donna L. Patterson and William R. Fraser
Polar Oceans Research Group, Sheridan, Montana, USA

Photo courtesy of Donna Patterson

A female Southern giant petrel and chick sharing the nest

Southern giant petrels (*Macronectes giganteus*) are large, surface feeding predator-scavengers with a circumpolar distribution in the Southern Ocean. Like many other Procellariids that have large oceanic feeding ranges in this region, Southern giant petrel breeding populations are decreasing throughout much of their range. Although this species is highly susceptible to some types of human disturbance near their breeding colonies such as tourism, aircraft operations and construction, studies suggest that the observed population decreases are due primarily to entanglement mortality induced by commercial longline fishing operations. These operations are rapidly expanding in the Southern Ocean, thus posing an increasing hazard to these wide-ranging predators and scavengers because they are attracted to the baited hooks associated with these fisheries. If hooked, giant petrels most often drown or are mortally wounded when trying to escape. Indeed, with current estimates that as many as 100,000 seabirds are being killed annually by these fishing operations in the Southern Ocean, the Southern giant petrel is now listed as vulnerable by the International Union for the Conservation of Nature (IUCN).

A notable exception to this decreasing population trend, however, occurs in the vicinity of Palmer Station, Antarctica (64° 46’ S, 64° 04’ W, Fig. 1), where our monitoring since the mid-1970s has shown that the breeding population has more than doubled to nearly 500 pairs over the past 30 years. Although we have noted an increase in the incidence of entanglement events in the vicinity of Palmer Station during the last decade (e.g., the presence of monofilament line and hooks around giant petrel nests, or birds that actually return as survivors bearing embedded hooks), we have long-hypothesized that the area’s increasing population may be due in large part to foraging ranges that exhibited minimal overlap with commercial longline fishing operations. Knowing that this hypothesis could only be tested with available satellite technologies, we began our research in the early 1990s with the objective of developing a better understanding of the foraging ranges and locations that characterize this anomalous, thriving population of giant petrels.

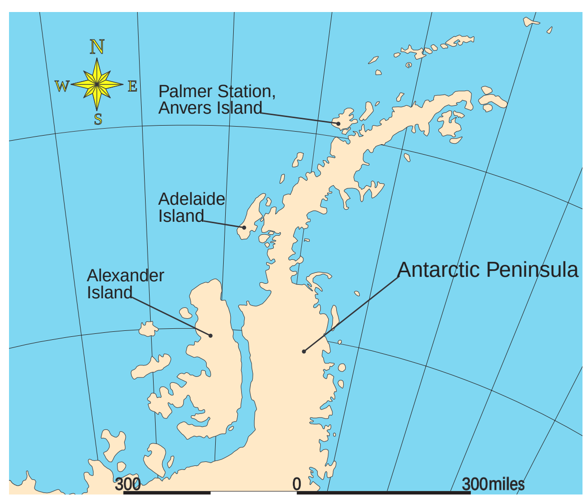


Fig. 1. Palmer Station, Antarctica is located on the southwest coast of Anvers Island, approximately 900 km south of South America

Because giant petrels are extremely skittish in the presence of humans, and we did not want our activities to impact the study population (the approach of humans, for example, will elicit vomiting of stomach contents by both chicks and adults), we spent the first two years of the study habituating a subpopulation of 15 breeding pairs on a nearby island to our presence. This was done primarily by visiting the colony every day during the breeding season (November-May) and slowly decreasing approach distances to individual nests, which, over time, eventually allowed us to weigh and measure chicks without consequences and to deploy satellite transmitters (PTTs) without having to restrain adults. Interestingly, during our continuing study, the giant petrel population on the entire island has increased to 55 breeding pairs from the original 30. About 35 pairs are currently habituated to our presence.

Photo courtesy of Heidi Geisz

A Southern giant petrel is instrumented with a 33 g PTT near Palmer Station, Antarctica

We attached PTTs weighing between 30 and 45 g (PTT-100) to the middorsal feathers with Tesa tape and plastic zip-ties, an attach-

Continued on page 4

Satellite Tracking Southern Giant Petrel: continued from page 3

ment method that requires no harness, with the objective of annually covering key phases of the breeding season from early December (mid-incubation) to late March (when chicks are mostly unattended and have reached weights of 5000 g or more). Duty cycles were typically set to record approximately 10 hours of movement per day, and instruments were usually left on individuals long enough to capture multiple foraging trips. During the past five austral summers, we have deployed PTTs on 72 giant petrels and averaged about 28 days of deployment per individual (range, 8-53 days).

Preliminary analyses of our data suggest two broad patterns that are potentially significant as underlying explanations for the increasing populations of giant petrels in the Palmer Station area. The first is that during all seasons, individuals made repeated trips to the same areas, some of which are more than 1200 km away (Fig. 2). Key among these have been polynyas and residual summer ice edges, which are found primarily south of the Palmer Station giant petrel population, and which oceanographic cruises have shown are associated with regions of high primary production and prey abundance. This finding is important because we know most commercial fishing activities take place to the north of this population, suggesting, much as we suspected, a limited overlap between local breeding giant petrel foraging ranges and commercial fishing activities.

The second broad pattern is more complex, but it too has the effect of keeping foraging giant petrels away from more northern fishing activities during the breeding season. Although the longest foraging trips (6-12 days) to the most distant locations discussed above were especially common during the incubation phase, trips tended to decrease in distance and duration (1-9 days) during the brood and guard phases. The guard phase in giant petrels is coincident with fledging period in Adélie penguins (*Pygoscelis adeliae*), which are abundant and highly vulnerable to petrel predation both on land and at sea. Despite evidence that during some seasons this pattern was more gender-specific (i.e., males rather than females were the predominant penguin predators), the net effect on where giant petrels foraged relative to the activities of fishing vessels was nevertheless the same (Fig. 3), at least from the standpoint that either foraging strategy (distant vs. local) still minimized their exposure to northern fishing vessels.

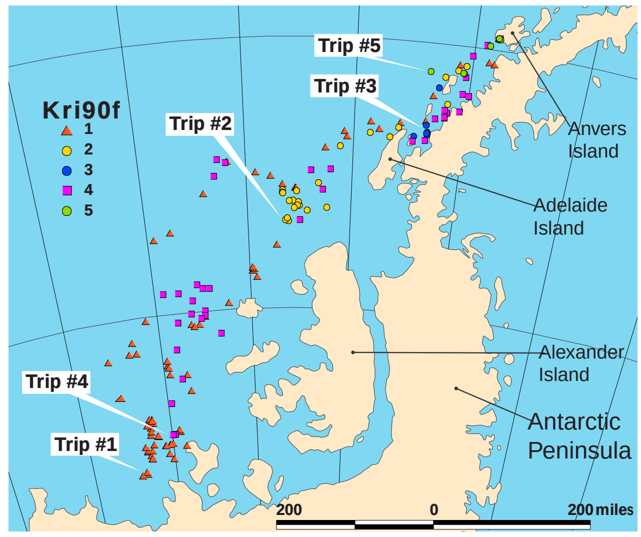


Fig. 2. Movements of a female Southern giant petrel that made five distinct foraging trips along the Antarctic Peninsula during summer 2000/01. Note the overlap between the foraging trips; giant petrels are drawn to predictably productive areas along the peninsula.

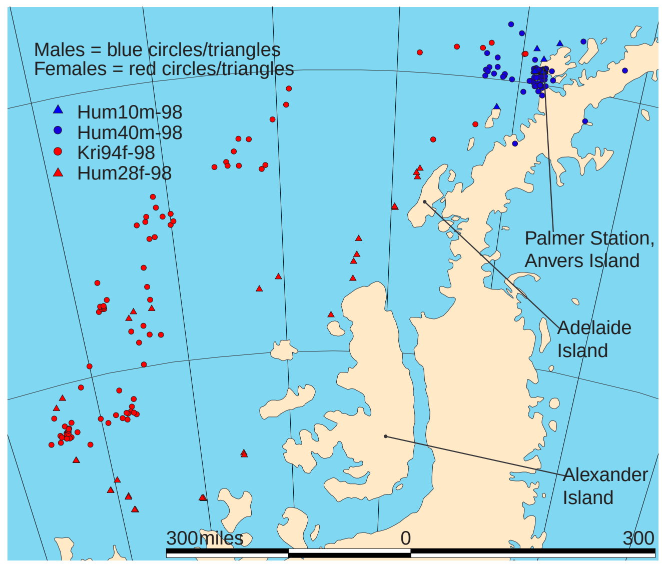


Fig. 3. Location data from the 1998/99 season illustrating a strongly gender-specific foraging pattern. Males remained local (within 100 km) while females fed up to 1200 km away.

Although our results suggest that the foraging ranges of breeding Southern giant petrels in the Palmer Station area are spatially isolated from commercial fishing operations to the north, we know much less about where the non-breeders and pre-breeders from this population forage. The Southern giant petrel breeding population in the Palmer Station vicinity is still increasing, in part due to a steady influx of new recruits. In future studies we intend to focus on this segment of the population to see if they too have foraging strategies that limit their spatial and temporal exposure to commercial fishing activities.

We thank the support staff of Palmer Station, Antarctica for logistical assistance. We wish to acknowledge our outstanding field team, without whom our research would be impossible. The National Science Foundation provided financial support for this research. ❖

New to Our Staff...

Lissa Werbos joined Microwave Telemetry in August 2002. A recent graduate of Massachusetts Institute of Technology, Lissa is chiefly involved in programming and analyzing Archival Pop-up Tag data. Those of you who have deployed archival tags know her well!

Lissa has many varied interests outside of programming. At MIT, she was a member of the ballroom dancing team (yes, MIT has one!) and she recently joined a community Shakespearean theater. Lissa made her debut as Aeneas in Shakespeare's history play, *Troilus and Cressida*. Her next role this spring will be Vitravia in the tragedy, *Othello*.

In addition to her work at Microwave, Lissa is taking two postgraduate physics classes at the University of Maryland.

Lissa in her role as software programmer

Tracking the Fate and Habitat Preferences of White Marlin Released from Commercial Fishing Gear with Archival Pop-up Tags

John E. Graves, Andrij Z. Horodysky, and David W. Kerstetter

Virginia Institute of Marine Science, College of William and Mary, P.O. Box 1346, Gloucester Point, VA 23062

Of all the billfish species in the Atlantic, white marlin are the most depleted—current population estimates are less than 10 percent of the virgin or unfished stock. The majority of white marlin mortality occurs as incidental catch on pelagic longline gear set for tunas and swordfish, although they are also the target of a directed recreational fishery. More than 90 percent of the white marlin caught by recreational anglers are released alive, and international management now requires longline vessels to release all live white marlin (about one-half of them are alive when the gear is retrieved). We have been employing Archival Pop-up Tags to determine the fate of white marlin after capture, and to better understand the vertical behavior of white marlin in order to adjust historical catch rates for changes over time in the depth of longline gear deployments.

Photo courtesy of Guy Harvey

Fig. 1a. White marlin carrying 10-day MT HR Archival Pop-up Tag offshore of La Guaira Bank, Venezuela.

To study post-release survival and habitat preferences, we required high resolution information over a relatively short duration period. We selected the HR Archival Pop-up Tag programmed to record light, temperature, and pressure (depth) every one to four minutes and to release after five or ten days (mortalities noted in previous acoustic tracking studies of other billfish species typically occurred within the first 24 or 48 hours). This tag provides serial (as opposed to summarized) data allowing us to reconstruct the actual diving behavior of each fish. To date, we have deployed a total of 24 tags, 22 on fish taken on recreational gear, and two on fish released from the longline fishery (Figure 1a, 1b). Tagging locations include the Dominican Republic (5), U.S. mid-Atlantic region (11), Georges Bank (2), and Venezuela (6).

Photo courtesy of John Graves

Fig. 1b. Positions of archival and conventional tags on a white marlin tagged in the Mid-Atlantic region.

Overall, 23 of 24 tags responded and approximately 80 percent of the light, temperature, and pressure (depth) measurements from each reporting tag were received. Data were consistent with survival for one of two white marlin released from the longline fishery. The fish that died sank to the bottom within an hour after release. The tag was apparently consumed on the bottom by a shark about ten hours later, and regurgitated a few days after the expected release date, allowing us to retrieve the unusual data set (see the Microwave Telemetry Winter 2002 Newsletter for details).

Five of 21 white marlin released from the recreational fishery died. Three of the mortalities occurred within one hour of release, one at fifteen hours, and the longest time at liberty before death was 64 hours. A higher post-release mortality was noted for white marlin caught on standard straight shank (J) hooks (5 of 15) relative to those caught on circle hooks (0 of 6), presumably due to the greater incidence of deep-hooking and tissue trauma associated with the use of straight shank hooks (four of the five fish caught on straight shank hooks that died were deeply hooked, while all six fish caught on circle hooks were hooked in the jaw). If this trend persists, it suggests that a minor change in hook types could have a profound effect on post-release survival.

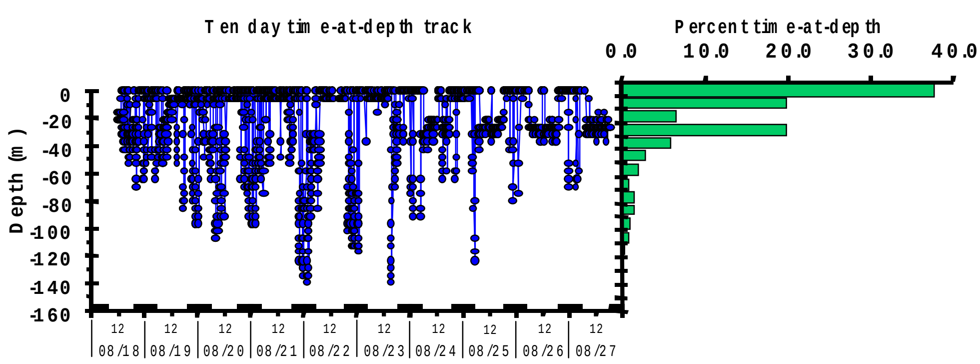


Fig. 2. Overlay of the ten-day depth track and summarized time-at-depth histogram of a white marlin tagged offshore of the Mid Atlantic in August 2002. This figure reveals both the overall depth preferences of the animal and the specific, high-resolution signature of individual dives. Note that many of the deeper dives are not readily apparent in the histogram.

Continued on page 6

Fate and Habitat Preferences of White Marlin: continued from page 5

The archival tag data demonstrate that white marlin spend the majority of their time in the upper ten meters of the water column, although dives to depths of 200 m were noted for some individuals (Figure 2). Because we received the data back in serial format, it was possible to reconstruct specific dive behaviors. Each fish typically made frequent, short-duration (20 - 40 min) dives in excess of 60 m, although there was considerable variation in the nature of these dives between tagging locations, among individuals at a tagging location, and even for the same individual over time. Typically, deeper dives of long duration were followed by longer times in surface waters. In addition, strong day/night differences in diving behavior were noted for some white marlin (Figure 3a), and the behavior of some individuals was observed to change as they entered different water masses (Figure 3b).

The frequency, duration, and patterns of white marlin dives suggest that these movements are probably associated with feeding. Although white marlin have evolved a special organ to heat the eye, the extended periods in surface waters may help to warm core temperatures after forays into cooler waters. If white marlin are undertaking dives into cooler waters to forage, this behavior pattern may account for the surprisingly high catch rates of a supposed surface feeder on deep-set pelagic longline deployments.

While we plan to continue Archival Pop-up tag studies of white marlin survival and habitat utilization over the next few years, our preliminary data indicate that live release of the animals can significantly decrease fishing mortality. Furthermore, it would appear that a change in hook types in the recreational fishery can have a dramatic increase in post-release survival. ❖

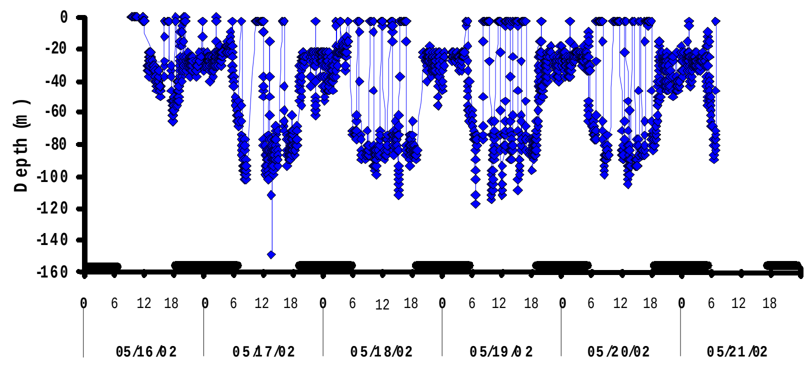


Fig. 3a. Strong day/night differences in the diving behavior of a white marlin tagged offshore of the Dominican Republic in May 2002 with a 5-day HR Archival Pop-up Tag. Black bars along the x-axis denote periods of darkness, derived from time-of-day and light level data archived by the tag.

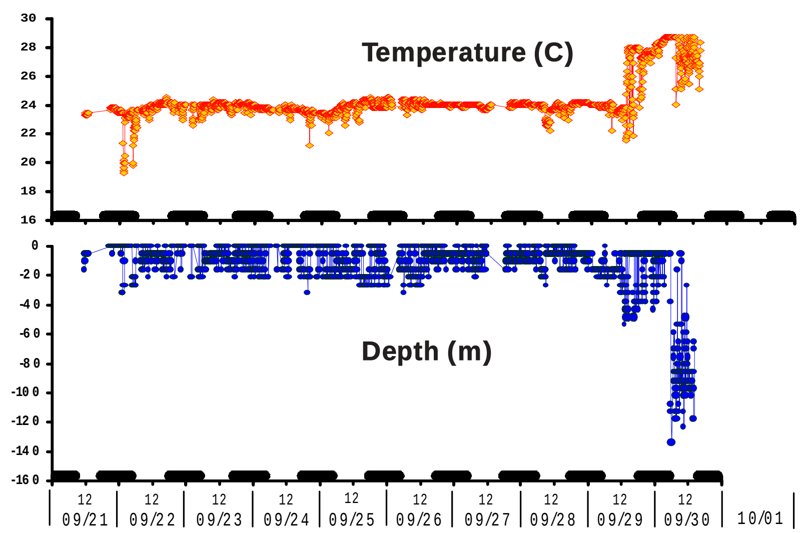


Fig. 3b. Change in the dive behavior of a white marlin tagged in the waters of the Mid-Atlantic in September 2002 with a 10-day HR Archival Pop-up Tag. Black bars along the x-axis denote periods of darkness, derived from time-of-day and light level data archived by the tag. The increase in dive depths concomitant with the increase in temperature readings and the general path of this animal (not presented) suggest that the change in diving behavior of this fish occurred as it entered the Gulf Stream on 29 September.

PTT Refurbishment

We know that utilization of satellite telemetry technology in your research projects is a major investment of precious resources. Fortunately, recovered PTTs can usually be refurbished and deployed again. Some guidelines are listed below to help you.

- To initiate refurbishment, call or email us for a two-page form and when completed, email or fax it back to us. Please also include a copy of the two-page form with your shipment.
- All PTTs returned for refurbishment should be sent via Federal Express, our preferred carrier. Refer to “Returning PTTs to Us” in the Field Manual shipped with your PTTs or the FAQ section of our website (www.microwavetelemetry.com) for instructions for international returns.
- Any damage to a reinforced antenna will result in a replacement of and charge for a new housing.
- Most of our PTTs, except the Archival Pop-up tags, can be refurbished. Archival Pop-up tags are essentially rebuilt with new pressure sensor, new light sensor, new battery and new housing.
- We reserve the right to determine whether or not a PTT can be refurbished. For instance, we may not be able to refurbish PTTs that have been damaged while deployed (by bullet holes, corrosion, etc.). Also, if your PTTs are over three years old, please consult us before returning them for refurbishment.

Refurbishment of your PTTs and rebuilding of Archival Pop-up tags is offered as a courtesy to our customers and charges to you in no way reflect the actual cost. A complete list of charges for refurbishment or rebuilding may be found in the FAQ sections of our website.

Third in a series of reports on School Project Awards.

Icarus, the Sun and Microwave Telemetry—a Winning Combination

John Holland, Institute of Natural Resources, Massey University, Palmerston North, New Zealand

The New Zealand falcon has been listed as threatened by the NZ Dept. of Conservation

Daedalus made wings out of wax and feathers for him and his son, Icarus, to escape the Minotaur's labyrinth. Enchanted by the fact that he could fly, Icarus tried to reach the sun but fell from the sky when he got too close and his wings melted. We overcame this problem by strapping a solar-powered PTT on the back of Icarus, our New Zealand falcon (NZF), and reaped a double dividend—insulation and power to burn!

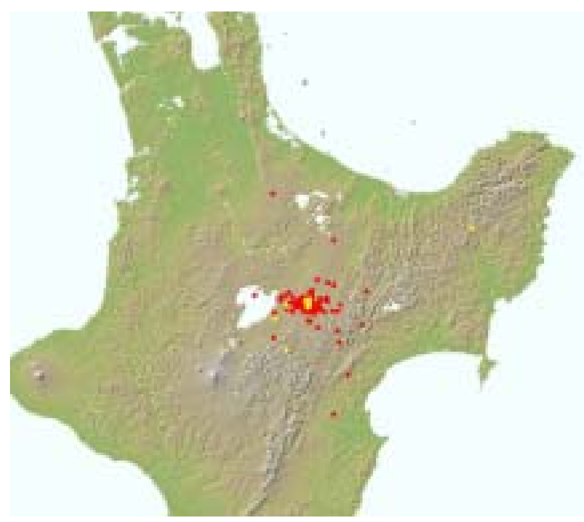
Icarus, a 540g New Zealand falcon, is ready for release after being fitted with an 18g solar PTT

Photos courtesy of Noel Hyde

As part of Microwave Telemetry's tenth anniversary celebration in 2001, they encouraged schools around the world to submit project applications to win a free PTT. New Zealand's Palmerston North Girls High School, in conjunction with Massey University, was one of four winners. Never before had anyone been able to follow the secretive NZF so we were over the moon. With our prize in hand we were able to apply for a government grant to pay for satellite time—again we were successful.

The New Zealand falcon, *Falco novaeseelandiae,* occurs only in this country and is a species under pressure. It's thought there are about 400 breeding pairs of the bush falcon in the North Island but no one knows for sure. Because of its limited numbers, it has been classified as 'threatened' by the Department of Conservation.

We had heaps of good advice from Bill Green (formerly of the Canadian Peregrine Foundation), Ken Meyer (Avian Research and Conservation Institute) and Guan Oon (Argos) and before long we were set. We practiced fitting the PTT harness countless times, drove around a third of this small country, walked untold miles in the bush and then, one memorable morning (14 February 2002), we attached the 18g solar PTT to Icarus, a 540g NZF.

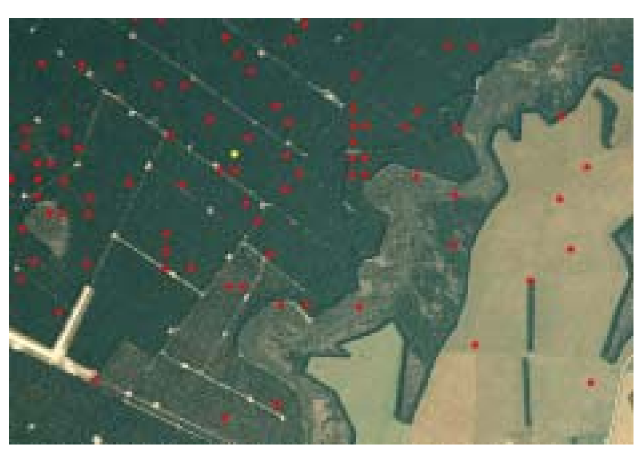


North Island, New Zealand. During the first few weeks, Icarus flew an average of 40 km per day, then settled in to an average of 7 km per day.

Since then we've been on a very sharp learning curve. At the start of each day we download the coordinates, convert them to a New Zealand grid reference and feed the results into ArcViewGIS to see where Icarus has been. During the first week or so Icarus flew an average of 40 kilometers per day but then settled into an average of about seven kilometers per day. Once a month the bird appears to go on a 'walkabout', sometimes venturing off 80 kilometers or so and then returning within 24 hours.

We've been lucky too—our bird spends most of the time in a commercial pine forest, Fletcher Forest, and the owners have been exceptionally helpful. They gave us one-meter resolution color orthophotos of the area as well as daily meteorological recordings.

We have a mine of data to work with. The high school girls (roughly five groups of five) have had a number of tutorials. The location data was sent to them and they became familiar with the technology.



Data points indicate that Icarus made frequent foraging trips to feed hungry chicks.

We confirmed that the NZF is a very sedentary animal and hoped to track the bird to its nest site during the 2002/3 breeding season. The nest was easily found and we confirmed the device had not harmed the bird at all, in fact, she went through the last breeding season smoothly, producing three chicks. Her chicks were weighed and banded and prey remains and castings collected from around the nest for examination. Using further funding from a government grant we put an infrared camera near the nest to record the comings and goings and how the birds nest and nurture their young.

Next, the students will correlate meteorlogical, biophysical, and location data and write reports on their findings. They will then make a presentation to the public. The school also hopes to do well in the 2003 National Science Fair. ❖

Mute Swan Impact on Chesapeake Bay Grasses

Larry J. Hindman, Waterfowl Project Leader, Maryland Department of Natural Resources

A mute swan fitted with a customized GPS PTT just after release

Native to Europe and Asia, mute swans were transported to North America in the late-nineteenth century by European immigrants for display on estates. Some mute swans eventually escaped, while others were deliberately released into the wild. Maryland's current population of about 3,600 birds was established when five swans escaped captivity along the Miles River during a storm in 1962. During the 1970s and early 1980s the population grew slowly, remaining at less than 500 birds. When the population rapidly increased in numbers and greatly expanded its range during the late 1980s and 1990s, their ecological impacts began to surface (Figure 1).

Submerged aquatic vegetation (SAV) or "bay grasses" have long been recognized as critical to the health and well being of myriad Chesapeake Bay organisms. Not only does this SAV protect water quality and prevent erosion, it also provides food and shelter for fish, shellfish, invertebrates and waterfowl. For example, research has shown that the density of juvenile blue crabs is 30 times greater in SAV beds than in unvegetated areas of the Bay. However, today only about 10 percent of the historic levels of SAV beds remain. Although the primary cause of SAV decline has been attributed to elevated levels of nutrients and sedimentation, shoreline property owners and resource managers are also increasingly troubled by the mute swan population's impact on SAV.

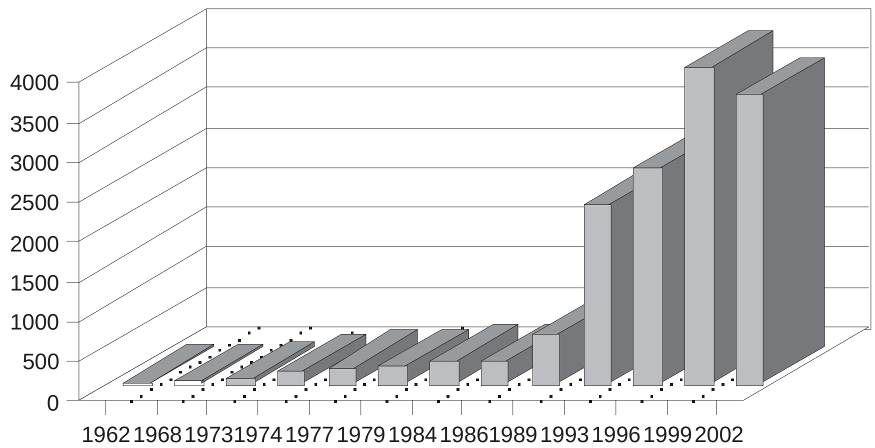


Fig. 1. Number of Mute swans in Maryland 1962-2002

Mute swans feed extensively on SAV, such as widgeon grass and eelgrass. Each bird consumes about eight pounds of SAV each day, accounting for the removal of about 10.5 million pounds of valuable bay grasses each year. Mute swans also feed on SAV during the plants' reproduction cycle, interrupting seed production and dispersal. At high densities, mute swans overgraze an entire area, leaving the Bay's bottom completely barren. Mute swan grazing reduces the amount of SAV in the Chesapeake Bay, thus reducing the Bay's capacity to support healthy wintering waterfowl populations that also use SAV. In fact, several wintering duck populations including redhead, canvasback, American widgeon, and black ducks have declined in Maryland's portion of Chesapeake Bay region attributed, in part, to the reduced availability of SAV.

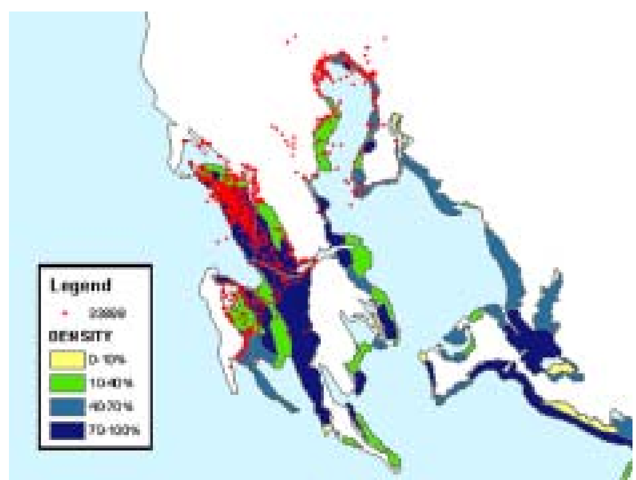


Fig. 2. GPS locations of a mute swan's movement overtop bay grass beds in the Hooper Island area of Maryland's Eastern Shore. The legend indicates density of SAV vegetation.

Photos courtesy of Larry Hindman

Rich Malecki, with the USGS Wildlife Research Unit in New York, attaches a special GPS transmitter on an adult mute swan.

Many questions regarding the ecological impacts of mute swans on SAV remain unanswered. It is clear that a large mute swan population is incompatible with native wildlife and SAV resources in Chesapeake Bay. To increase the understanding of mute swan impacts on SAV, movements of a small sample of male swans (members of large nonbreeding swan flocks that concentrate on large SAV beds) are being tracked using unique GPS satellite transmitters attached to the swans. The GPS satellite transmitters provide an exact location of the marked swans 24/7. Preliminary movement information gathered during the fall and winter of 2002/2003 demonstrates that swans spend nearly all their time in areas where bay grasses occur (Figure 2). This study will be expanded in the coming months and the new information gained from the use of this technology will aid wildlife managers to better understand the daily and seasonal movements of swans in relationship to SAV resources, water depth, and salinity. ❖

Microwave Telemetry, Inc.
8835 Columbia 100 Parkway
Suites K and L
Columbia, MD 21045, USA
phone 410·715·5292
fax 410·715·5295