Winter 2002
Volume 3, Issue 2

Microwave Telemetry, Inc.

Growing pains...

Dear Customers and Friends,

As we pause to reflect on 2002, it is very rewarding to see our hard work come to fruition: more of our customers are making good use of our latest technology—our 70g Argos/GPS solar transmitters and our Archival Pop-up tags. We thank Peter Sharpe, David Garcelon and Jessica Dooley for their interesting article on tracking bald eagles with our Argos/GPS PTTs. We also thank Mike Musyl, Yonat Swimmer and Rich Brill for their fascinating article on the use of Archival Pop-up tags to study the survival of pelagic fish and sea turtles caught on long line fishing gear.

However, these high tech devices are also more complex and more labor intensive to produce. In order to streamline production, we have reorganized our facility and expanded our production area. We also have a major recruiting effort under way to increase our staff. Please bear with us as we go through our growing pains. We ask for your cooperation as we put our new system into place (see pg. 2).

Last but not least, we again proudly present to you the second in a series of articles submitted by the schools awarded free transmitters; please join us in sharing the children's enthusiasm. We especially thank Ken Meyer for his article, and Genie Sturtevant for her participation with her science students at Yankeetown Middle School.

We wish you peace, health and happiness this holiday season and throughout the coming year, and we look forward to continuing to work with you.

Sincerely,
Paul and the staff at MTI

Many thanks to all who gave permission for the use of their photos for our new Tee-shirt design: clockwise from the top right, Rob Bennetts, Michael Scholl, Yonat Swimmer, and Paul Howey.

Two Archival Pop-up Tags are Designed for Short-term and Long-term Studies

Microwave Telemetry's line of Argos compatible Archival Pop-up tags for fish tracking now includes two models. The original PTT-100 Archival Pop-up Tag can archive temperature, depth, and sunrise and sunset times (for subsequent geolocation calculation) for over a year. The PTT-100 Archival HR Pop-up Tag, our short-term archival tag, records temperatures, depths and light levels at a high sample rate (readings every one to four minutes) for up to four weeks. It is particularly suitable for short-term mortality studies.

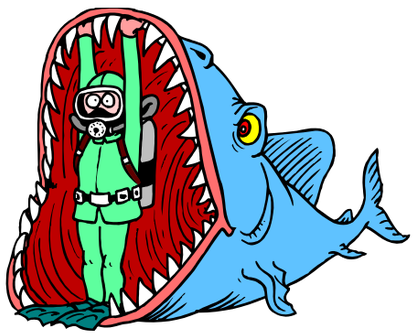
Both models incorporate our SiV™ (Satellite in View) technology, pioneered on our bird PTTs, to enhance data collection.

The tags are rated to withstand 3000 psi (6500ft. or 2000m) and have an optional pressure initiated pop-off feature to allow the tag to pop off and start transmitting if it descends below a predetermined depth or remains at a constant depth (e.g., at the surface or on the bottom) over a predetermined length of time.

Photo courtesy of Alex Antoniou

Whale Sharks, unknown to science until 1838, can now be studied through the use of Archival Pop-up tags.

We need your help!



We have always viewed the development and production of our PTTs as a collaboration between ourselves and you, the field biologist, to produce transmitters that fill the specific requirements of your research. With each passing year, we are manufacturing more and more PTTs. As production increases, we cannot and will not sacrifice the quality you have come to rely upon.

As we continue to strive to improve customer service, we also juggle the demands of increased production. In a continued spirit of cooperation and collaboration, please help us with the following:

- Always fill out a two page form to initiate any work order. A completely filled out form gives us all the information we need to properly build your transmitters in a timely manner. It is your assurance that all information about your order is in our hands and in one place.
- If we are sending items to Sirtrack for you, give us plenty of notice. We need to build the extra time into our production schedule so that you receive your PTTs from Sirtrack on time.
- Please take the time to read the *Field Manual* included with each order. You will find the answers to most of your questions there.
- When you deploy your pop-up tags, be sure to arrange for all of the data to be sent to you *and* to us, so that we can process the data and send your reports. Should you opt to retrieve your data yourself, it is only available on the system for a period of ten days, after which it is archived. If you need to retrieve it later, you will be charged by Argos.
- Be sure that any IDs you give us are indeed active (i.e., not in backup mode) and are still in your program!
- Please don't wait until the last minute to ask for help with your Argos forms. Coding in the PTT IDs comes early in the production process and may cause us (and you) to lose valuable time.

Contact us at microwt@aol.com if you have any questions—we answer every e-mail. Our goal, as always, is to give every customer priority treatment and excellent service.

New Duty Cycles for Solar PTTs

We have changed the recommended duty cycle for all solar powered PTTs to 10 hours ON 24 hours OFF. Originally, the duty cycle was set for 10 hours ON and 21 hours OFF.

We recommend the new duty cycle because Service Argos gives a discount if the PTT transmits for no more than twenty-four hours in a three day period. Previously the discount was given for duty cycles of less than one third ON time.

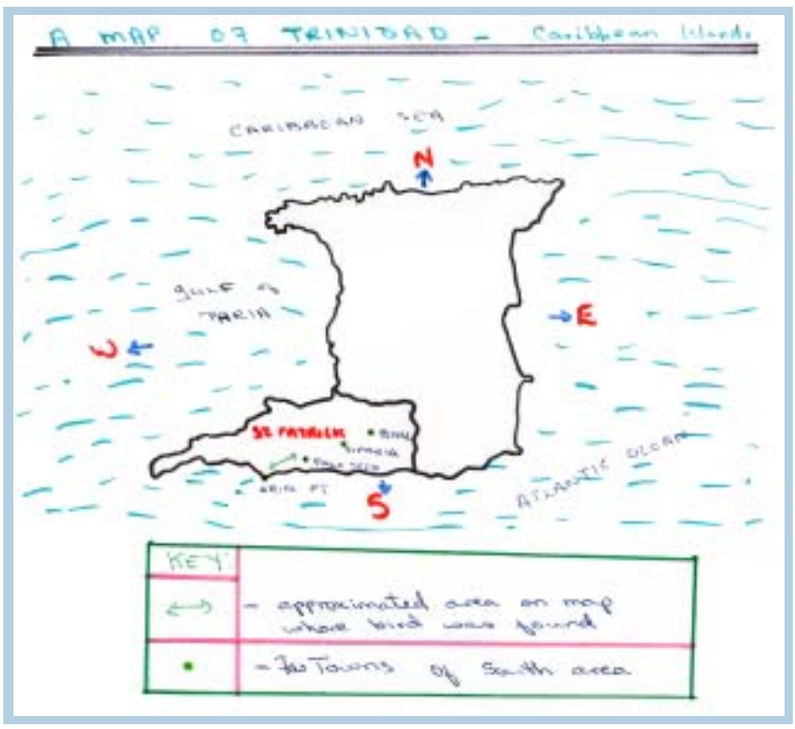
Additionally, the longer duty cycle allows more time for the battery to charge up. Please let us know if you require a different duty cycle.

Couple in Trinidad finds an unusual bird

Henri Weimerskirch
Centre d' études Biologiques de Chizé

In April 2002, we initiated a study of the foraging movements of magnificent frigatebirds off the coast of French Guiana. It was the first time that the life at sea of this enigmatic group of seabirds was investigated. We were able to track the movements of eight birds, incubating eggs or brooding chicks, during forty-two foraging trips. The frigatebirds foraged at maximum range 261 km from the breeding island.

During their post-breeding dispersal, birds moved quickly from the breeding island, and one of the PTTs stopped working at 1200km from the island along the coast of Trinidad. A few weeks later we were informed by Lauren at Microwave that a 20g solar PTT was found on a dead frigatebird by Mr. and Mrs. Balgobin living on the coast of Trinidad (just where the PTT stopped transmitting). Just from the address on the side of the PTT, the Balgobins wrote to Microwave and reported finding a strange bird in their garden. After an exchange of mail, Mr. Balgobin kindly sent the PTT back to us in France. The transmitter is working perfectly, and will be redeployed on the same species next March.



Map of Trinidad, hand drawn by Mr. Balgobin, indicating the location of the dead frigatebird

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

Monitoring Reintroduced Bald Eagles Using Satellite Telemetry

Peter Sharpe, David Garcelon, Jessica Dooley
Institute for Wildlife Studies, P.O. Box 2500, Avalon, CA 90704

Bald eagles (*Haliaeetus leucocephalus*) disappeared from southern California by the 1960's, primarily because of habitat loss and the introduction of the pesticide DDT into the marine environment. Once in the food chain, this pesticide caused the eagles to lay fragile eggs that broke under the incubating adults, eventually driving the population toward extinction.

The Institute for Wildlife Studies (IWS) began bald eagle restoration efforts in southern California on Santa Catalina Island (Fig. 1) in 1980. This ongoing project has successfully restored a bald eagle population of approximately twenty birds to the island. In the spring of 2002, IWS, in cooperation with the National Park Service (NPS) and The Nature Conservancy, began a similar project to reintroduce bald eagles to the northernmost Channel Islands. Twelve eight-week-old eaglets, which were acquired from either the San Francisco Zoo or wild nests in Alaska, were placed in two release towers built on NPS property on eastern Santa Cruz Island and released when they were ready to fly at about twelve weeks of age.

There were several questions we had regarding reintroducing bald eagles on Santa Cruz Island. First, Santa Cruz Island is one of four islands (San Miguel, Santa Rosa, Santa Cruz, Anacapa) in a chain of islands that are about 5-10 km apart and cover a linear distance of approximately 100 km. We wanted to know whether it would be possible to restore eagles to all four islands using only the release sites on Santa Cruz Island. To answer this we would need to closely monitor the eagles' movements to determine whether they moved between the islands. The second question was whether released bald eagles would negatively impact several species of nesting seabirds that are found on the islands. Finally, our previous experience has shown that a portion of the released birds often migrate to the mainland, sometimes returning to breed in the future. We wanted to be able to closely follow the birds' movements both on the

Photo courtesy of Jim Spickler

A pair of eaglets acquired from a wild nest in Alaska were released on eastern Santa Cruz Island when they were ready to fly.

Fig.1:The Channel Islands, CA were the focus of the bald eagle reintroduction project.

island(s) and on the mainland to determine survival and movement patterns and to establish whether there were differences between the eagles acquired from San Francisco and Alaska that may affect the success of the reintroduction efforts.

In order to answer these questions, each bird was fitted with a backpack-mounted 70g Argos/GPS Solar

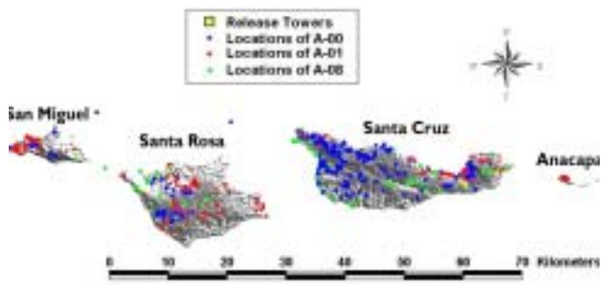


Fig. 2: Locations of three bald eagles originally released on Santa Cruz Island

PTT. Using the PTT data, we have found that the birds can and do move among the islands. Three of the twelve released birds have spent time on at least three of the four islands (Fig. 2). Several birds have also made short trips to Anacapa Island, where much of the seabird breeding activity occurs. Therefore, we will be closely watching eagle activity on this island in the future to determine if the eagles pose any threat to seabirds breeding in that location.

We have also found apparent differences in movement patterns between birds bred at the San Francisco Zoo compared to those removed from nests in Alaska. Of seven birds from Alaska, two are still on the islands (A-08, A-10), two (A-04, A-07) have trav-

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Photo courtesy of Jessica Dooley

Young bald eagle with Argos/GPS Solar PTT (solar panel visible between shoulder blades) and patagial wingmarkers

Second in a series of reports on School Project Awards.

Students make the connection between swallow-tailed kite conservation and habitat loss

Submitted by Kenneth D. Meyer
Avian Research and Conservation Institute

Nestled on the upland edge of the beautiful Gulf Hammock region, Yankeetown's oak hammocks and riverine forests comprise some of the familiar places first seen by returning swallow-tailed kites. What changes will the kites find when they complete another 5,000 mile passage from their winter range in southwestern Brazil and arrive this year to establish territories and build nests?

The soil and weather in Gulf Hammock make trees grow fast, so lumbering is lucrative. Where it's not (or where homeowners are willing to pay extra to be close to the water), RV and trailer parks, subdivisions, and all the supporting amenities proliferate. Granted, things move slowly here relative to the rampant growth transforming most of Florida. Given most people's idea of "long-term"—the life of an SUV's tires, a condo roof, a pair of golf shoes—the natural landscape might seem unthreatened. Viewed in relation to the evolution of a vulnerable species with low reproductive potential, however, the life-supporting web is rapidly unraveling.

Nurtured by a local economy that feeds on the land, even Genie Sturtevant's science students at Yankeetown Middle School in Levy County, Florida must feel the conflict between protecting a special place and benefiting from the things that threaten it. From Yankeetown's idyllic perch on the Withlacoochee River, they have a clear view of the aborted Cross-Florida Barge Canal and the Crystal River nuclear power plant, feeding energy to Tampa and Orlando. Still, there are native forests and clean wetlands, manatees and migrant songbirds, stunning waterways, swallow-tailed kites and children—unconcerned enough with property taxes, health insurance, and mortgage rates that they remain awed by nature.

The rapid evolution of wildlife telemetry, especially highly sophisticated satellite-tracking technology, represents some of the best of human inventiveness. Avian Research and Conservation Institute began affixing Microwave Telemetry's then smallest satellite transmitters to swallow-tailed kites in 1996. In a matter of weeks, we went from knowing virtually nothing about kite migration behavior to uncovering fine details of route, timing, and wintering destination.

Students at Yankeetown Middle School map the travels of swallow-tailed kites.

Nonetheless, these electronic achievements are overshadowed by the biotechnology of the migrating birds that carry these transmitters—feats of orientation, navigation, and physiological endurance, all in a one-pound, streamlined mass of flesh and feathers. None of this is lost on Genie's seventh and eighth graders. With a generous grant from Microwave Telemetry in 2001, we expanded our sample size and launched a cooperative program with Yankeetown Middle School. When we talk in the classroom about tracking methods, migration biology, the effects of weather and the dynamics of long-distance flight, these kids show a surprisingly clear understanding of technical details, a credit to their science teacher and their uncorrupted curiosity.

Making the connection between swallow-tailed kite conservation and habitat loss in their own neighborhood is an easy leap for these students, but the story doesn't end there. During the 40 percent of the year they spend migrating, swallow-tailed kites traverse Cuba, the Yucatan Peninsula, coastal Central America, the Colombian Andes, and the headwaters of the Amazon, encountering degraded or destroyed native habitats. Wintering habitats in Brazil are

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Photos courtesy of Genie Sturtevant

Students find connections between the project's biology lessons and related ones in math, geography, and social studies.

Southbound migration of 33 Swallow-tailed Kites tracked by satellite, 1996–2002

All charts in this article are provided by Avian Research and Conservation Institute (Do not use or reproduce without permission).

Archival Pop-up Tag Studies of Pelagic Fishes and Sea Turtles in the Pacific Ocean: Treasure Trove of Data

Mike Musyl[1], Yonat Swimmer[1] and Rich Brill[2]

[1]University of Hawaii, Joint Institute of Marine and Atmospheric Research, Pelagic Fisheries Research Programme, Kewalo Research Facility, 1125-B Ala Moana Blvd., Honolulu, HI 96822

[2]Virginia Institute of Marine Science, PO Box 1346, Gloucester Point, VA 23062

Integrating the latest technology into their research strategy, scientists from the National Marine Fishery Service Honolulu Lab, and the University of Hawaii, Pelagic Fisheries Research Program, are tackling many questions about the ecology and management of pelagic fish and turtle species in the Pacific Ocean using archival pop-up tags. These tags contain a veritable treasure trove of immediately useful ecological information that can be used to help solve a number of important management questions such as delimiting stock boundaries, identifying possible spawning areas, and investigating the post-hooking survivability.

Photos courtesy of Phil White and Mike Musyl

An oceanic white-tip shark is fitted with a harness drilled through the dorsal fin to which an Archival Pop-up tag is attached.

Archival pop-up tags are *fishery independent* and thus do not require fishermen to physically return tags because data are downloaded via the Argos System of polar orbiting satellites. After a pre-programmed pop-off date or if the animal dies and sinks, the tag automatically jettisons and floats to the surface, whereby it transmits archived data to these satellites. The tag is equipped with several "fail-safe" measures to ensure successful downloading of collected data (e.g. pressure, temperature, and a daily geolocation estimate). Changes in light intensity can be used to calculate times of dusk and dawn from which longitude can be estimated from local noon, while latitude can be estimated by day length.

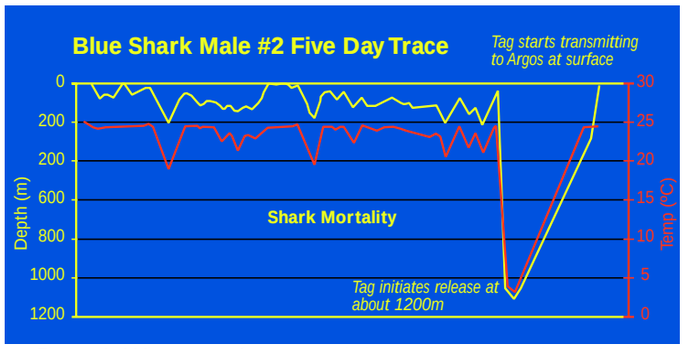

Figure 1. When one of the tagged sharks died and sank, the Archival Pop-up tag jettisoned and uploaded its data.

The type of tag selected for our studies depends on the research questions at hand. For example, we are trying to determine if blue sharks and turtles survive after release from longline fishing gear. If a shark was implanted with a conventional archival tag and it died and sank, we would get no data back. Instead, we chose Archival Pop-up tags to answer our questions about morbidity and mortality in post-released blue shark (and other pelagic species) in the Pacific Ocean because these tags can still provide data in the event of a mortality. Moreover, the data prior to transmissions of data will enable detection of a mortality and allow for differentiation between a shed tag and a dead animal. One of our tagged sharks died and sank, and its tag automatically jettisoned and uploaded its data. According to the temperature and depth chart (Figure 1), the shark showed some apparently normal vertical behaviors for the first five days, then expired. We are confident that this tag's data clearly represented a mortality event—the system worked just like we thought it would for showing the mortality of tagged individuals (i.e., the tag's pressure-sensitive depth-release mechanisms worked properly at about 1200m).

A blue shark is fitted with an Archival Pop-up tag.Telemetry from the tag helps to determine the mortality and morbidity of released sharks from fishing gear.

Obviously we don't view the mortality as a failure because we expected results like this for some of the deployments. We faced a Hobbesian choice in this study. On one hand we didn't want to tag moribund sharks that were obviously going to die, because that wouldn't provide useful information. But we also didn't want to tag only extremely vigorous animals, because that would skew our conclusions as to rates of post-release mortality. Dr. Chris Moyes, a colleague at Queen's University, will conduct analysis of blood samples to look for biochemical correlates of post-release survivability; with some luck, his data should confirm that the tagged shark was in bad shape when released. In view of the results to date, we envisioned archival

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Archival Pop-up Tagging of Pelagic Fishes and Sea Turtles, Continued from page 5

tags deployed on turtles should act in a similar fashion, allowing researchers to determine unequivocally the mortality of released animals.

Preliminary findings have started surfacing (literally) in the initial stages of research projects intended to determine, among other things, the survivability of bigeye tuna *(Thunnus obesus*), yellowfin tuna (*Thunnus albacares*), blue marlin (*Makaira nigricans*), bigeye thresher shark (*Alopias supercillious*), blue shark *(Prionace glauca)*, longfin mako (*Isurus paucus*), oceanic white-tip shark (*Carcharhinus longimanus*), swordfish (*Xiphias gladius)*, and sea turtles (Green *Chelonia mydas)*, Leatherback *Dermochelys coriacea*, Loggerhead *Caretta caretta*, olive ridley *Lepidochelys olivcea*) caught and released from commercial longline gear. We are using model PTT-100 Archival Pop-up tags in our projects to resolve a number of environmental and behavioral details about the animals, including:

1. daily depth distribution and horizontal and vertical movement patterns;
2. the effects of oceanographic conditions on the sharks' vulnerability to longline gear;
3. the survival rates of sharks captured and released from longline gear; and,
4. stock identification, dispersal and possible fishery interactions.

Last November we traveled to Costa Rica where the incidental capture of sea turtles (primarily olive ridleys) in fishing gear is very high. Our goal was to investigate whether free-swimming green turtles exhibited different behaviors than longline caught and released animals. We affixed archival tags to control animals (n=3) (i.e., caught by divers free swimming) and ones caught directly from longline gear (n=4) (Figure 2). Although horizontal movement patterns for the two groups appeared to be similar and indicated neritic behavior, the vertical behavior differed. While turtles that had been hooked rarely made dives greater than 100m depth, control animals frequently made dives beyond 200m depth. Further studies such as these will provide solid baseline data in which to infer the mortality and morbidity of turtles released from fishing gear.

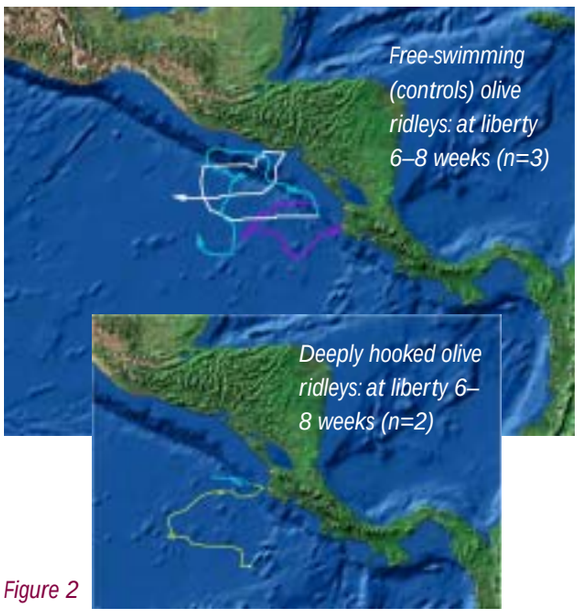

Figure 2

As for the mortality of tags, there are perils out there besides loss due to sinking, implosion, shedding and shark nuptial bites. We got an e-mail from a Japanese longliner to let us know they had pulled in one of our tagged sharks. The funny thing was, no data had uploaded from the tag even though it should have already. We contacted them to ask about it, and it turned out the crew had put the tag in a tackle box or something, and stored it in the wheelhouse. We figure the tag couldn't establish a link with the satellite because its signal couldn't penetrate the metal of the box or the wheelhouse roof. We asked the ship's crew to place the instrument outside and the tag started to transmit archived data on temperature and depth experienced by the shark for nearly one month. ❖

Current field studies are led by NMFS scientist Dr. Richard Brill and by Drs. Michael Musyl and Yonat Swimmer of UH-PFRP. Other personnel contributing to the success of the projects include crew and officers of the NOAA RV *Townsend Cromwell*, Tom Kazama, Dan Curran, and Lianne Mailloux. For more information, contact Mike Musyl (mmusyl@honlab.nmfs.hawaii.edu).

You need to know...about new Argos IDs

You no doubt have noticed that newer Argos ID numbers are larger than those issued years ago. The new Argos ID numbers are larger than 32768 and are "28 bit" IDs whereas the older ID numbers are 32767 or smaller and are "20 bit" IDs. PTTs with 28 bit IDs require a slightly different sensor format than ones with 20 bit IDs. Be sure Argos is aware of the proper sensor format for each PTT ID you are using. (We will be giving Argos sensor format templates to help them insure you have the correct format for your particular PTT.)

We program in the Argos ID provided by you early in the prodction process. However, we run final tests through the satellite before shipment. If the ID is found to be in backup service, or no longer in the customer's program, we cannot access the test data. This brings production to a halt until the problem can be resolved.

Reprogramming your PTT will definitely delay shipment!

***Important!* Be sure the Argos IDs you supply to us:**

- ✔ ***Are in your program***
- ✔ ***Are in active service, not in backup***
- ✔ ***Have the proper sensor format***

For more information, check your* Field Manual *or our website at www.microwavetelemetry.com/Bird_PTTs/FAQs.htm.

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Monitoring Reintroduced Bald Eagles, Continued from page 3

eled to the mainland (Fig. 3), and two (A-05, A-09) died while unsuccessfully attempting to fly between Santa Cruz Island and Anacapa Island, or to the mainland (Fig. 4). The remaining Alaskan bird was picked up alive in the water halfway to the mainland and will be returned to the Santa Cruz Island towers until it is ready to be released again. Of five birds bred by the Zoo, there are currently three on the islands (A-00, A-01, A-02) and the location of one is unknown. The fifth bird (A-03) also failed to make the crossing to Anacapa Island (Fig. 4). From this year's data, it appears as though the Alaskan birds have a greater tendency to migrate, which might be expected for birds from a more northern population. In the future we will likely attempt to acquire eagles for release from populations in California (Zoo and wild), Oregon, and Washington to reduce the number of birds leaving the release area.

The PTT data are also providing us additional information that was not available to us when using traditional VHF transmitters. It appears that birds dying in the water may be a major source of mortality among bald eagles, especially those that have to cross large bodies of water. Prior to using the PTTs, we assumed that most birds made the crossing to the mainland from Santa Catalina Island. During the twenty three years of the Santa Catalina Island project, there have been only four occurrences of birds being found dead or alive in the ocean.

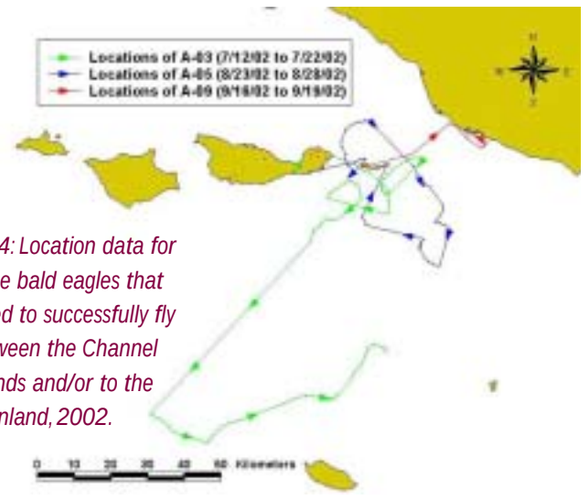


Fig. 4: Location data for three bald eagles that failed to successfully fly between the Channel Islands and/or to the mainland, 2002.

We are also getting information on travel paths and rates that were not previously available. The two birds that are currently on the mainland moved an average of about 200 km/day during their initial dispersal. One bird (A-07) flew approximately 1500 km, to southwestern Wyoming, in only eight days, and A-04 flew approximately 850 km in four days (Fig. 3). Prior to using the PTTs, we depended on reports of eagle sightings (primarily of the wingmarkers) to get information on mainland bird locations, general travel rates, and survival.

Over the next few years, the PTT data should provide us a clearer picture of the outcome of our reintroduction efforts than has been possible in the past, allowing us to modify our techniques. ❖

Fig. 3: Movements of two bald eagles that flew to the mainland during September and October, 2002

For more information on this and other projects conducted by IWS, please visit our website at www.iws.org.

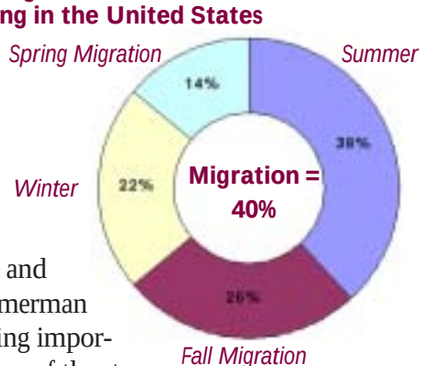
Yankeetown students: Continued from page 4

rapidly evolving from forest to ranchland to intensive row-crop agriculture. The students are learning about these places as they map the travels of swallow-tailed kites and see and hear what we have learned there with our field work; there are obvious connections between the project's biology lessons and related ones in math, geography, and social studies.

These pursuits will be enough to fuel hours of classroom learning until spring, when the kites return. Then it will be time to involve the students in finding nests, looking for radio-tagged kites, monitoring nesting progress, and perhaps helping to capture and mark a few more birds. The swallow-tailed kites they have followed from afar through fall and winter will be back with them, within sight, and within their care.

There have been many generous contributors to the broad project of which the Yankeetown school program is a part: Florida Fish and Wildlife Conservation Commission, Disney Wildlife Conservation Fund, Felburn Foundation, Georgia Department of Natural Resources, Plum Creek Timber Company, and the U.S. Fish and Wildlife Service.

Relative proportions of breeding, wintering, and migration seasons for swallow-tailed kites nesting in the United States



Audrey Washburn and Gina Zimmerman are providing important chapters of the story with their challenging graduate research on swallow-tailed kite genetics and migration stopover ecology (respectively). We all hope that we can continue the program with the Yankeetown students, perhaps even expanding it to other schools. We offer a special thanks to Genie Sturtevant for adding this project to the challenge of doing so much with so little, and to Microwave Telemetry for creating their grant program. ❖

New to Our Staff...

Lauren joined the crew at Microwave Telemetry in February of this year. She is the friendly voice at the other end of the phone line and the one who answers your e-mails. Her duties include customer service, scheduling, shipping, correspondence—pretty much everything except building the transmitters!

Lauren is a recent graduate of Rollins College in Winter Park, Florida where she earned a degree in Anthropology.

Off hours, you might find Lauren playing ultimate frisbee for the Fillet Minyaks in a league down on the National Mall in Washington, DC. She also loves to cook and is something of a wine connoisseur.

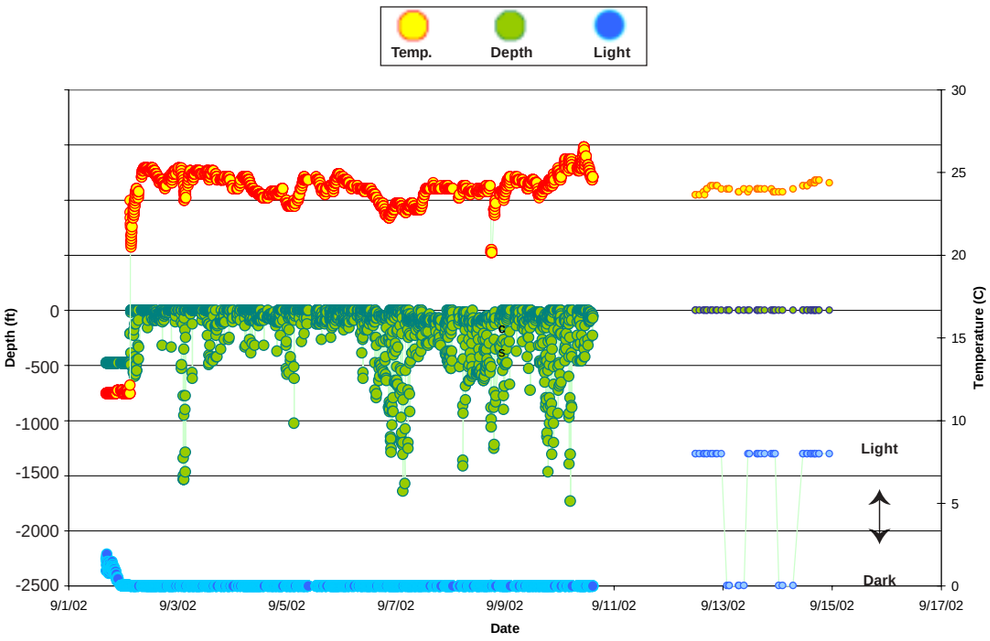
Lauren shares an office with Napoleon, a Siamese fighting beta fish (no need to track him because he doesn't go anywhere). He has become the office mascot and swims around to greet whomever comes into Lauren's office.

Lauren and Napoleon hard at work

Pop-up Tag Reveals Surprising Results from Recycled Marlin

John Graves
Virginia Institute of Marine Science

Temperature, Depth and Light Readings from "Recycled, Regurgitated" White Marlin



Dave Kerstetter, a graduate student at the Virginia Institute of Marine Science, is using Archival Pop-up tags to study survival and habitat utilization of white marlin released from commercial pelagic longline gear. On August 31, Dave was fishing on the F/V *Carol Ann* and deployed a pop-up tag programmed to release in ten days on a 50 pound white marlin caught off the southwest corner of Georges Bank. From the light level data collected by the tag, the animal appeared to have died and was on the bottom (i.e., no recorded light) for almost the entire time, but the temperature and depth (pressure) data suggest otherwise. After ten hours at 12° C water at 400 feet, the tag began to record both warmer temperatures and depths ranging from the surface to over 1800 feet, even though there was no light recorded.

What happened? Apparently, the white marlin died and sank to the bottom soon after tagging. After about ten hours, the white marlin (with the tag still attached) was eaten by a large shark and the tag continued to collect data from within the shark's gut.

The tag appears to have released from the remainder of the marlin on schedule, but it took another day and a half for the shark to regurgitate the tag, providing an opportunity for it to float to the surface and transmit its most unusual data.

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