Traditionally one of the biggest obstacles facing wildlife biologist has been the gathering of positional data concerning movements and migrations of wide ranging species. This pertains particularly to pelagic marine life, highly migratory birds, and large migratory mammal species. Traditional means of tracking wildlife included such methods as tag-recapture studies, such as bird banding, or attaching a form of radio transmitter tag and following the animal over the course of a migration.

The accuracy and feasibility of such applications is hindered on several levels. In the case of bird banding results rely on the recapture of banded birds. The recovery rate of banded birds is normally very low which can lead to a severe lack of reliable data (Higuchi et al 2004, Meyburg et al 2003). The use of radio transmitters on marine and terrestrial animals requires the animal to be followed by the researcher by following the radio signal, this is both time consuming and expensive. Limiting the time and distance that a species can be tracked. Additionally species that migrate long distances may cross many political boundaries where access to the animal may be restricted for political reasons (Higuchi et al 2004).

Satellite telemetry is an up and coming means of remotely obtaining positional data that side steps most problems associated with traditional long range tracking methods. In 1978 the ARGOS system was launched as a joint venture between the French Government and NOAA (Argos 1996). The ARGOS system consists of low orbiting satellites that receive transmissions from land based transmitting platforms (PTTs). The satellites then calculate the position of the transmitter and send the information to a land based data station that relays the data to the subscribed user (). While the technology was originally intended for collecting oceanographic data and as a safety devise for expeditions into remote areas use of the ARGOS system is becoming widely accepted in the biology world for tracking wildlife, and has led to some important discoveries such as an unknown migration route for Steppe Eagles migrating from Asia to Africa (Meyburg et al 2003), the expansive use of the Atlantic ocean by Bluefin Tuna (Block et al 1998), or the un expected pelagic nature of Pacific White Sharks (Boustany et al 2002).

Since the ARGOS system is primarily used to collect data on geographic positions the data is easily integrated into a GIS. The data is entered as geographic points, similar to GPS readings. The most obvious application is the ability to simply map the data accurately, allowing the researcher to visualize such things as migration routes. Once the data is mapped distances traveled can be easily calculated with GIS software tools and since the time each data point was collected is known the speed of travel between each point can be calculated.

The integration of satellite telemetry data and GIS becomes most potent when the AROS data is overlaid with other data sets. The ability to observe wildlife movements and behavior in relation to environmental data has a number of implications for both conservation and behavioral ecology. It appears as though this ability has not been fully exploited by a large number of wildlife biologists however some recent studies show the potency of integrating ARGOS data with more complex data sets in the context of a GIS.

Some of the best examples come from studies of marine animals. For instance Block et al (1998) plotted the movement of Atlantic Bluefin Tuna with AVHRR (advanced...
very-high resolution radiometer) sea surface temperature data, showing that despite the
tuna's warm bodied physiology they preferred the warmer water masses as they moved
up the coast. Nichols et al (2000) traced the movement of a Loggerhead Turtle across
the Pacific Ocean in relation to data on sea currents. The authors calculated the speed
the turtle was traveling between each data point and examined it in context of the sea
currents and strength, concluding that turtles travel in a path that minimizes swimming
against strong currents.

A great example of the conservation implications of integrating ARGOS data with
GIS is the work done by Higuchi and associates (2004) on White-naped Cranes in
Russian and Asia. The authors tracked the movements of White-naped Cranes from
their breeding sites in Russia to their wintering sites in China and Japan. They identified
important stop over wintering areas and by mapping bird with land use data found that a
large number of birds relied heavily on sites that fell outside of conservation lands, thus
identifying areas that should be considered for protection.

Information on migration seems to be the most popular use of ARGOS tracking,
however since PTTs are being designed with sensors that can relay more then
geospatial data (this is particularly true with marine PTTs) disciplines such as
environmental physiology have adopted the technology. For instance data on dive depth
and time can be collected along with geospatial data; this data can be collected for a
marine mammal and plotted with such things as sea temperature, bottom topography,
and ocean currents. This can be used to determine how environmental conditions may
affect when, how long, and how deep an animal dives (Fedack et al 2002). On a spatial
scale smaller then a multi-continent migration, satellite telemetry can be used to
determine home range characteristics in more sedentary situations (McGrady et al
2002).

While ARGOS satellite telemetry over comes a lot of pitfalls of other long range
telemetry techniques it is not fool proof. Money is one issue, PTTs are expensive,
running up to several thousands dollars a piece, and the researcher must pay for use of
the ARGOS system. Although it is possible that in the long run the investment is
cheaper then physically tracking a migrant very long distances. The practical problems
associated with obtaining and tagging organisms still exist. Prior to tag deployment the
investigator must program how often the transmitter is on and how often to transmit to
satellites. These setting must take into account battery life of the PPT, money, the
desired length of time of data collection, and the type of data desired. This can vary
tremendously depending on the specific project. Battery life and tag size are important
for instance tag size puts a lower limit on the size of birds that cane be studied.
Transmitters can a do fail and fall off animals prematurely.

Additionally, raw data received must be examined closely prior to being
analyzed. Location accuracy can vary tremendously for each data point. The ARGOS
system assigns an index of accuracy for the longitude and latitude of each point; LC3 is
within 150m, LC2 150-350m, LC1 350-1000m, LC0 >1000m, LCA and LCB arte not
assigned a value by ARGOS (Argos 1996). Which points to use in analysis should be
based on LC index as decreases in accuracy can have sever implications in the quality
of subsequent data analysis (Hays et al 2001). Most studies use only points with an LC
index of 1-3 ( see Block et al 1998, Nichols et al 2000, Higuchi et al 2004, Meyburg et al

While not fool proof or automatic ARGOS tracking is none the less a very
effective means of tracking wildlife over long distances. The integration with GIS is
naturally and can advance ecological studies and have profound benefits on
conservation, particularly for species who’s’ ranges encompass many political bounds. It
seems that full integration (beyond simple mapping) of data gathered by satellite
telemetry is not generally utilized to its full potential, at least not yet. It is this author’s hope that the two technologies will be used in greater conjunction in the future.

**Literature Cited**


**Annotated Bibliography**

This is one of the first papers to use pop-up archival satellite tags on a marine animal. The authors tracked short and long term movements of medium and giant bluefin tuna caught on wintering grounds off the coast of North Carolina. Location of release and the point at which the PTT “popped off” are reported. GIS was used to over lay the points on averaged seas surface temperature data. This showed that as the tuna moved north in the spring and summer they favored areas of warmer water. The PTTs also recorded ambient temperature so this tested the accuracy of the temperature data loggers, which were surprisingly accurate, with in a degree.


This studied wanted to test the hypothesis that Loggerhead turtles use the entire Pacific Ocean from Japan to California during their life cycle. They tracked an adult that was released off Baja across the pacific to breeding grounds in Northern Japan. GIS was utilized to overlay the path of the turtle with data on sea currents direction and speed (NOAA world Atlas data). It showed that the turtle avoided swift currents, when it reached the coast of Japan it was carried northward by swift currents in the area. Average speed between each data point was calculated, in this paper the authors only used data points with a LC of 2 or above. My one problem with this paper doesn’t lie in the GIS application but in the fact that an adult captive turtle was used when only juveniles are ever found in the area where it was released.


This was good paper because it investigated the effects of positional accuracy on data analysis. It first tested the accuracy of the LC index values and attempted to get a value for LC A and LC B which ARGOS gives no data for. They did this by placing PTTs in fixed locations and averaging the accuracy of locations gathered for each class. It turned out that LC A was comparable to LC 1 and that LC 0 was the least accurate. The authors then illustrate how large inaccuracies in location data can affect data by a series of hypothetical speed calculations.


Peregrine falcons were captured on wintering grounds on the gulf of Mexico and fitted with PTT backpacks. The interesting thing abut this paper is that is analyzed movement on a small spatial scale. Transmitters where set to transmit long and often for the first 35 cycles which generated a large amount of data in the few months the birds where on winter grounds. With this concentrated data the authors were able to use GIS software to design polygons representing each bird’s winter home range. After the first 35 cycles the amount and time of transmission was reduced and the birds were tracked until battery failure, up into their summer breeding grounds. The birds wintering Mexico had a surprising geographic range of breeding sites spread all across sub-arctic Canada.

White-naped Cranes, an endangered species, were fitted with PTT tags on their breeding grounds in Russia and tracked as they migrated south into China and Japan for the winter. Important migration rest-over and winter —over location were identified. Areas of heavy use (high data locations) were mapped with land use data obtained from various sources to determine if the cranes were using conservation areas. Most of the area used by cranes as winter or rest locations was not within the boundaries of conserved land; these areas are threatened by human disturbances including development. The authors suggest areas that should be considered for protection. This paper brings out the difficulties of working over large political areas; four countries were involved, however it also showed that satellite telemetry is a viable option for studying migrations across political boundaries.


The timing, migration and the wintering locations of ospreys breeding in three different regions of North America, the east, mid-west, and west coast. GIS was used simply to map migration routes and wintering and summer locations. Timing of migration, the routes taken, as well as the wintering locations differed across each region. Birds in the East migrated the earliest and wintered the furthest south, well into South America. Birds in the West commonly only traveled as far south as Central America/Mexico. The paper provided data on the success rates of data return, 60% of transmitters gave fall and winter data, 18% only fall data, 18% failed before fall migration, and only 4% transmitted into a second fall.