



Lioness with tracking collar. Photo iStockphoto.com

The nature trail

Tracking and telemetry have emerged as vitally important conservation tools in the past few years. GPS and satellite-based services can assist those working to save species in ways that early conservationists could only have dreamed of. Helen Jameson assesses the benefits and how satellite technology is literally saving endangered species.

Scientists and conservationists are using satellite technology now more than ever due to the fact that tracking and telemetry can give extraordinary access to information that was previously unavailable to those working in the scientific environment. Satellite tracking and telemetry can give a complete view of the world from the tops of mountains to the bottom of the oceans and can track the

movements of all types of species from mammals to birds to fish. Incredibly detailed information on migration patterns help the scientific community to understand their movements and therefore to protect them.

Not only is tracking and telemetry vital for animal conservation but it plays a huge part in the fishing and maritime industries and in



- Locating buoys;
- Fishing vessels;
- Wildlife;
- Ocean temperature profiles to;
- River levels or animal heart rates;
- Observing the oceans;
- Measuring ocean currents, temperature and salinity;
- Monitoring public health ;
- Managing fisheries; and
- Enforcing maritime security.

Governments use Argos to protect marine ecosystems and ensure responsible fishing.

Argos is used to observe the oceans and understand climate change. Yacht races depend on Argos beacons to track race progress. Scientists use Argos to better monitor and understand wildlife.

How does Argos work?

The only system currently available to offer wildlife tracking and telemetry is Argos. The system depends on a constellation of five polar-orbiting satellites located at around 850km above the earth's surface. The satellites receive signals emitted from special radio transmitters called Platform Transmitter Terminals or PTTs that are attached to the animal to be tracked. And these PTTs can also be fitted with sensors that may collect additional environmental data along the way.

The signals operate at a fixed frequency of 401.650MHz and are emitted every 50-90 seconds. The information is then relayed in real-time to one of the Argos System's earth stations in France, Alaska or the US.

The principal feature of Argos is the fact that it can locate the PTT anywhere on the earth using the Doppler Effect. Each time one of the satellites receives a message from a PTT it measures the frequency of the signal by comparing it with the nominal frequency of 401.650 MHz and the system is then able to measure the Doppler shift in the frequency of the transmission from the relative motion of the satellite and the transmitter. This difference will then dictate the region of the earth from where the signal was sent which is determined by the curve joining the points of constant Doppler effect. Once this process is repeated at least twice, the system can geometrically establish the location of the transmitter that will be at the intersection of the various curves calculated. The resulting information is then collated and posted onto the Internet allowing users to know the position of the transmitter and therefore the animal being tracked in several hours time. The accuracy of the location obviously depends on how many signals were received and it must be remembered that the signals do not travel through water meaning that the tracking of turtles, for example, would take place when they come to the surface of the water.

The Argos instrumentation flies on board the National Oceanic and Atmospheric Administration's (NOAA) satellites. It is also planned that they will also feature on board the new EuMetSat's MetOp satellites to be launched in 2010 and 2014.

Both MetOp and NOAA satellites see the North and South Poles on each orbital revolution. The orbital plane rotates around the polar axis at the same rate as the Earth around the Sun, or one complete revolution per year. Each orbital revolution transects the equatorial plane at fixed local solar times. Therefore, each satellite passes within visibility of any given transmitter at almost the same local time each day. The time taken to complete a revolution around the Earth is approximately 100 minutes.

Argos applications

Public Health and Well-Being - In developing countries, the risk of food shortage and epidemic outbreak is high. Yet, there are often no surveillance systems in place to detect early warning signs. Because they are dependable and easy-to-use, Argos terminals are used by

the monitoring of oceans and ocean currents and also the security of the maritime environment.

Tracking devices must be compact, weatherproof and rugged, lightweight and contain an antenna and battery. These transmitters can weigh as little as 20 grams and can be mounted onto the animal in various different ways. There are issues surrounding the life of the battery which will need to last a long period of time and also will have to consume very little power per transmission. Solar power however, is providing an alternative means of powering the battery nowadays.

Argos

Argos is a unique worldwide location and data collection system dedicated to studying and protecting the environment by satellite. Since 1978, Argos has responded to the needs of the world's scientific and industrial communities. Argos gives scientists a tool to enhance their understanding of our environment and helps industry comply with environmental protection regulations. Today, over 16,000 Argos transmitters are active each month worldwide.

Applications of the Argos system include:



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many humanitarian aid programs to relay crucial information from remote areas. In Africa and the Middle East, Argos terminals are used to monitor school attendance and food distribution data. Argos terminals are also used for early detection and warning of communicable disease outbreaks (such as malaria, cholera...), by relaying information about case loads and drug availability from remote areas to health ministries. Information relayed by Argos allows local, national or international organisations to better monitor and manage aid programs and prevent humanitarian crises.

Monitoring Water Resources - Fresh water resources and supplying enough water for the world's growing population are increasingly important issues. Today, water in rivers, lakes and wetlands only represents 0.3 percent of the world's freshwater. The loss of freshwater resources has an impact on food availability, water quality, public health, climate and can even lead to environmental disasters. Major national and international programs run by national governments or the World Meteorological Organization (WMO) use Argos to relay key data: water level of a river, snow cover, state of installed equipment or dams. These Argos-based monitoring programs increasingly help the global community to better manage and distribute available water resources.

Managing and Protecting Marine Ecosystems - The future of our fisheries depends to a large extent on our ability to preserve stocks effectively. As a result, most coastal nations now mandate fishing vessels operating within their Exclusive Economic Zone (EEZ) to be equipped with a satellite-based vessel monitoring system (VMS). Argos provides a global solution, ArgoNet, which meets the requirement for monitoring fishing vessels and their catches. Argos has been certified by most of the leading seaboard nations around the world and is already operating on thousands of vessels worldwide.

Improving Maritime Security - To improve the security of mari-

time transportation, the International Maritime Organization (IMO) has mandated all passenger and cargo ships over 500 gross tonnage to install a Ship Security Alert System (SSAS). The comprehensive ShipLoc product uses the Argos system to allow ship owners to meet IMO standards and keep constant track of their fleet. If intruders board a ship, ShipLoc lets the crew send an alert signal automatically and discreetly to teams ashore. ShipLoc is part of an exclusive agreement with the International Maritime Bureau's Piracy Reporting Centre and is the only product on the market to be a proven antipiracy tool.

Tracking adventurers and yacht races - Argos has been a reference for over 25 years for adventurers and yacht racers as the unique location and data collection system fully adapted to the most extreme environments on the planet. The trustworthy Argos transmitter sends fully automatic signals at regular intervals, tracking the exact progress of expeditions and reassuring the adventurers' family and base. Similarly, yacht racers count on the robustness of Argos to track their boats as they whip around the globe through treacherous waters. The Argos processing centres are open 365 days/year, 24 hrs/day, monitoring all incoming data and location calculations, and ensuring the most accurate and up-to-date information possible.

Argos is also an important part of programmes to prevent and manage human and natural disasters. Argos buoys deployed in oil spills help scientists and governments to lead targeted cleanup efforts, by tracking the spill's movement. Furthermore, Argos platforms are part of early warning systems for volcanic activity in Japan and Indonesia, alerting observatories as soon as seismic activity is detected. When it comes to managing energy resources, Argos is present as well, helping predict the amount of hydraulic energy based on snow melt rates and water levels high in the mountains.



Satellite tracking of wild birds

Satellite tracking of peregrine falcons is not new. The Peregrine Fund in Boise, Idaho, widely recognised as the leader of North America's peregrine recovery effort, has studied hundreds of peregrines in this manner over the years, including many juveniles. Previous experience with satellite telemetry by the Peregrine Fund in central and western North America has demonstrated that satellite transmitters have no bearing on the flying and hunting behaviour of the birds, or the reproductive success of the peregrines wearing them.

Solar-powered satellite transmitters were obtained through the Canadian Peregrine Foundation for deployment on peregrines in this project. These units have been found to be more reliable than battery-powered transmitters and can transmit signals more frequently and for a longer duration. Canadian Peregrine Foundation personnel and Game Commission wildlife biologists will attach transmitters to those birds captured for the study. The 18-gram transmitter (less than 3 percent of a male's body weight) will be attached with a snug, but comfortable neoprene harness that wraps around the body. The harness will be attached to the transmitter and fitted on the bird in a process that takes about one hour. The young birds are hooded and kept as comfortable as possible during the fitting. They usually adapt quickly to their new backpacks.

Radio transmitter signals are received on the France/NASA ARGOS Satellite and relayed to the Canadian Peregrine Foundation via the Internet. The data collected from all transmitters will then be converted to latitude and longitude for posting on the website and relayed to all partners.

Location coordinates will be recorded and entered into an Arc Info compatible database. Once entered, the data will be plotted on a corresponding digital map of Pennsylvania, and later on maps of eastern North America, the Caribbean, and, if necessary, South America. These maps will be posted on this website.

Funding for this programme is provided currently by the federal Wildlife Conservation and Restoration Program and from the state Department of Environmental Protection. The Game Commission administers the funds and provides logistical support and coordination. Many volunteer hours, by falcon watchers, and supporting roles, including webmasters and GIS expertise, are essential to make this process a success and make the information available to you.

GPS Tracking

The Global Positioning System consists of a set of 24 operational satellites and land-based control stations. The system was designed for and is operated by the US military, owned by the US Department of Defense (DoD). Worldwide coverage is available to all civil GPS users free of charge.

GPS determines distance between a GPS satellite and a GPS receiver by measuring the amount of time it takes a radio signal to travel from the satellite to the receiver. Radio waves travel at the speed of light, which is about 300,000 kilometres per second. Therefore, if the amount of time it takes for the signal to travel from the satellite to the receiver is known, the distance from the satellite to the receiver ($\text{distance} = \text{speed} \times \text{time}$) can be determined. If the exact time when the signal was transmitted and the exact time when it was received are known, the signals travel time can be determined.

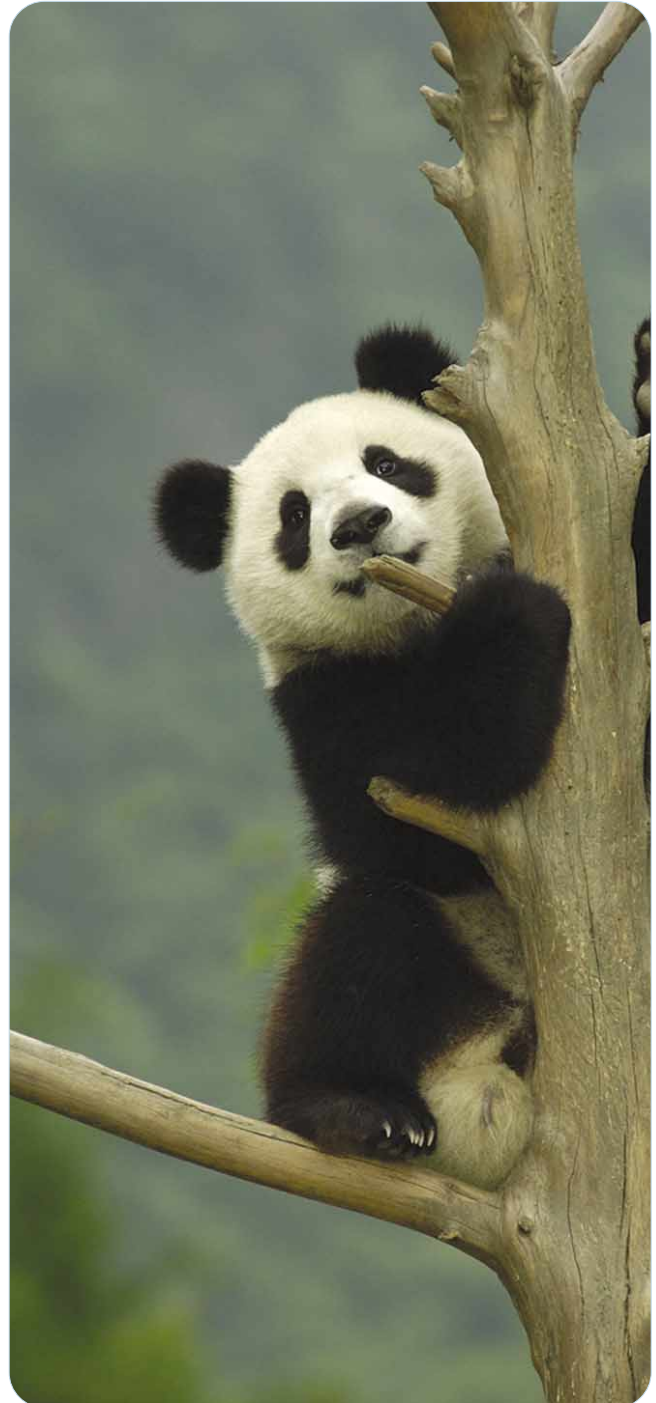
In order to do this, the satellites and the receivers use very accurate clocks which are synchronized so that they generate the same code at exactly the same time. The code received from the satellite can be compared with the code generated by the receiver. By comparing the codes, the time difference between when the satellite generated the code and when the receiver generated the code can be determined. This interval is the travel time of the code.

Each satellite transmits a coded signal on two carrier frequencies that says, amongst other things, where it is in the sky. In its simplest form a GPS receiver receives the signal from the GPS satellite and uses the code to determine its distance from the satellite. If the distance to four satellites can be determined simultaneously, then

the receiver can calculate its own position in real time. A position calculated in this way is typically accurate to within 5 - 15 metres

It was in 1991 when the GPS system was first used for wildlife tracking and telemetry. Since this time, the systems have improved – they are now cheaper, smaller, lighter and can retain huge amounts of data.

It really is incredible when you actually realise just how much information can be obtained from systems such as Argos and GPS about the wildlife and environment of our planet. ●



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