

SOUTH AFRICAN PENGUINS

USING TECHNOLOGY TO MONITOR THREATENED BIRDS



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Robben Island, off Cape Town, South Africa — Crawling underneath the bush, thorns catching her clothes, the penguin researcher stretches her arm between a tangle of branches towards the alert and defensive penguin. Gently placing the end of a pole under the bird's white breast, she lifts the parent up off the nest. The penguin bites at the pole a couple of times and waits tentatively as the scientist checks beneath its body for eggs — or chicks. Amongst the twigs, feathers, and dirt, she spies a tiny fuzzy chick, its eyes still closed. "P1," she quietly calls out to a fellow researcher. "P" referring to penguin and "1" referring to a newly hatched chick. The scientists are monitoring the nests of threatened African penguins on Robben Island, South Africa. The researchers carefully note the relevant data, including the band number on the penguin's left flipper and move on to the next study nest.

PENGUINS OF AFRICA

It might surprise you to find out that penguins do not just live in the Antarctic. In fact, of the 17 species of penguins, only four actually live in or around Antarctica. The African penguin, *Spheniscus demersus*, is the only species of penguin that breeds in Africa, but others live in Australia, off the coasts of Chile, and as far north as the Galapagos Islands. The coast of southern Africa is an appealing location for penguins because of the offshore islands for breeding and the cold, nutrient-rich Benguela current, which originates in the Southern Ocean. As strong trade winds sweep across the southern African coastline they cause an upwelling of cold Antarctic waters, creating a fertile environment for phytoplankton, a major food source for marine life. Enormous schools of anchovies and other fish come to feed on the plankton, making this one of the richest fishing grounds in the world, both for people and penguins.

Once numbering 1.5 million, the population of African penguins has declined by 90 percent in the last century. Today there are only 56,000 breeding pairs of African penguins remaining. Robben Island, an island off of Cape Town, South Africa, is home to the third largest African penguin colony in the world, with roughly 6,000 breeding pairs, and is the research site for the *South African Penguins* research project.

ROBBEN ISLAND

"It is an absolute privilege to live and work on Robben Island, where Mandela and other political opponents were imprisoned, and which is now a symbol of freedom for South Africa. As PI Les Underhill states, the island breathes this history and you can feel it deeply. This might be the only place in the world where volunteers can work in a wild penguin colony. I appreciated every day there. African penguins are amazing birds and I can't imagine a planet without them. This project goes a long way towards ensuring their survival."
 — Earthwatch volunteer

GOOD INSULATION

The penguin's feather density is greater than that of any other bird in the world. They have up to 80 feathers per square inch! These tightly placed feathers insulate the penguins, protecting them from cold water and wind.



THE *TREASURE* OIL SPILL

In 2000, the tanker *Treasure* spilled 1300 tons of oil between Robben and Dassen islands, threatening 40 percent of the remaining African penguins. The Southern African Foundation for the Conservation of Coastal Birds (SANCCOB) launched a huge rehabilitation effort, cleaning around 20,000 oiled birds and transporting more than 19,000 un-oiled birds via sheep-shipping trucks roughly 800 kilometers away for release. Three of the birds, called Pamela, Peter, and Percy, were fitted with satellite transmitters, and their movements carefully monitored. Peter's tracking device revealed that he was the first to return to Robben Island, making the journey in just 15 days. In June 2004, Peter Barham spotted Peter the penguin alive and well.

WHAT HAPPENED TO THE PENGUINS?

The 19th century was not a good century for penguins. Sailors and settlers in Africa hunted these birds for oil, feathers, leather, and meat, and also gathered their eggs for food. Penguin eggs are large, and were considered a delicacy. In one year, more than 700,000 African penguin eggs were collected from African penguin breeding colonies.

Also in the 19th century, European and North American traders discovered that **guano**, or penguin excrement, was a great source of nitrogen, and harvested tons of this "white gold" to sell to farmers for fertilizer. Decades of guano harvesting eventually denuded the islands of their layers of guano, which was bad news for the African penguins because the harvest deprived them of their primary nest-building material. With most of the guano removed, African penguins are forced to nest in the open on their rocky, often bushless islands. Without the protection of burrows, penguin eggs and chicks are more vulnerable to predators and temperature fluctuations.

Today, penguins are protected from hunting and guano harvesting, but the threats they face are more wide-spread and harder to control: competition with commercial fisheries for anchovies and sardines, their main food sources, are becoming a major issue for the birds, as is pollution of their habitat by oil. Disastrous oil spills, as well as the illegal dumping of excess oil by tankers, greatly endanger all kinds of coastal birds, including penguins. Penguins rely on the insulation of their feathers to protect them from the cold water. When oil damages their feathers, penguins are not able to keep warm. They then have to stop feeding and swim ashore, where they attempt to preen, ingesting the toxic oil. Unless the penguins are rescued and washed, they die from ingesting the oil.

PENGUINS AND THE PHYSICS OF TAGS

Long-time penguin enthusiast Dr. Peter Barham, a **polymer** physicist at Bristol University in the U.K., became involved in penguin research when he learned that the steel tags researchers used to tag penguins were problematic for the penguins. Tagging animals for identification is one of the oldest research techniques in the study of animal populations. Tagging allows researchers to recognize individuals and gather data on longevity, movements, behavior, breeding success, and population dynamics. However, when tagging wild animals, researchers require tags that will not hinder an animal's normal activity or adversely affect the animal's well-being. With small animals, like African penguins, this can be quite a challenge.

Traditionally, penguin researchers have used metal bands attached to the upper part of the flipper to tag penguins. However, these bands increase the **hydrodynamic** drag on swimming penguins and cause feather wear. If penguins have to exert more energy when hunting and lose heat through bare patches on their skin, they need to catch more fish to maintain their energy and feed their chicks — making the tag expensive, in terms of energy, to the penguin. The steel bands also sometimes catch on bushes, causing the tangled penguins stress and injury, exactly what researchers want to avoid.

To address these problems, Barham is developing and field-testing new kinds of **silicon** bands on Robben Island's penguins. These tags are designed to prevent feather wear and reduce drag when penguins are swimming. They hope that these high-tech tags will enable researchers to study penguins without costing the birds' precious energy.

TESTING NEW TAGS

Working with a team of scientists coordinated by Dr. Leslie Underhill, Dr. Robert Crawford (Marine and Coastal Management), and Barham, the researchers are tagging penguins on Robben Island. First, researchers search for suitable study nests. The researchers select nests that are easily accessible and have either eggs or small chicks and parents without bands. Then, they record the location of the study nest using a Global Positioning System (GPS) so that they can find the nest site later. The nests are divided into three groups: those with unbanded penguins, those with penguins that will be banded with silicon tags, and those that will be banded with conventional steel tags. Over time, scientists compare data from each study group. When researchers check the nests, they record breeding data in notebooks and on data sheets. The researchers mark one of the birds on the side of its head

with a pink dye, called rhodamon, so that they can easily distinguish the bird from its partner — penguins are **monogamous** and generally mate for life. Both male and female penguins take turns sitting on the nest while the partner hunts at sea.

In addition to comparing the breeding success of banded and unbanded birds, researchers also monitor the steel-banded birds by a process called “re-trapping.” This observation technique does not actually involve any trapping or handling of the birds. Instead, using binoculars or a spotting scope, researchers watch the penguin highways (well-worn paths to and from the sea), breeding colonies, and beaches and record the tag numbers of the birds they see.

Many of the birds with steel tags were rescued during the 2000 *Treasure* tanker oil spill, which affected nearly 40,000 African penguins. All of the rehabilitated birds were given steel tags upon their release. In total, more than 10 percent of African penguins have at some point been oiled, cleaned, and released. By keeping track of these birds, scientists can monitor how the penguins are recovering from the *Treasure* oil spill, among others.

The research teams also walk **transects** of certain penguin nesting areas to get a better idea of how many breeding pairs live on Robben Island. This involves walking along an invisible line, counting how many nests there are, and noting the activity in each nest. All data collected during the field research is entered into a computer each evening and is eventually analyzed by University of Cape Town students under the supervision of Underhill.

Part of understanding penguin **population dynamics** involves gathering data on the habitat. Researchers drive around the island counting antelope species, rabbits, and feral cats to get a better understanding of the island’s wildlife. Because the feral cats prey on penguin chicks and eggs, they are being removed from the island whenever possible. The counts enable the researchers to keep track of any changes and find out whether any species are competing with one another for habitat or food. As the penguin colony grows, it needs increasing amounts of habitat for breeding. Researchers need to monitor any degradation of penguin habitat, for example, rabbits eating the vegetation that penguins rely on for protection from predators.

The research team also monitors other bird colonies, such as swift terns, Hartlaub’s gulls and endangered bank cormorants, to determine their breeding success and survival.

GETTING RESULTS

Though the tags have required some design improvements, Barham, Crawford, Underhill, and their research teams have yet to find any negative effects of the new tags on penguins in the wild. In fact, pairs of birds with the new bands raise a similar number of chicks as do penguins with steel bands and those with no bands. After studying the numbers of eggs laid, chicks hatched, and chicks fledged from the different groups, the data revealed that there were no statistically significant differences in the productivity of penguins fitted with new and old bands. The researchers concluded that the new plastic tags do not have any significant drawbacks. Additionally, researchers in the field noted that the new tags were much easier to read from a distance than the steel tags and that they can be fitted more quickly and easily on the penguin’s flipper. The new material also decreases the chances that penguins can become entangled in bushes. If penguins do get caught, the flexibility of the plastic would allow them a greater chance of freeing themselves.

Barham, Underhill, and Crawford will use the new bands to begin a long-term study of African penguin productivity. The scientists hope to eventually make the new bands available to penguin scientists all over the world.

Researchers on Robben Island have also been able to provide valuable data on the fate of the penguins cleaned and released following the *Treasure* oil spill. So far, the team has recorded about 7,000 penguins that were involved in the spill. In 2001, data gathered by the research teams showed that between 45 and 70 percent of the oil-covered Robben Island penguins returned to the island within one year, and that many of these birds were breeding.

Barham, Crawford, and Underhill’s research helps scientists monitor the lifetime productivity and survival of penguins so that the proper conservation



A PENGUIN PERSON

Dr. Peter Barham became interested in penguins after meeting his wife Barbara, an avid penguin watcher. Together, they have taken trips to see all 17 species of penguins in the wild, including two visits to Antarctica. In 1996, the Barhams attended the International Penguin Conference in Cape Town and met the world’s leading penguin biologists. Barham, an expert in Materials Science through his work as a polymer physicist, discussed the problems of steel flipper tags with the researchers. Together, they came up with a project to design and test new silicon-rubber bands on Robben Island’s penguins. Barham has been leading the research for the last four years with funding from Earthwatch Institute. His team includes scientists from South Africa and the UK and volunteers from all over the world. When not studying penguins, Barham is a physics reader at the University of Bristol in the UK. He can often be seen at scientific conferences wearing one of his 130 penguin ties.

management measures can be put into place. Results of the research were discussed in a workshop to develop a policy for banding penguins in South Africa. In 2005, the country will use Barham's, Underhill's, and Crawford's data to revise its Sea Birds and Seals Protection Act of 1973. The project's results will also be incorporated into sea bird conservation plans and will influence laws governing the total allowable catches of the fishing industry and management of the fisheries overall. This will take into account the approaches recommended by the World Summit on Sustainable Development and help policy makers determine where to establish protected marine areas. The research will also contribute to understanding the health of the Benguela ecosystem in South Africa, upon which penguins and other wildlife rely. Finally, the data collected will ensure that tourism to the penguin colonies does not harm penguins by disrupting their breeding behavior and success.

Over the next 10-15 years, the researchers will use the new bands to research the reproductive success, nest fidelity, partner fidelity, breeding time and survival of the birds nesting within a particular study area. Information about abundance of prey, oil spills, and other factors influencing population trends will be used to analyze the data. This research will be crucial for long-term conservation planning for African penguins.

One of Barham's students is also testing new technology based on computer-aided pattern recognition that would enable researchers in the field to identify individual penguins by the unique spot pattern on their chests. This would eliminate the need for banding penguins. The system would involve a camera in the field, run by solar power and controlled by a laptop up to 400 meters away, which would photograph and extract the spot pattern on the chest of each penguin that passes by. A **biometrical** identifier would be generated for each penguin based on the pattern properties. Each penguin's 'fingerprint' would be collected by a server and compiled in a database, which would enable researchers to easily identify individual penguins and ultimately monitor penguin activity, movements over time, and population trends.

FIND OUT MORE

Books

Whittington, P. 2001. *The Adventures of Peter the Penguin*. The ADU Press.

*Author is former project PI.

Hockey, P. 2001. *The African Penguin: A Natural History*. Struik Publishers.

Web sites

SANCCOB

<http://www.sanccob.co.za/>

Bristol Zoo Gardens webpage on African Penguins (PI Duncan Bolton is Curator)

<http://www.bristolzoo.org.uk/learning/animals/birds/african-penguin>

Avian Demography Unit at the University of Cape Town

<http://web.uct.ac.za/depts/stats/adu/>

Pete & Barb's Penguin Pages

<http://www.adelie.pwp.blueyonder.co.uk/>

Video

"City Slickers" - International Emmy Award winning film about two African penguins, Henry and Margo, and their conflict with humans on Boulders Beach, South Africa. Available from SANCCOB.

Key Words

African penguins, Robben Island, avian demography unit, SANCCOB, flipper tags, Treasure oil spill

GLOSSARY

biometrics - the statistical study of biological phenomena.

feral - having returned to an untamed state from domestication.

guano - a substance composed chiefly of the excrement of seafowl and used as a fertilizer.

hydrodynamic - of or relating to the motion of fluids and the forces acting on solid bodies immersed in fluids.

insulate - to separate or protect from the transfer of electricity, heat, or sound.

monogamous - having only one mate during a breeding season or during the breeding life of a pair.

polymer - any of numerous natural and synthetic compounds consisting of up to millions of repeated linked units, each a relatively light and simple molecule.

population dynamics - changes in population size over time due to a variety of factors, such as disease, habitat destruction, and predation.

silicon - a nonmetallic element that occurs combined as the most abundant element next to oxygen in the earth's crust and is used in alloys and electronic devices.

transect - a sample area, usually in the form of a long continuous strip.

Volunteers have joined this project through Earthwatch Institute. Read more about this study and other scientific field research at www.earthwatch.org.



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