The CyberTracker Story

By Louis Liebenberg

The Origin of Science

CyberTracker has grown from a simple hypothesis: The art of tracking may have been the origin of science. Science may have evolved more than a hundred thousand years ago with the evolution of modern hunter-gatherers. Scientific reasoning may therefore be an innate ability of the human mind. This may have far-reaching implications for indigenous knowledge, self-education and citizen science.

Born to Run

In 1990 I ran the persistence hunt with !Nate at Lone Tree in the Kalahari. The persistence hunt involves running down an antelope in the mid-day heat on an extremely hot day – chasing the antelope until it drops from heat exhaustion.

Persistence hunting may well be one of the oldest forms of hunting, practiced long before humans invented bows and arrows. In 2001 I worked with David Attenborough on the BBC film showing Karoha doing the Persistence Hunt. And in 2009 the persistence hunt was brought to the attention of the endurance running world in the best-selling book *Born to Run* by Christopher McDougall.

You can watch Karoha running down a kudu in the video at:
http://www.cybertracker.org/persistence-hunting-attenborough

Reviving the Dying Art of Tracking

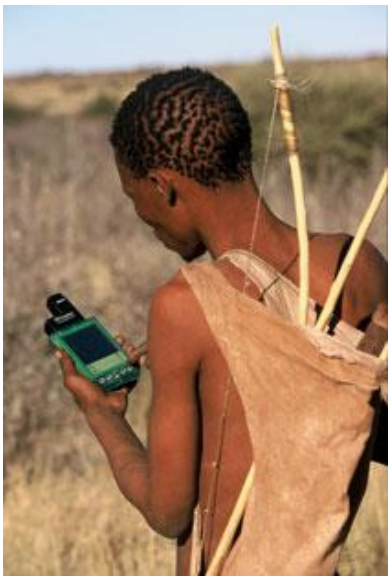
!Nate asked me to help them. They could no longer live as hunter-gathers and needed jobs. Wildlife in the Kalahari has been decimated by fences that cut off migration routes. It was no longer viable to live as hunter-gatherers. And the art of tracking was dying out. After hundreds of thousands of years, traditional tracking skills may have been lost. Yet tracking can be developed into a new science with far-reaching implications for nature conservation.

After discussions around the fire, it was decided that I should try to find a way to create jobs for trackers. Only by developing tracking into a modern profession, will tracking itself survive into the future.

I developed the CyberTracker Tracker Evaluation certification of practical tracking skills, which enables trackers to get jobs in ecotourism, as rangers in anti-poaching units, in wildlife monitoring and scientific research. Tracker evaluations have since 1994 resulted in a steady growth of more than 4000 qualified trackers with increasing levels of tracking skills in Africa, USA and Europe, thereby reviving tracking as a modern profession.

CyberTracker Software for Non-literate Trackers

If the art of tracking was the origin of science, then modern-day trackers should be able to do science. However, some of the best traditional trackers in Africa cannot read or write. To overcome this problem, the CyberTracker software was developed with an Icon User Interface design that enabled expert non-literate trackers to record complex geo-referenced observations on animal behaviour. The Icon User Interface design differs fundamentally from the conventional Graphic User Interface (GUI) design.



In 1996 I teamed up with Justin Steventon, a brilliant young computer science student at the University of Cape Town. The CyberTracker user interface was developed with the help of Karel Benadie, a tracker working in the Karoo National Park in South Africa. Together with fellow ranger and tracker James Minye, they tracked the highly endangered Black Rhino, recording their movements and behaviour in minute detail. Together we published a paper on rhino feeding behaviour in the journal *Pachyderm*. This is perhaps the first paper based on data gathered independently by two non-literate trackers, confirming a hypothesis about rhino feeding behaviour put forward by the trackers. It was a demonstration that non-literate trackers can do science.

In 1999 a CyberTracker project was initiated with the Kwe San Bushmen in the Caprivi in Namibia. And in 2008 the Western Kgalagadi Conservation Corridor Project was initiated with !Xo and /Gwi Bushmen in Botswana. Community members were employed to use the CyberTracker to conduct animal track counts.

CyberTracker projects have also been initiated with indigenous communities in Australia, Canada and other parts of the world. Involving scientists and local communities in key areas of biodiversity, CyberTracker combines indigenous knowledge with state-of-the-art computer and satellite technology.

Towards an Inclusive Citizen Science

The CyberTracker story is captured in the powerful image of Karoha holding the CyberTracker, with his hunting bag slung over his shoulder. The image symbolises the cultural transition from hunter-gatherer to the modern computer age. Persistence hunting may be the most ancient form of hunting, possibly going back two million years, long before the invention of the bow-and-arrow or the domestication of dogs. After two million years, Karoha may well be one the last hunters who has been doing the persistence hunt. Yet of all the hunters at Lone Tree, Karoha is the most proficient in using the CyberTracker. In Karoha, one individual not only represents one of the most ancient human traditions, but also the future of tracking with computers.

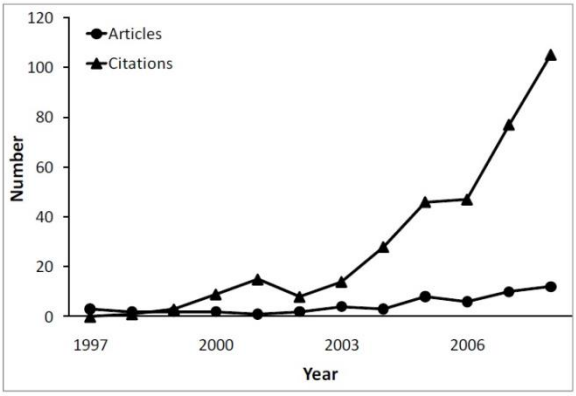


Fig. 1. Historical trend of citizen science articles. Data represent peer-reviewed articles as identified in ISI Web of Science using the search term "citizen science" from 1980 through 2008. The number of unique articles (n = 55) published is indicated by "articles," and the number of unique citations (n = 353) is indicated by "citations."

Karoha's story represents the most profound cultural leap – a story that gives hope for the future: The ancient art of tracking can be revitalized and developed into a new science to monitor the impact of climate change on biodiversity.

At a more fundamental level, it shows us that anyone, regardless of their level of education, whether or not they can read or write, regardless of their cultural background, can make a contribution to science. Over the last 15 years the field of Citizen Science has experienced exponential growth. We strive to broaden the horizon of Citizen Science - Everyone can participate in an Inclusive Citizen Science.

Preventing Human Outbreaks of Ebola

A significant potential value of long term biodiversity monitoring by communities is that outbreaks of infectious diseases may be detected in time to avert the tragic loss of human lives.

The recent outbreak of Ebola in West Africa has resulted in huge cost in human lives and economic losses. Even the indirect economic impact on Africa as a whole has been huge, as tourists have cancelled visits to Africa due to the fear of Ebola. In future it may be more cost-effective to monitor signs of potential outbreaks of Ebola among wildlife, especially along trade routes that may spread Ebola to highly populated areas.

From 2001 to 2007 the CyberTracker Monitoring Programme in central Africa was funded by the European Commission. At the time of the Ebola outbreak in 2001 no conventional statistical data was available, since the outbreak was not anticipated. The only data available was

CyberTracker patrol data that showed the presence of lowland gorilla before the outbreak of Ebola, and absence of gorilla over a large area after the outbreak. During the Ebola outbreaks in Gabon and the Republic of Congo from 2001 to 2003 CyberTracker data showed a significant drop in animal numbers by monitoring signs of gorilla, chimpanzee, duiker and bush pig. Wild animal outbreaks began before each of the five human Ebola outbreaks. Twice it was possible to alert the health authorities to an imminent risk for human outbreaks, weeks before they occurred.

Science and Environmental Education in Elementary, Primary and Secondary Schools

The NatureMapping Program and BioKIDS are using CyberTracker in elementary, primary and secondary schools in the USA for science and environmental education. Customized Applications allow students to display collection data as both icons and text, making it ideal for elementary age students. This data collection is a core component of the science curriculum.

BioKIDS is a unique science education program that teaches students to be better observers and places emphasis on critical thinking skills through the study of biodiversity. Students gather data on living things in their schoolyard, upload the data to a central server, then get reports on the combined data for further analysis as part of the curriculum. This facilitates exploration of local biodiversity using advanced technologies as tools for research and learning. Use of the BioKIDS App as part of a science curriculum can help students become sophisticated thinkers and develop complex reasoning skills.

Scientific study leads to the development of critical thinking and complex reasoning skills that can enhance student achievement.

Decades ago, only a small percentage of all jobs in the U.S. were considered technical. As technology has grown, so too has the demand for people who can think in the abstract terms of math and science. Today, technical jobs make up nearly one-third of all employment opportunities. Science education emphasizes the skills that prepare students to acquire and evaluate information and learn how to use it to understand and solve problems.

Students Collecting Field Data for MSc and PhD Theses

Graduate students worldwide are using CyberTracker to collect field data for their MSc and PhD theses. We received a beautiful thank-you letter from PhD student Sarah Dwyer, who wrote that: "I wanted to share a recent publication with you about bottlenose dolphins in New Zealand. I used CyberTracker for 3 years of boat-based data collection for my PhD project that I am in the final stages of writing up now. Thanks for all the hard work you do to enable students like me to use the software for free :-)"

Scientific Research

CyberTracker makes it possible to gather rich field data for scientific research. Two of the many papers that illustrate the value of CyberTracker in scientific research include:

In Kruger National Park, Foxcroft *et al* (2009) used data collected by rangers using CyberTracker devices to paint an accurate and detailed picture of alien plant distributions, in order to provide recommendations for more appropriate monitoring of plant species on different scales. The Kruger National Park CyberTracker data base presents a unique spatial data set, covering an extensive area. The full richness of the data set will only emerge over time as the data are explored from a number of perspectives.

Another paper that demonstrates CyberTracker as an invaluable tool for scientific research is "Animal behaviour and marine protected areas: incorporating behavioural data into the selection of marine protected areas for an endangered killer whale population" by E. Ashe, D. P. Noren & R. Williams, pubished in the journal *Animal Conservation*.

National Parks and Protected Areas

CyberTracker is operational in all South African national parks (SANParks) and is widely used in protected areas around the world. The potential richness and complexity of data that trackers can gather is illustrated by the range of data collected in the Kruger National Park (KNP) in South Africa. Up to 120 CyberTracker units have been deployed on daily patrols across the KNP.

Field rangers are imperative for conservation – from the ground, they contribute directly to the management of the park by collecting basic environmental data during their daily patrols. Information such as the distribution of rare and endangered species, availability of surface water and disease outbreaks are integral in the ongoing management of the park. These indicators are used by the SANParks management to provide an early warning system for disease outbreaks, identify trends in illegal exit and entry points, and enable the control of invasive alien species.

With the Icon User Interface and descriptions in both English and the local Shangaan language, the CyberTracker system is easily accessible to field rangers regardless of literacy. Moving map functionality allows the ranger to pinpoint his exact location on a topographical map or aerial photograph should a ranger urgently need assistance from the KNP Head Quarters. With a built-in camera, rangers can document and geotag exactly what they see and send the photo immediately from the field to the office for review. Furthermore it is now possible to track and accurately map poacher movements. In this way patterns can be established and plotted on maps. This helps to plan preventative operations.

Scientists use the collected data to facilitate research and assist in making informed management decisions regarding rare species monitoring, fire mapping and ecosystem interactions. Thresholds

of Potential Concern in the database are set so that the limits of acceptable change in the environment can be monitored. The data in the database is then used in routine analyses run through the programme in order to assess whether there is any danger of ecological factors exceeding those thresholds, thereby warning park management of any unacceptable changes.

For example, monitoring data is analysed for each river which flows through the Kruger National Park and should water levels lower and exceed the threshold set by park management, urgent action is required. With an ever-changing ecosystem, accurate data is essential in its efficient management.

By using the irreplaceable knowledge and ability of field rangers, curbing human error through easy-to-use software and technology with GPS capabilities, the SANParks team is efficiently managing the vast and diverse ecosystem of the Kruger National Park and engaging in the ongoing fight against rhino poaching.

World Agroforestry Centre

The World Agroforestry Centre (http://landscapeportal.org/), have been using CyberTracker in a total of 190 LDSF sites (about 30,000 plots) in about 30 countries globally. Senior Scientist Dr. Tor-G Vagen said that:

"I downloaded CyberTracker in 2008 and just started using it right away. I have not required any tech support, so I would say it is very easy to get it up and running, and most importantly deploying it in the field has been trouble-free."

Community Forest Management

Many constraints are holding back the use of spatial information technologies, especially GIS, for local community mapping and monitoring of forest carbon services. The poor availability of user-friendly methodologies hampers the use of these technologies by laypeople. High-cost specialists from consultancies, universities and government agencies are then required to control the information processes. Moreover, there are very few freeware applications available to acquire and manipulate geo-referenced information and databases. Most of the methods available make use of expensive software and mobile devices out of reach of the budgets of communities and local NGOs.

CyberTracker was used for mapping the community and forest boundaries, and mapping the forest strata in the field. It also provides menus and screen templates to ease the process of data acquisition on the sample plots, carbon pools and on the community forest management systems and types and sources of degradation, which are essential to the Reduced Emissions from Deforestation and Degradation in Developing Countries (REDD) approach.

User-friendly software such as CyberTracker has demonstrated the potential to involve local communities' knowledge as they contribute to the design of the applications, as well as the choice of icons and queries to facilitate and speed the process of data capture.

This project has demonstrated the potential for using CyberTracker for mapping and visualising of Community Forest management in the context of REDD. The experience in Mexico

demonstrated that handling new technologies and software is not an obstacle for a deeper involvement of local communities as long as learning by means of user-friendly tools and methods is provided.

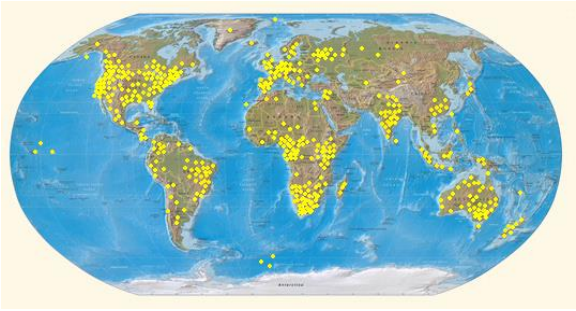
Farming

Organic farming is becoming increasingly important for long-term sustainability of food production. In contrast to conventional farming, organic farming minimizes the impact of food production on the environment. One of the challenges of organic farming is the increased complexity of natural variables.

In particular, Integrated Pest Management involves gathering data on pests as well as natural predators that control pests on a continuous basis throughout the fruiting season. CyberTracker makes it possible to gather large quantities of detailed data on an ongoing basis.

A Vision of a Worldwide Environmental Monitoring Network

Climate change, pollution, habitat destruction and loss of biodiversity may have serious impacts on human welfare. To anticipate and prevent negative impacts will require ongoing long-term monitoring of all aspects of the environment.



From its origins with the Kalahari Bushmen, CyberTracker projects have been initiated to monitor gorillas in the Congo, snow leopards in the Himalayas, butterflies in Switzerland, the Sumatran rhino in Borneo, jaguars in Costa Rica, birds in the Amazon, wild horses in Mongolia, dolphins in California, marine turtles in the Pacific and whales in Antarctica.

CyberTracker is being used by indigenous communities, in national parks, scientific research, citizen science, environmental education, forestry, farming, social surveys, health surveys, crime prevention and disaster relief.

Our ultimate vision is that Smartphone users worldwide will use CyberTracker to capture observations on a daily basis. Data streaming into the Cloud will make it possible to visualise changes in the global ecosystem in real time.

www.cybertracker.org