twas

South African Institute for Aquatic Biodiversity

GRAHAMSTOWN, SOUTH AFRICA

SAIAB

EXCELLENCE IN SCIENCE

Profiles of Research Institutions in Developing Countries

PUBLISHED BY TWAS,
THE ACADEMY OF SCIENCES
FOR THE DEVELOPING WORLD

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Published by TWAS, the academy of sciences for the developing world

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Foreword

For the past decade, **TWAS, the academy of sciences for the developing world**, in collaboration with several other organizations and funding agencies – including the United Nations Development Programme's Special Unit for South-South Cooperation (UNDP-SSC), the Global Environment Facility (GEF) and the Packard Foundation – has developed a large number of profiles of scientific institutions of excellence in the developing world. The profiles have been published as books (by Harvard University Press and Kluwer Academic Publishers), as articles (in *Environment* Magazine) and as news stories (in the *TWAS Newsletter*). To date, more than 150 institutions have been examined. Each profile details how the institutions have developed and how their research programmes are organized. Each points to their strengths, probes their weaknesses – and, most importantly – examines how their experience can offer valuable insights for other institutions seeking to build their scientific capacity.

The ultimate purpose of this decade-long initiative is to showcase the high level of scientific excellence taking place in the developing world and to illustrate how science is being put to work to address critical social needs in the South. In this way, we hope that our expanding series of best practices in the applications of science can serve as a valuable 'blueprint' for policy-makers and those involved in the administration of national science policies.

The case study that follows – which examines the work of the South African Institute for Aquatic Biodiversity in South Africa – is one such successful scientific institution in Africa.

Dismal statistics about the state of science and society in Africa abound, and publications that detail the difficult circumstances the people of Africa face are large in number. A less-examined trend, however, has been the increasing emphasis that Africa is placing on science and technology as primary engines of sustainable growth. This trend can be detected in the growing investments that a number of African countries are making in research and development. It is discernible, as well, in the increasing number of scientific institutions of excellence in Africa that are making significant contributions to their societies. Signs of progress are especially discernible in South Africa, which has the continent's strongest research community and, not surprisingly, its strongest economy.

Yet, it is also true that the investments remain too small and the number of scientific institutions of excellence in Africa too few. Progress, moreover, has been uneven and fragile. Reversals in fortune are not uncommon. And the global economic crisis, which began in mid-2008, has placed the future at risk even for those African countries that have made significant strides forward. Nevertheless what is happening is encouraging. TWAS hopes to explore these promising developments in its profiles of scientific institutions of excellence that are leading the way for a better future on the continent.

Daniel Schaffer
TWAS Public Information Officer
Trieste, Italy


SOUTH AFRICAN INSTITUTE
FOR
AQUATIC BIODIVERSITY
the National Research Foundation

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Introduction and Issues

Some of the world's least studied ecosystems lie off the coast of Africa. This is especially true along the east coast, where the warm waters of the western Indian Ocean support a rich diversity of life.

These watery ecosystems play an important role in the health and wealth of the continent, where fish not only feed the hungry but also attract a growing number of tourists whose dollars, euros, yen and pounds have become an essential part of the coastal economies.

As in the rest of the world, the vitality of Africa's oceans, rivers and lakes, and the contributions that they make to the economy, are threatened by overfishing, pollution and climate change. A scarcity of knowledge about these ecosystems, moreover, makes the impacts posed by these threats difficult to predict.

For the past 50 years, a small South African research institute, the South African Institute for Aquatic Biodiversity (SAIAB), has spearheaded efforts to study Africa's fish fauna and the ecosystems in which they live. At a time when fish taxonomy is a dying discipline, the institute is the continent's undisputed leader in this field, with a collection of fish specimens that attracts researchers from around the world.

The institute offers postgraduate training in ichthyology (the study of fish) and aquatic biodiversity in partnership with Rhodes University's Department of Ichthyology and Fisheries Science. In addition, it oversees programmes to teach fisheries officials in South Africa and other Southern African Development Community (SADC) countries how

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to identify fish, understand their importance and preserve vulnerable aquatic ecosystems.

SAIAB also contributes to local, national and global policy discussions on issues related to the sustainable management of aquatic biological resources. This is a growing challenge in Africa, where booming populations and intensive development have exerted unprecedented pressures on rivers, lakes and other waterways.

> *"SAIAB casts a net well beyond its resources, not just because of its skilled and dedicated staff but also because of the value of its international networks and partners."*

NATIONAL RESEARCH FOUNDATION

• South Africa's National Research Foundation (NRF), established by an act of parliament in 1998, is responsible for promoting and supporting basic and applied research and innovation. One of its major activities is to fund South Africa's national research facilities. In addition to SAIAB, these facilities include the South African Astronomical Observatory (SAAO), which oversees the South African Large Telescope (SALT), the National Zoological Gardens of South Africa (NZG), the South African Environmental Observation Network (SAEON), iThemba Labs, Hermanus Magnetic Observatory (HMO) and Hartebeesthoek Radio Astronomy Observatory (HartRAO).

SNAPSHOT

Resilience and success

SAIAB is a lean operation. In December 2009, the Institute had just eight permanent scientific staff members. But SAIAB casts a net well beyond its resources, not just because of its skilled and dedicated staff but also because of the value of its international networks and partners.

For instance, SAIAB encourages 'honorary research associates' — retired scientists or researchers collaborating closely with the Institute's researchers — to publish their research under the Institute's address.

The arrangement is mutually beneficial. Associates benefit because their research becomes more visible than it would be if they had published it on their own. SAIAB benefits because it boosts its publication output.

Equally important, the arrangement increases the Institute's funding. That's because the government provides bonuses for publications in peer-reviewed journals. SAIAB receives 40% of the bonus money and researchers receive 60%. The money must be spent on future research initiatives. In 2008, the bonus totalled ZAR830,000 (USD10,600).

SAIAB's budget is modest, particularly as research facilities go. For 2009/10, it's ZAR34 million (USD4.6 million), with the government providing just under one-third of the total.

Research contracts and grants account for a large portion of the funding. The latter comes from a variety of sources, including individual government departments, universities, nongovernmental organizations and private firms.

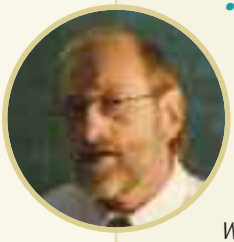
"Funding is a challenge," says Wendy Sweetman, SAIAB's finance manager. "And it's a challenge that's likely to remain in the years ahead." The annual increase the Institute receives as a national research facility has largely tracked the rate of inflation. SAIAB, moreover, is facing a mere 4% annual increase in its government grant over the next three years. In light of these constraints, "additional income will have to be raised from external sources," Sweetman says.

SAIAB spends about 40% of its government funding on research. It spends a third on administration and a quarter on communications and managing its collections.

Despite limited resources, SAIAB participates, and often takes the lead, in large-scale research projects. That should come as no surprise. The Institute's history not only reveals a flair for the dramatic but also a resilience and level of productivity that have made it one of Africa's most successful scientific institutions.

> *SAIAB participates, and often takes the lead, in large-scale research projects.*

PAUL SKELTON



• ***Paul Skelton*** *was born in 1948 in Johannesburg. He earned each of his degrees from Rhodes University, including a PhD in 1980. His thesis topic focused on the redfin minnow, a small fish endemic to South African rivers that is currently threatened by bass and other invasive species.*

From 1972 to 1983, Skelton worked as a curator of fishes at the Albany Museum in Grahamstown and then joined SAIAB as a freshwater researcher. When Skelton was named director of SAIAB in 1995, he found that the one significant gap in his resume — his inexperience as an administrator —would prove to be his greatest asset. That's because it allowed him to bring fresh thinking to the situation.

At the time of his appointment, South Africa's first democratic government, which had assumed power just a year before, was conducting a comprehensive review of the country's science system. A small institute like the JLB Smith Institute of Ichthyology, as SAIAB was called until 2001, could have easily been marginalized.

"I was like a little minnow that had to be careful around the big sharks," Skelton recalls. But while many of the big research institutes that were accustomed to having a foothold in the corridors of power resisted change, Skelton saw the wisdom of following the government's lead. "I think my attitude was appreciated as a welcome change from those pools of resistance in the establishment."

Skelton has travelled extensively in southern Africa, including to Angola and Zimbabwe. He is a member of the Zoological Society of Southern Africa and the Royal Society of South Africa.

His book A Complete Guide to the Freshwater Fishes of Southern Africa *(1993) was the first comprehensive account of this fauna to be published in a quarter century.*

SAIAB History

On 22 December 1938 a trawler fishing the waters off South Africa's eastern coast caught something astonishing in its nets: a coelacanth, a fish thought to have become extinct during the Cretaceous period that ended 65 million years ago.

"I would not have been more surprised if I had seen a dinosaur walking down the street," said JLB Smith, the South African chemistry professor who introduced the "living fossil" to the rest of the world.

Smith and his wife Margaret, who were also colleagues, worked in the chemistry department at Rhodes University in Grahamstown, in what is now South Africa's Eastern Cape province. They named the fish *Latimeria chalumnae* after the Chalumna River near where it was caught and Marjorie Courtenay-Latimer, the museum curator who had notified Smith of the find.

The coelacanth is one of the most significant zoological discoveries of the 20th century. It propelled the Smiths to fame overnight and went on to shape the course of South African marine science.

If not for the living fossil, it is doubtful whether Grahamstown — a sleepy town 50 kilometres from the sea as the crow flies, and longer by road — would be the home of Africa's foremost institute of ichthyology, the South African Institute for Aquatic Biodiversity (SAIAB).

Smith era

At the time the coelacanth was discovered, Rhodes University did not have a dedicated department of ichthyology. But following the discovery, JLB Smith was asked in 1946 to head a new department, backed by a fellowship from the newly formed Council for Scientific and Industrial Research (CSIR).

Smith's fish collection became the heart of what is today the largest collection of specimens in Africa. It also became the centrepiece of South Africa's national fish collection, which is housed at SAIAB.

The grant Smith received from the government did not cover the cost of his expeditions. For that, he would need to raise funds by tapping his networks of officials and private donors in southern Africa. Smith's tireless efforts would gain global recognition and open up little-studied aquatic ecosystems in and around Africa to international study.

The fate of ichthyology in Grahamstown hung in the balance when Smith died in 1968. The CSIR wavered over whether to fund the department without the renowned man at the helm. There were even suggestions to move the fish collection to either Durban or Cape Town.

“Smith's fish collection became the heart of what is today the largest collection of specimens in Africa. It also became the centrepiece of South Africa's national fish collection.”

However, Margaret, Smith's widow, persuaded the CSIR to create a separate institute within Rhodes to house the collection in order to allow her to continue her husband's life work. Shortly after her husband's death, Margaret became the first director of the newly named JLB Smith Institute of Ichthyology. She held the post until 1982.

From 1961 to 1986, the number of known species of marine fishes in South Africa grew by nearly 60% from 1,400 to 2,200. Under Margaret's leadership, the university also constructed a building on Somerset Street. The collection was kept in the basement of the building until 2007 when a new facility was constructed next door.

Apartheid and the freedom years

Beginning in the 1960s, international scholars engaged in an academic boycott of South Africa to protest the country's apartheid regime. This isolated South Africa's scientists from the rest of the world. Researchers at the JLB Smith Institute were restricted from travelling to many countries, including those in Africa.

"Namibia and Botswana would let us in reluctantly. But Zambia, Swaziland, Lesotho and Mozambique were out of bounds," says Skelton.

When Skelton became director in 1995, a year after the first democratic elections, he saw the opening up of Africa to South African scientists as an historic opportunity. "It liberated us. The political shackles had been shed," he says.

But at the same time that South Africa was enjoying redemption in the eyes of the world, the JLB Smith Institute faced a new challenge.

During apartheid, the Institute had essentially been funded as a museum. The new government regarded museums as a holdover from colonial times, and wanted all museums outside the main cosmopolitan areas in Cape Town and Johannesburg to be handed over to local governments. For the Institute, this would have meant ending up as a provincial museum in the Eastern Cape.

"It would have been the kiss of death," notes Alan Whitfield, the Institute's current chief scientist, who at the time was its senior ichthyologist. We would have been starved of funding and status, and lost much of our staff as a result, he believes.

Skelton managed to persuade the government that the Institute deserved national status and, in 1999, it was declared an NRF research facility – a move that guaranteed

core funding and confirmed the Institute's status as an internationally competitive facility. The decision also brought about a welcome boost in morale for staff, since the conditions of employment were more favourable than those for an independent entity.

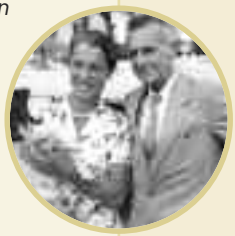
But salvation came at a price. To live up to its role as a national research facility, the Institute had to redefine its mission. Scientifically, it would become more outward looking and thus would be required to focus more attention on providing services to 'customers', including policy makers and educational experts residing far beyond Rhodes University.

To reflect this broader mission, in 2001 the Institute changed its name to the South African Institute for Aquatic Biodiversity (SAIAB). The decision was not universally popular, especially in Grahamstown, where some thought it folly to relinquish the globally recognised 'JLB Smith' brand.

In retrospect, "it was the right choice," Skelton says. Since then, SAIAB has gone from strength to strength. It's now one of the jewels in the NRF crown.

> *"To live up to its role as a national research facility, the Institute had to redefine its mission."*

JLB and Margaret Smith



• ***James Leonard Brierley Smith*** *was born in 1897 in South Africa's Eastern Cape province. A star chemistry student, he went abroad to earn a doctorate degree at the University of Cambridge. He returned to South Africa in 1923 to become a faculty member at Rhodes University.*

A keen angler, Smith developed a passionate interest in ichthyology. Museums along the coast were soon routinely asking him to help them classify fish and curate their collections.

In 1938, the same year the first coelacanth was trawled off the Chalumna River, Smith married his second wife, Margaret. The couple made scientific history by describing the coelacanth. In the years that followed, they travelled across southern Africa collecting rare fish specimens and discovering new species.

JLB and Margaret Smith were a productive scientific team. Margaret proved to be an excellent administrator, which enabled her husband to pursue his science unhindered. She also was a skilled graphic artist. Her illustrations adorned Smith's seminal work The Sea Fishes of Southern Africa*, published in 1949, and she went on to illustrate all his later publications. However, one specimen eluded the couple — a fresh "wet" sample of a coelacanth. The first one caught in South Africa in 1938 had been preserved, with its soft organs discarded, before being sent to JLB Smith in Grahamstown. That made it less than ideal for taxonomic purposes.*

A second chance at examining a coelacanth came in 1952 when a fisherman caught one off the coast of the Comoros, an archipelago island territory then belonging to France that is near Mozambique. Transporting the specimen would prove a race against time. With no refrigeration on the islands, it was likely to decompose in the tropical heat before reaching Smith's laboratory in Grahamstown. JLB Smith managed to persuade South Africa's prime minister, D.F. Malan, to make a military plane available to secure and bring back his prize. From today's perspective, Smith essentially smuggled the fish out of the Comoros, a French territory. The specimen, preserved in alcohol, is on display in the lobby of SAIAB.

Following a long illness, JLB Smith tragically ended his life in 1968 at age 71 by taking cyanide. He left behind a note, explaining that he had felt for some time that his mental powers were deteriorating. In his lifetime, JLB Smith described more than 375 new fish species for science.

After her husband's death, Margaret proved a formidable director of the JLB Smith Institute of Ichthyology, serving from 1968 to 1982. She excelled at public relations, wrote numerous popular articles and made frequent appearances on radio and television. She passed away in 1987 at the age of 71.

National Fish Collection

SAIAB's fish collection, which houses more than 80,000 lots, is the largest in Africa. Indeed the collection is one of the largest in the world. The oldest specimen, dating back to 1880, is a flathead mullet (*Mugul cephalus*). It was given to Smith by David Jordan, a collector based in California.

The oldest South African fish in the collection is a large-scale yellowfish (*Labeobarbus marequensis*), collected in 1887 in Pretoria.

Other prized specimens include several coelacanths and a 1.5 metre great white shark with albinism, a congenital condition characterised by the absence of skin pigmentation that renders the skin a translucent white. It is the only preserved specimen of its kind, caught in 1996 by an Eastern Cape fisherman.

The most valuable section of the collection contains "type specimens" — individual specimens used to describe that species.

Researchers rely on the National Fish Collection for a variety of reasons, including investigations into taxonomy, systematics (the study of fish diversity and the evolutionary relationships between populations and species) and genetics research. Not surprisingly, children love to come and look at the strange and wonderful creatures on display.

SAIAB researchers have collected most of the specimens. But some have been received from museums, as part of an exchange agreement, and others from private individuals.

"The collection is uninsurable," says Vanessa Rouhani, SAIAB's science communicator. "Some species would be hard to replace. They come from war-torn areas or places ravaged by pollution."

Caring for the collection has been one of SAIAB's main tasks. For a long time, the collection was housed in the basement of the Institute's main building on Somerset Street. But health officials came to regard the large amount of volatile alcohol used to preserve the specimens as a health and safety threat. As a result, the collection was moved to a separate building completed next door to SAIAB in 2007.

The new state-of-the-art building features sophisticated fire-prevention technology and such safety devices as eye washers, a fume extraction system and closed drains. Meanwhile, the SAIAB basement has been partly refurbished and turned into a collection management centre that was officially named for JLB Smith in March 2009. It's here that researchers work on the specimens.

SAIAB began digitizing its collection in the early 1990s. Today, a computerized database provides key information corresponding to the rows of jars on shelves. "Keeping the data safe and accessible are our primary concerns," says Willem Coetzer, manager of SAIAB's biodiversity information systems.

Data backups are kept off-site to make sure they are not lost due to damage or theft. Updated versions of the database enable researchers to track how often specimens are cited in the scientific literature, giving SAIAB a valuable tool for showing funders how useful the collection is to science.

In 2007, SAIAB launched a portal that enables researchers and the public to search and browse the collection online (jaws.saiab.ac.za/infoportal/). It features a large number of images of fish, information about marine biodiversity and taxonomic keys.

OFER GON, Senior Aquatic Biologist

• ***Ofer Gon**, a researcher originally from Israel, has worked at SAIAB since the early 1980s. He joined the Institute to help prepare an updated reprint of* JLB Smith's Sea Fishes of Southern Africa, *first published in 1949.*

Gon's research interests include marine fish systematics, the biology and ecology of marine fishes, and the history of ichthyology in South Africa.

"There is more to systematics than just discovery and names," he says. "Finding out what's there is only the beginning of the story. You also want to know why they're there, and how and when they got there."

Gon would like to produce easy-to-use taxonomy tools for officials that visit harbours and docks to check catch sizes and monitor fishing quotas. Many only have high school certificates and find conventional classification tools too technical, he explains.

"Smith's sea fishes book, which contains the only recent fish identification keys in the country, claims to be for lay people. But there is a lot of scientific terminology in there," he says.

Gon also wants to develop a user-friendly online system that people can access through their mobile phones. The system would provide basic information on common fish species, including whether they can be caught legally.

In recent years, the collection has been expanded to include other aquatic organisms besides fish. For example, a private collection of amphibians was recently added that contains frog specimens from southern Africa. The database also includes South Africa's national collection of diatoms — single cell organisms — which is housed at North West University in Potchefstroom. SAIAB is also collecting genetic samples for the purposes of creating a biobank.

> *"SAIAB began digitizing its collection in the early 1990s. Today, a computerized database provides key information."*

Research at SAIAB

Fish systematics was the main research focus of the JLB Smith Institute for Ichthyology when it was established 50 years ago. Over time, however, its research mission has expanded to encompass the wholesale study of aquatic ecosystems — from freshwater systems to the deep ocean. "Our scope is much broader than before," says Alan Whitfield, SAIAB's chief scientist.

The field of systematics has also undergone dramatic changes in recent years. The advent of genetic analysis has challenged the traditional, appearance-based means of classification. Modern fish systematists now must be as well versed in molecular genetics as in morphology.

ALAN WHITFIELD, Chief Scientist

*• Before joining the JLB Smith Institute in 1987, **Alan Whitfield** worked for Rhodes University's Swartvlei Laboratory where he earned a reputation as a pioneer in the field of estuarine ichthyology. His scientific interests range from the "feeding" biology of fishes in KwaZulu-Natal to the use of such fish species as mullet as indicators of ecological and environmental change.*

Whitfield recently joined a group of international scientists investigating the similarities and differences in northern and southern hemisphere "transitional waters" — a term used to describe the brackish surface water near river mouths where ocean and river water meet. Another recent research interest of his is the effect of global warming on the distribution of fish in South Africa.

In 2008, the NRF granted Whitfield a rare "A" rating – the highest rating South African researchers can attain. Recipients are deemed leading international scholars in their field. Whitfield is the only A-rated estuarine scientist in South Africa. The same year, he was awarded the Gilchrist Memorial Gold Medal, given by the South African Network for Coastal and Oceanic Research, for research contributions to South African marine science. Whitfield is rightfully regarded among an elite group of South African scientists.

So why is systematics important? To begin with, aquatic ecosystems have enormous economic importance. In most societies, fish are a mainstay of the diet and, unlike livestock that are farmed in corralled areas, they are by and large taken straight from their natural habitat.

With overfishing and exploitation threatening fish stocks in many parts of the world, it is more important than ever to understand how this precious resource can be used sustainably. Such understanding is particularly vital in developing countries.

"We have underestimated the economic value of taxonomy research in the developing countries," says Franz Uiblein, a visiting researcher at SAIAB from the Institute of Marine Science, in Bergen, Norway.

Plumbing the depths – marine research

"The South African marine floor and ocean ecosystems have never been studied in detail," says Skelton. Filling this knowledge gap will be a primary focus of SAIAB research in the years ahead.

SAIAB's flagship marine science programme is the African Coelacanth Ecosystem Programme (ACEP), established in 2002 to investigate the watery world in which the coelacanth lives.

During ACEP's first five-year phase, researchers from SAIAB embarked on 10 research cruises aboard the RS Algoa, a research vessel owned by the South African government. Some expeditions followed the coast northward to the Indian Ocean. Data from the expeditions was shared with neighbouring countries.

The second phase of ACEP, which began in 2007, is scheduled to run until 2012. The research will involve more than 30 scientists from over 10 institutions in South Africa. Some 50 postgraduate and postdoctoral students will also participate. Working closely with the Agulhas and Somali Current Large Marine Ecosystems (ASCLME) project, which has been hosted at SAIAB since 2007, the second phase of the programme has developed a more national focus than the first.

Today, SAIAB manages ACEP through the Elwandle Node of the South African Environmental Observation Network (SAEON), which it also hosts. SAEON is an NRF research facility. One of five ecosystem nodes, Elwandle supports long-term monitoring of the South African coastline from Kosi Bay in the east to the mouth of the Orange River in the west. The coastline includes rocky shores, beaches, estuaries, reefs and dunes.

COELACANTHS

• In 1989, two coelacanths were caught near the Comoros Islands. Since then, coelacanths have been found as far north as Kenya. But the question of where the first South African coelacanth that had been caught came from was not answered until 2000, when a group of recreational divers photographed a living coelacanth in a deep underwater cave in Sodwana Bay near the Mozambican border. In 2002, scientists confirmed that a group of six coelacanths lived in the area.

The coelacanths' lifecycle remains a mystery. The young, which hatch inside the mother's body, are 20-30 cm long when they are born. However, for a long time, no youngsters were observed. In October 2009, Japanese researchers were the first to film a juvenile Indonesian coelacanth in its natural habitat.

Because its flesh is extremely oily and unpalatable, the coelacanth has no commercial value. Its real worth lies in the contributions it can make to natural history through the evolutionary link it provides between prehistory and the present. Still, its habitat remains under threat from pollution and coastal development. In 2009, for example, environmentalists warned that plans to construct a new harbour in Tanzania threatened a local coelacanth population.

Like many other at-risk species, the coelacanth requires protection. If it is not actively protected, the "living fossil" might join the fossil record again – this time for good.

SNAPSHOT

"*Like many other at-risk species, the coelacanth requires protection. If it is not actively protected, the "living fossil" might join the fossil record again – this time for good.*"

ELAINE AND PHIL HEEMSTRA

• ***Elaine Heemstra*** *joined SAIAB in 1998 as a scientific illustrator. Her detailed scientific drawings have been used in numerous academic and popular publications. "It started out as a job, now it's a passion," she says.*
She and her husband Phil, a leading international authority on marine fishes, are working on a book entitled Fishes of the Western Indian Ocean. *Scheduled for publication in 2010, it will feature 200 new fish species discovered in the past decade.*
"We hope our book will be as useful as its predecessor, Fishes of Southern Africa*," says Phil, who spent 25 years as a staff researcher at SAIAB before retiring in 2003. He still works actively as curator emeritus at SAIAB.*

Oceanographic research does not come cheap. In fact, it usually requires an expensive research vessel to gather data. In the past, SAIAB has relied on research vessels from the South African government or from international partners.

In September 2009, SAIAB launched its first marine research vessel, *uKwabelana*, which means "to share" in isiXhosa, one of South Africa's 11 official languages. The 13-metre vessel, moored in Port Elizabeth, can spend several days at sea.

uKwabelana will allow SAIAB's scientists to sample the marine ecosystem, including plankton, fish, marine mammals and birds, from the shoreline to beyond the continental shelf.

With its own ship, the Institute will have more latitude in the way it plans its expedition cruises. "If there's an event to investigate, we can be there very quickly," says Whitfield.

It will also enable SAIAB and other academic researchers to do four months of research over the course of a year to obtain detailed data from each of the four seasons. In the past, this would have been too expensive. The data likely would have all been collected over a one-month period.

The vessel is large enough to carry a submersible remotely operated vehicle (ROV). SAIAB launched *uKwabelana* and its new ROV in March 2010. The first deployment of the ROV was off the Agulhus Banks in May 2010.

Nature's nurseries – estuarine research

Estuaries are important breeding grounds for many fish. South Africa's estuaries are worth an estimated ZAR1.3 billion (USD100 million) annually to the economy. They serve a vital function as nurseries for commercially fished species and provide valuable recreational opportunities for the public.

In South Africa, estuaries are also attractive areas for development, which is having a damaging effect on water flows.

"There is a lot of pressure on the ecosystems," says Whitfield, an estuary specialist. This is true across the globe, as illustrated for instance, by the global crash in eel stocks. According to recent data, eel migrations from spawning grounds in the Sargasso Sea in the North Atlantic to rivers in northern Europe have come to a virtual halt, decreasing an estimated 99%.

Africa has one of the world's last remaining eel stocks. However, as harvests continue to increase in response to rising demand, eels could be threatened in Africa as well.

A prime example of an estuary under severe pressure is the St Lucia estuary near the Mozambique border. This estuary accounts for almost half of South Africa's estuarine productivity.

St Lucia is a UNESCO World Heritage site, but sugar cane plantations upriver have curtailed the flow of freshwater into the estuary, drying out areas that are prized for their wildlife. The challenge faced by environmental advocates, however, is that the sugar plantations are among the most productive in South Africa.

There is no clear solution to the challenge, says Penny Haworth, SAIAB's communications manager. But, she adds, "If St Lucia were to lose its World Heritage status it would be an indictment of the country and spell trouble for the future of this precious habitat."

Dusky kob, spotted grunter – tracking fish

Paul Cowley, a senior aquatic biologist at SAIAB, is pioneering new techniques for monitoring fish that spend part of their lives in estuaries.

Traditional ways of monitoring fish include fish tagging, which provides information on growth rates, movement patterns and seasonal migrations. Such information is needed to manage fisheries successfully. There are several active marine fish tagging projects in South Africa. The largest, the Oceanographic Research Institute (ORI) project, relies on volunteer anglers to tag fish. SAIAB's 082 TAG FISH project, meanwhile, focuses on specific species and/or fish dispersal from designated study sites, such as marine protected areas or estuaries.

In addition to conventional plastic dart tags, Cowley and his group rely on sophisticated telemetry equipment to track and monitor the movement of fish equipped with acoustic transmitters. The signals are captured by receivers moored in estuaries along the Eastern Cape coast.

Cowley uses fish ear bones, or otoliths, as keys to their past. The water in different estuaries contains a distinct composition of trace elements that are deposited in the bone structure of fish as they grow. In this respect, fish otoliths are like tree rings — they tell the fish's age and reveal where it has lived.

Cowley's methods offer a detailed look into the world of three estuary species – the dusky kob, spotted grunter and white steenbras. These species are important to subsistence and recreation fishing.

The research will answer such questions as whether fish always return to the estuary where they are born to spawn. Traditional tagging research suggests the answer is yes, says Cowley. "Most fish are caught where they were tagged."

DUSKY KOB

•The dusky kob is a large silvery fish that lives along the shore and in estuaries. It is prized by recreational and subsistence anglers alike. Dusky kob populations along South Africa's coast have plummeted by more than 95% over the past 150 years. A major factor in their decline is that they are late bloomers. Scientists discovered in 1985 that dusky kob only become sexually mature when they are about 1 metre in length. That usually doesn't happen until they are six years old.

However, the legal catch limit, a mere 40 cm, remained in place for 20 years following the discovery of dusky kob's sexual maturity profile. It was not until 2005 that the limit was increased to 60 cm — a questionable victory for the conservationists since it is still not sufficient to protect the species.

One solution might be to forego catch limit sizes completely — they are often flouted anyway — and to introduce no-fishing zones. The proposal is not popular among anglers. Yet it may be the only way to secure the fish stocks and therefore the anglers' pastime for the future.

SNAPSHOT

> *"Fish otoliths, or ear bones, are like tree rings – they tell the fish's age and reveal where it has lived."*

Livelihoods vs conservation – freshwater research

As an arid country with few lakes, South Africa historically has had virtually no inland fisheries. Its native freshwater species are small and when Europeans first settled in the country, they brought with them their own sporting fish — trout and bass in particular.

These invasive species today pose the biggest threat to South Africa's endemic freshwater fish. SAIAB's freshwater biologists have studied the effects of these species on the local fauna and also evaluated ways of preventing them from spreading into pristine rivers.

There are ways of controlling or eradicating alien species from waterways. One method is to use Rotenone, a compound produced from the Derris root that kills invasive fish but does not adversely affect the well-being of birds, mammals or humans.

However, widespread resistance to the wholesale eradication of these species from the economically important recreational fishing industry (see "From Science to Policy," p. 41) makes it unlikely that such control measures will ever be taken.

Pollution and development, both of which contribute to increasing water shortages across South Africa, also impact local freshwater fish.

Staff at SAIAB have conducted detailed surveys of waterways in countries such as Zambia and Angola, where they assist researchers and governments in devising strategies for protecting indigenous species.

Their efforts have helped uncover many previously unidentified species. But with growing development pressures in South Africa and neighbouring countries, describing them before they become extinct may prove to be a race against time.

In 2009, Skelton co-authored a report for the IUCN's (World Conservation Union) "Red List" — an initiative designed to assess critical trends in biodiversity conservation and use and, more specifically, to call attention to the growing number of endangered species.

The report states that South African freshwater fishes face a higher risk of extinction than those in neighbouring countries, since the more developed a country is, the more pressure there is on freshwater ecosystems.

FISHING FOR A LIVING

•During apartheid, the fishing industry was controlled exclusively by and for white South Africans. This led to restrictions on subsistence fishing – which largely involved non-whites – until 1998, when subsistence fishers were given the right to responsibly utilize resources in lakes, rivers and oceans.

However, the opening up of fishing to subsistence fishers is proving difficult to monitor. Subsistence fishers are expected to obtain permits and obey quotas. But obtaining a permit is expensive and time-consuming, and quotas are difficult to police. The situation is exacerbated by reports of nepotism and corruption in key government agencies.

SNAPSHOT

Taxonomy – an old tool made new

Scientists believe that many more species remain to be discovered. But the traditional way of describing new species requires lengthy expert studies of their morphology.

To describe all these species in the traditional way would require an impossible number of taxonomists and large amounts of funding. Unfortunately, funding for taxonomy research is declining in many parts of the world and the field is falling out of vogue with students.

The advent of genetic analysis has created a new way of dealing with this "taxonomic crisis." A new initiative, the International Barcode of Life (IBOL) project, is creating a unique genetic "barcode" for every species on the planet.

The IBOL project maps a sequence of 600 base pairs in an area of the genome known as CO1 — a sequence that codes for proteins and displays high variations between species.

KEY PERSONNEL

MONICA MWALE

• ***Monica Mwale*** *is an aquatic biologist who has worked for SAIAB since 2004. Born in Zambia, she received her undergraduate degree in her home country before coming to Rhodes University to earn an MSc and PhD. She is well versed in genetics. She is also passionate about attracting young people to science. Mwale conducts genetics workshops with small groups during South Africa's premier science festival, Scifest Africa, which is held annually in Grahamstown. "They love it," she says. She also runs the South African Biodiversity Initiative (SABI) Student Network Forum.*

"The aim is to create a library for all species, linked to reference specimens and stored in a reputable museum," says Monica Mwale, who co-chairs, with Ernst Swartz, SAIAB's Africa Barcode of Life project (FISH-BOL).

Barcodes could contribute to testing for illicit products. For example, shark fins could be tested to make sure they are not from endangered or restricted species.

SAIAB is Africa's lead institution for identifying barcodes for the continent's fish species. To date, about 30% of marine fish around Africa have been coded, the vast majority by FISH-BOL.

Climate change – a rising priority

Climate change poses a huge threat to both freshwater and marine fish. Not surprisingly, it has emerged as a primary area of research at SAIAB.

"Fish are sensitive to climate change," says Nikki James, a SAIAB researcher who is pioneering ways of modelling the likely effect of climate change on the distribution of fish in South Africa.

Thus far there have been no signs of change in the abundance of species along the South African coast, she says. However, this could rapidly change as surface temperatures change in coastal areas.

James modelled the effect of three climate change scenarios outlined by the Intergovernmental Panel on Climate Change (IPCC) on two fishes living along the South African coast: the white steenbras, which enjoys temperate seas and can be found from the Orange River on the west coast to southern KwaZulu-Natal on the east coast, and the robust mullet, a tropical fish that keeps to the warm waters from the Eastern Cape northward along the coast towards Mozambique.

STEPHANIE PLÖN, marine mammals researcher

- ***Stephanie Plön**, who has a contract appointment with SAIAB, recently embarked on a project to map whale and dolphin populations in Algoa Bay, where Port Elizabeth, the fast growing coastal city in the Eastern Cape province, is located.*

Algoa Bay is home to many cetaceans, including southern right, humpback and Bryde's whales, and four types of dolphins. But many projects with potentially adverse environmental impacts are developing in the bay, including an expansion of the port and the construction of an oil refinery and offshore wind farms. During her three-year project, Plön will establish baseline information about the bay's cetacean populations, allowing the impact of development on marine mammals to be more effectively monitored. The hope is that the information will encourage developers to avoid areas particularly important for breeding or feeding. Plön's research is supported by SAIAB, SEAON, the Port Elizabeth Museum and South Africa National Parks (SANParks).

All IPCC scenarios anticipate significant changes in the range of the two fish species. As sea temperatures rise on the east coast, the mullet is likely to migrate further south. Meanwhile, the range of the white steenbras will become more restricted as many of its estuary-located nurseries become inhospitable breeding grounds.

Changes in the natural ranges of fish species will have huge societal impacts. Popular angling species like white steenbras draw tourists to remote areas, and poor communities along the coast increasingly rely on fishing for their subsistence.

There are signs, for example, that climate change could be disrupting the sardine run that takes place along South Africa's east coast between May and July each year. This "greatest migration on earth" — when millions of pilchards spawn in the waters off Cape Agulhas, the southernmost point of Africa, and swim north along the coast — is hugely important financially.

Lately, SAIAB research associate Stephanie Plön discovered that dolphins caught in shark nets off the KwaZulu-Natal coast have mackerel, not sardines, in their stomachs, indicating a change in the available prey.

The sardine run is not only a boon to coastal communities – it also sparks a feeding frenzy off the coast, with sharks, dolphins, seals, seabirds and whales pushing the fleeing fish into enormous "bait balls" from which few escape. Drastic changes in the sardine run would therefore likely have profound ecological and financial effects.

A science hub for Africa

Since apartheid ended, SAIAB has engaged more actively with researchers in the rest of the African continent. This has enabled the Institute to use its considerable resources and expertise to help build capacity in neighbouring countries.

SAIAB has sought to advance this goal largely through its flagship marine programme, the African Coelacanth Ecosystem Programme (ACEP), conducted in collaboration with the Agulhas-Somali Current Large Marine Ecosystem (ASCLME) initiative, which SAIAB hosts across the road from its main building.

The ASCLME project involves a five-year collaboration among nine countries along the western Indian Ocean: Comoros, Kenya, Madagascar, Mauritius, Mozambique, Seychelles, Somalia, South Africa and Tanzania.

An estimated 56 million people in these countries depend on the resources of the two large marine ecosystems that are the focus of the project: the oscillating Somali Current,

which moves the waters off the horn of Africa east in the northern hemisphere's winter and west in summer, and the Agulhas Current, which sweeps down the coast of Mozambique towards South Africa.

The project is funded by the Global Environment Facility (GEF) and implemented by the United Nations Development Programme (UNDP). Its first phase, which concentrates on regional data collection, has included two research cruises on the Norwegian research vessel *Dr Fridtjof Nansen*.

Researchers have only recently realised that the water coursing through the channel between Mozambique and Madagascar, previously assumed to be a simple current, is in reality a system of eddies moving slowly southwards. This phenomenon, which the ASCLME project will study, could vastly increase our understanding of weather patterns and marine life in the region.

The project will also investigate how water flows over the Mascarene Ridge that stretches for 2,200 km between Mauritius and the Seychelles. The ridge's islands, banks and shoals form a long shallow shelf that acts as a barrier against the current. That, in turn, effects nutrient distributions and energy flows.

To collect data that could improve our understanding of monsoon behaviour, cyclones and droughts, the project will also deploy information-gathering buoys in collaboration with the U.S. National Oceanic and Atmospheric Administration (NOAA).

The ASCLME project will not only collect data, but also form the basis of joint policy-making between governments within the region. The second phase will produce a strategic plan to safeguard the marine ecosystems in the western Indian Ocean.

"None of these countries can act alone," says Magnus Ngoile, the project's policy and governance coordinator. Discussions must ultimately take place at a high level, perhaps by ministers of finance or foreign affairs. "It is not a one country or one ministry issue," he adds.

TRANSPORTING FISH

• The increasing attention given by governments in developing countries to biopiracy — the exploitation of biological resources or traditional remedies without obtaining local permission or sharing the benefits — has led to stringent regulations for importing and exporting biological material.

This used to make life difficult for international research projects that depend on transporting biological samples and other restricted material for laboratory analysis.

However, in recent years, things have become a little easier. One reason is that host countries are now more likely to be actively involved in the research. SAIAB, for example, aims to collect more than one sample of each species when it visits the waters of neighbouring countries. The additional sample is kept safe and can be returned at any time to the country of origin.

During the ASCLME cruises, three samples, in fact, are collected whenever possible. One goes to Norway, in exchange for the loan of its cruise ship. The remaining two samples are held at SAIAB, one for the Institute and the other for the country of origin.

"There is now more understanding and willingness to respect the origin of the data," says Magnus Ngolie, ASCLME policy and governance coordinator.

SNAPSHOT

> *"Since apartheid ended, SAIAB has engaged more actively with researchers in the rest of the African continent."*

Aquaculture – a growing staple

Fish farming is becoming increasingly common in many African countries, including Egypt, Kenya, Madagascar and Nigeria. Its popularity is growing as fish stocks in the wild dwindle.

According to a 2005 New Partnership for Africa's Development (NEPAD) technical review paper, "Hidden harvests: unlocking the potential of aquaculture in Africa", African aquaculture must grow 10% annually to meet expected requirements for human nutrition in Africa. That would amount to a rise in annual production from approximately 700,000 tonnes to more than 3 million tonnes over the next 15 years. Farmed aquatic species include Nile tilapia, flathead grey mullet, carp, catfish and prawns.

However, fish farming has potentially serious adverse effects on aquatic ecosystems, particularly freshwater systems. Fish farms consume a great deal of water, which is taken from natural waterways that support indigenous species. Many farmed species are also invasive. Unless carefully managed, they could wind up in natural waterways, posing a threat to endemic species.

From Science to Policy

As an NRF national research facility, SAIAB is obliged to provide advice and information to policy makers. The Institute has played a key role in shaping several important national acts and regulations, including:

- The Marine Living Resources Act (1998), which seeks to conserve marine ecosystems and encourage the sustainable use of marine biological resources.
- The National Biodiversity Act (2004), which protects South Africa's biodiversity and promotes the sustainable use of biological resources and the equitable sharing of benefits.

Recreational fishing is big business in South Africa. Freshwater angling often focuses on "alien species," including bass and trout, but such native species as carp and tilapia are also popular. In the Eastern Cape alone, fly-fishers estimate they contribute

PROTECTED AREAS

• South Africa is famous for its natural beauty and its national parks and marine reserves. SAIAB helps provide South Africa's government with the science-based evidence it needs to help ensure that the right areas are being protected in the right way.

Tsitsikamma National Park, established on the Garden Route southwest of Port Elizabeth in 1964, remains one of the world's largest protected marine parks despite intense pressure from the angling community to open it up for recreational use. For SAIAB researchers, it provides valuable baseline data for evaluating the deterioration of other, non-protected stretches of coast.

SAIAB has also been involved in plans to extend the Addo Elephant Park, northwest of Port Elizabeth, to include large parts of Algoa Bay. When implemented, visitors to the park will be able to add sightings of the ocean's big two — the great white shark and the southern right whale — to South Africa's famous "big five" — the leopard, rhino, buffalo, lion and elephant.

SNAPSHOT

"Angling is worth millions to the economy.
It's bigger than rugby, cricket and football combined."

ZAR12 million to ZAR15 million (USD1.5 million to USD1.9 million) to the province's economy each year.

"Overall, angling is worth millions to the economy," says Olaf Weyl, an aquatic biologist at SAIAB who studies the ecological impacts of alien fishes. "It's bigger than rugby, cricket and football combined," he notes.

SAIAB is working with all stakeholders to devise a strategy that both protects the fisheries and provides ample opportunities for recreational fishing – a compromise that both the anglers and the conservationists find acceptable. "If we can get this right, it could be a very good tool for conservation," says Ernst Swartz, a freshwater biologist at SAIAB.

SAIAB also helps the Marine and Coastal Management (MCM) agency, which is responsible for making sure marine protection regulations — such as fishing quotas — are adhered to in practice.

Training and Commitment

Many of SAIAB's senior staff trained at Rhodes University and joined the Institute as young scientists. This tradition is likely to continue as the Institute is now training postgraduate students in ichthyology and aquatic biodiversity in partnership with the university's Department of Ichthyology and Fisheries Science. SAIAB also oversees programmes that teach fisheries officers in South Africa and other SADC countries how to identify fish, understand their importance and preserve vulnerable aquatic ecosystems.

Since today's undergraduate student might be tomorrow's rising star, SAIAB staff take their training responsibilities seriously. "We're really trying to grow our own timber," says Whitfield.

In addition to having supervised some 29 postgraduate students in 2009, staff gives lectures to students enrolled in biology courses.

IN THE TANK

• In 2002, The Methodist Education Initiative in Gauteng gave SAIAB a bus to use for mobile education. Billed as "The Fantastic Fish Tank," the bus traveled to rural areas in the Eastern, Southern and Western Cape provinces several times a year, reaching between 800 and 2,000 students and teachers each time.

In 2004, the "Fantastic Fish Tank" was decommissioned and a new bus was purchased to help SAIAB continue its outreach efforts. In addition to the presentations and workshops, the tours include such activities as the "fossil-fish dig" (in which participants "dig out" their own fossils) and the handling of unusual fish specimens.

SNAPSHOT

Like most organisations in post-apartheid South Africa, SAIAB is expected to take measures to increase the number of blacks and women on its staff. The Institute is also expected to actively encourage more young people from disadvantaged backgrounds to study and pursue careers in science.

SAIAB has made some progress on both fronts. In 2005/06, 31% of its employees were non-white. In 2008/09 the figure had grown to 54%. The Institute's scientific staff is becoming younger. In 1999, the average age was 48; in 2009, it was 40. Meanwhile, more than 25% of SAIAB's postgraduate students are non-white.

White males, however, still dominate the Institute's list of permanent scientists. Of SAIAB's eight permanent research staff, two are women and one is black.

SAIAB is committed to increasing the talent pool of young, black scientists and to hiring more permanent black scientists, says Alan Whitfield. But, he adds, the Institute needs to balance the desire to hire people from non-traditional backgrounds with the need to ensure that staff are well-qualified.

TOMORROW'S RESEARCH STARS

• ***Poogendri Reddy***, *from Durban, earned an honours degree in zoology at Rhodes University. She first learned about SAIAB when she was awarded an internship from the government's Department of Science and Technology for an assistant research post at SAIAB. She was subsequently awarded an NRF scholarship to further her studies. Reddy says her degree choice was a "toss up between biology and engineering," but that "the fish have grown on me." Most of her friends, she adds, went into other, more lucrative fields, like accounting and business. But she says she does not regret her decision. "Here, the results of your projects contribute to saving the world."*

• ***Mpho Ramoejane***, *who hails from the Free State, is seeking a master's degree at Rhodes University. His thesis topic is 'New molecular systematics of fish'. "In 10 year's time, I plan to be working in a research institute or a museum in South Africa."*

• ***Moqebelo Morallana***, *also from the Free State, is enrolled in Rhodes University's master's degree programme in molecular systematics. He was inspired by programmes he watched on the National Geographic Channel. In the future, he would like to earn a PhD degree at Rhodes. "In 10 years, I hope to be an established researcher in genetics."*

• ***Pholosi Maake***, *from Polokwane in the Limpopo Province, is a PhD student at Rhodes University, studying fish taxonomy. "For me it's about discoveries." While earning his master's degree, which he did through SAIAB, he believes he discovered a new species, which he is now trying to verify as part of his PhD by deciphering a morphological difference to match the genetic variations that he previously spotted.*

> *"SAIAB is committed to increasing the talent pool of young, black scientists, and to hire more permanent black scientists."*

Bright Sparks

In addition to its formal training role, SAIAB also works with local school children who have demonstrated an aptitude for science. The goal is to urge them to pursue careers in science.

Since 2005, SAIAB's Bright Sparks programme has selected 10 students annually from township schools in the region and taken them on a tour of South Africa's science institutions and cultural heritage sites. When they return, they are encouraged to form science clubs at their schools and become ambassadors for science.

The trip marks the first time many of them have travelled outside of the Eastern Cape province, let alone seen cutting-edge science equipment. Their province is one of South Africa's poorest, and SAIAB is the only national research facility located there.

"The main purpose is to expose the students to science careers through visiting South African science institutions," says Penny Haworth, SAIAB's communication manager. "In the Eastern Cape, there are few programmes that challenge them to become scientists."

Future Prospects

What's next for SAIAB? Expansion — both in terms of funding and the number of staff — is high on the Institute's own wish list.

In Skelton's view, over the next decade, the Institute will have to focus on continuing to fulfil its core mission as a national research hub.

"When we became a national facility a decade ago, the aim was to develop a hub for research on aquatic biodiversity," he says. "We think that we have done that, and that we are now delivering the goods and services that society requires of us."

There is still a vast amount of science that needs to be done, he adds. "The South African marine floor and ocean ecosystems have never been studied in detail. As a result of the strides that we and other scientific institutions have made, especially in the past five years, we can provide opportunities for scientists from all over — and not just from our Institute — to use our facilities and equipment, including our new ROV (Remotely Operated Vehicle), to advance the frontiers of science."

The Institute also has to deliver on its mandate to have a more ethnically diverse staff. And, it will clearly want to keep building its networks in Africa, using its resources to empower researchers in other parts of the continent.

Broad, detailed studies are needed to create a better overview of Africa's aquatic biodiversity and to establish a baseline so that threats to ecosystems can be diagnosed rapidly. Meeting the growing demand for goods and services created by an increasing population and greater wealth will require additional resources, Skelton adds. "We will need to grow. Perhaps, one day, we'll have twice the number of permanent researchers that we do today."

But even if SAIAB triples in size, quadruples its budget and acquires additional offices in Cape Town or Durban, its outward-looking, collaborative ethos will not change, says Skelton.

"We'd want to keep the same far-reaching collaboration model that we use today. In short, we will continue to be an internationally renowned institute doing world-leading research."

Conclusions

Scientifically, SAIAB's national and international impact belies its small size. And, as a national research facility catering to the needs of a young democracy, it is already delivering significant benefits to science and society. As the story of SAIAB shows, in science, biggest does not always mean best.

The story also illustrates how hardship can breed excellence. From the years of isolation to the strategically challenging post-apartheid era, SAIAB and its staff emerged from South Africa's political upheavals stronger and better.

With its well-managed collection, SAIAB is also a beacon of hope for the rest of the continent. In an article for South Africa's popular science magazine *Quest*, published in 2007, Skelton wrote that it's time for African countries to expand their own expertise and traditions in natural history and national species collection. Without such progress, he writes, African biodiversity will remain "a global feast at which African scientists will be uninvited bystanders, without the facilities to earn the respect or recognition that is their due".

To overcome the problems that the entire continent of Africa faces in the area of aquatic biodiversity — water shortages, pollution, unscrupulous development, overfishing, acidification, alien invasive species, and a lack of understanding of the ecosystems — will require local knowledge and local solutions.

By acting together, the continent's scientists, policy makers and local communities have a real chance to avoid wasting the considerable economic and environmental resources that aquatic ecosystems represent.

SAIAB has a key role to play in this transformation, by taking a lead in the scientific programmes and by showing policy makers that aquatic ecosystems provide a wealth of services to their societies that they simply cannot afford to lose.

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TWAS

TWAS, the academy of sciences for the developing world, is an autonomous international organization that promotes scientific capacity and excellence in the South. Founded in 1983 by a group of eminent scientists under the leadership of the late Nobel Laureate Abdus Salam, TWAS was officially launched in Trieste, Italy, in 1985, by the secretary-general of the United Nations.

TWAS has more than 900 members from 90 countries, over 85 percent of whom live and work in developing countries. A Council of 13 members is responsible for supervising the Academy affairs. TWAS is assisted in the administration and coordination of programmes by a small secretariat, headed by the executive director. The secretariat is located on the premises of the Abdus Salam International Centre for Theoretical Physics (ICTP) in Trieste, Italy. UNESCO is responsible for the administration of TWAS funds and staff. A major portion of TWAS funding is provided by the Ministry of Foreign Affairs of the government of Italy.

The main objectives of TWAS are to:

- recognize, support and promote excellence in scientific research in the South;
- provide promising scientists in the South with research facilities necessary for the advancement of their work;
- facilitate contacts between individual scientists and institutions in the South;
- encourage South-North cooperation between individuals and centres of scholarship.

To achieve these objectives, TWAS is involved in various activities and collaborates with a number of organizations, especially UNESCO and ICTP.

For additional information, see www.twas.org.

EXCELLENCE IN SCIENCE

This series of booklets – published by TWAS, the academy of sciences for the developing world – highlights successful scientific institutions in the South and explains how their research has both been sustained over a number of years and how it is helping their host nations achieve sustainable economic development.

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