

FRESHWATER CONSERVATION

Race on to save SA's unique eel species before they slip into extinction

Research efforts are underway to understand more about the diversity, distribution and spatial ecology of Africa's freshwater eels. These enigmatic creatures are considered key indicator species, offering unique and valuable insights into the diverse range of habitats they are found in. Article by Jorisna Bonthuys.



"There is a lot we still don't know about Africa's eels," says Dr Céline Hanzen from the University of KwaZulu-Natal's Centre for Functional Diversity in the School of Life Sciences. "What we do know is that there are indications that they are on a slippery slope in their survival race."

Hanzen is the lead author of a paper titled 'Spatial ecology of freshwater eels in South Africa: implications for conservation', published earlier this year in the journal *Hydrobiologia*. The paper contains the findings of the researchers' preliminary investigation of the spatial ecology of three eel species in the Thukela River. This is the first study to have measured the home range and quantified habitat use of freshwater eels in African freshwater habitats.

The researchers focused their efforts on the Thukela catchment. This catchment is the largest in KwaZulu-Natal (30 000 km²). It flows from the Drakensberg Mountains for about 500 km before ending in the Tugela Mouth in the Indian Ocean. The river itself is highly dynamic, with substantial differences in water levels between the low flow season (winter) and the high flow season (summer).

The researchers' study area was a 6 km river reach, located at Zingela, a private nature reserve, approximately 300 km upstream from the river mouth. This particular stretch of the river included glides and deep pools with large boulders in it, providing good cover for the eels.

The science of tagging eels

Capturing the eels for tagging purposes was no easy task. “Catching eels involved a lot of paddling on the Thukela and a lot of teamwork,” Hanzen says. “Eels can be rather large, very strong, and slippery. They are also almost impossible to handle if they’re not sedated.”

The researchers sampled the eels with fyke nets and electrofishing methods. They briefly kept the eels in a sizeable 50-litre bucket containing aerated water after capturing them. The eels were sedated, weighed, measured, and photographed. Nineteen yellow-stage eels were surgically implanted with radio-tags, comprising *A. mossambica*, *A. bengalensis* and *A. marmorata*.

The researchers also extracted genetic material from individual eel fin clips. This allows them to do DNA barcoding, using a short section of DNA from a specific gene or genes to identify species. Hanzen says this genetic information could provide useful information about species of eel that are harvested and traded. This field of research that includes the use of molecular techniques was also the focus of her PhD study on eels.

In the Thukela study, most of the eels were released back into the water after the radio-tags were implanted. “We then tracked the tagged eels from the riverbank or a kayak using a wideband receiver with an antenna,” Hanzen says. “For safety reasons, our tracking sessions were flexible.” The researchers had to be mindful of factors like the movement of poachers, fire, dangerous wildlife and high water levels.



Dr Céline Hanzen from the Centre for Functional Diversity in the UKZN School of Life Sciences with one of the eels she studies.

“Where we worked, the water was relatively turbid all year round,” Hanzen says. “The water visibility in was less than half a metre making any visual observations of eel behaviour very difficult.”

The scientists employed radio telemetry techniques to track the eels from October 2018 to August 2019. At river level, the detection range was 200-300 m depending on habitat, and up to 1 000 m when tracking from higher ground.

The researchers used the geographic coordinates of the tracked eels to analyse their home range, spatial overlap and habitat preferences. They also created a high-resolution digital map of the recorded, tagged eel locations from drone footage.

Some of the research findings of this project were unexpected. “We observed seasonal change in home range, core area and habitat use,” Hanzen explains. The tagged eels exhibited high individual variability in the habitats they used, and all species had relatively low activity in winter.

“We also recorded very small home ranges in winter for all species,” Hanzen says. “A lack of apparent territoriality among species found in the same area was observed.”

The three eel species tended to use similar glides in the river. Their habitat preferences, however, changed across seasons and between species. “This means that the management of river flows needs to be sensitive to their habitat requirements all year round,” Hanzen says. “But in many water-stressed South-African rivers, this may be unlikely.”

Conservation challenge

Africa’s freshwater eels are habitat generalists and can use many aquatic realms through their long and complex lifecycle, including oceanic waters, continental shelves, estuaries and freshwater environments. This unique feature, coupled with difficulty in separating species based on morphology, makes them complex targets for conservation.

After spawning in the Indian Ocean in the Mascarene Plateau, pelagic larvae proceed through several developmental stages into glass eels (subjuveniles) before migrating into southern African river systems. In freshwater systems, they develop into elvers (juveniles), followed by the resident yellow eel stage (subadult form). Following the progression to silver eels (adult or mature form), individuals will leave the freshwater river systems and return to their marine spawning grounds off the coast of Madagascar to breed and die.

“As long-distance migratory species with a widespread distribution across the highly diversified South African landscape, freshwater eels represent important and unique ecological indicators yet are potentially in dire need of conservation,” Hanzen says.

Globally, there is concern about the stock status of many eel species. Freshwater eels face multiple stressors from sea to source and back, including habitat loss and fragmentation, pollution, overexploitation, pollution, climate change, diseases and parasites, and barriers to their movement.



Eels who had been radio tagged were monitored from the riverbank or a kayak using a wideband receiver with an antenna.

A worrying decline and contractions in the four eel species distribution ranges have also been observed in recent years. In KwaZulu-Natal, a decline in the distribution range of ~50% over three generations (30 years) has been estimated for *A. mossambica* in some rivers, according to the IUCN *Red List of Threatened Species 2020*. These records indicate a decline in distribution – and very likely abundance – of this species in some rivers in the province. This pattern, if reflected in other areas across the range of this species, would be a significant cause for concern.

Given the dramatic declines in temperate eel stocks in recent years, the demands for alternative resources are relatively high. Many eel populations are now under threat and highly traded. In Europe, the illegal eel trade also remains high despite the dramatic declines in their stock and the increased arrest of smugglers. In 2019, EUROPOL even described the illegal traffic of freshwater eels as the “world’s greatest, yet least know, crime”.

Following the ban on freshwater eel exports from the European Union in 2010, some African countries have entered the global trade. As a result, the endemic *A. mossambica* is now under scrutiny from international investors. In this regard, DNA barcoding could provide useful information on what species of African eel are harvested and traded, Hanzen points out.

More research is needed, given that ten species of anguillids occur in the tropics/subtropics, including the four species in South Africa. “It is likely that tropical and subtropical anguillids also face a broad range of threats,” Hanzen says. “Still, the level of understanding of these is poor.”

Sustainable conservation will only be possible through coordination with all countries within the distribution of the four African species. Unfortunately, most countries in the region lack data on eels, Hanzen believes.

Réunion Island is currently the only country in the region where a conservation plan for the African eel species has been implemented. “It is now more urgent to obtain basic knowledge on aspects of the ecology, biology, and well-being of the African eel species before it is too late,” Hanzen says.

Ecosystems remain key

Although migratory fish are largely understudied in South Africa, it is estimated that more than 100 species have requirements for migration (to varying degrees). These species have been directly affected by water quality and habitat stressors and reduced river flows, affecting connectivity between the rivers and sea.

African eels are the only long-distance migrating catadromous species in the region, making them particularly vulnerable to river connectivity disruption. As a result, and owing to existing and planned dam development, they represent a particularly vulnerable component of the regional fish community.

“River connectivity and fish migration management practices should be elevated to contribute to the sustainable use of water resources and ensure the resilience of eel populations in the region,” Hanzen says.

Freshwater eel species are a taxon that is particularly vulnerable to environmental changes. Where they do occur, these eels play an essential ecological role. In rivers in the Eastern Cape, they are, for instance, the only native top predator, Hanzen points out.

Anguilla spp. offer a unique insight into the physical, chemical and hydrological connectivity at a catchment scale, Hanzen says.

Maintaining river connectivity and the associated ecosystem service is a challenge in regions prone to drought. In South Africa, fish migrations are not clearly linked to ecosystem sustainability and, as such, have not specifically been addressed in water resource management.

Overall, studies of the ecological role of eels living in marine habitats and the extent to which trends in abundance of the marine resident mirror those in freshwater are still at an early stage. This will be an important area for future research, Hanzen adds. More research is also needed to ensure science-based decision-making and natural resource management, she points out.

Knowing the locations of spawning areas is an important first step for understanding life histories and population dynamics, simply because the characteristics of these locations influence the reproductive success of adults and the eventual recruitment of glass eels.

“There is a huge variety in our understanding of these eel species,” Hanzen says. “We need more research to review and synthesise existing knowledge to help develop and inform management or recovery plans and to collect new information where knowledge gaps exist.”



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More about freshwater eels

- Anguillid (freshwater) eels are elongated fish with snake-like bodies. Their long dorsal, caudal and anal fins form a continuous fringe.
- These eels are found across the globe except in the eastern Pacific and South Atlantic.
- Four freshwater eel species (*Anguilla* spp.) occur in South Africa. These species are the longfin eel (*A. mossambica*), which is endemic to Africa, the shortfin eel (*A. bicolor*), the African mottled eel (*A. bengalensis*), and the giant mottled eel (*A. marmorata*).
- Freshwater eels are catadromous fish, meaning they spend their adult lives in freshwater sources but migrate to the ocean to spawn.
- The spawning areas of most of these eels are typically located in the open ocean, tens to thousands of kilometres offshore from their growth habitats.
- The yellow eel stage, during which eels grow towards maturity in fresh or coastal waters, can last between 7 and 50 years, depending on the species, sex, and geographic location.
- In the 19th century, eels made up about a third of the total European freshwater catch by value. Today, eels are still an important food fish in many countries. Some species are now farm-raised but not bred in captivity.
- Since 1970, migratory freshwater fish (including eel

species) saw a 76% decline in numbers.

- Nearly a third of all freshwater fish, including many eel species, are threatened with extinction.
- Some migratory fish affect the local culture and spirituality, as is the case with the freshwater eels, which are believed to have inspired the mythical creature 'Inkanyamba' that is part of the Zulu and Xhosa cultures.

Sources: *The World's Forgotten Fishes; Hydrobiologia; Fish and Fisheries*



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