

ECOLOGICAL INFRASTRUCTURE

(Re)connecting fish, rivers and people in the Kruger National Park

Many migratory fish species are swimming upstream in the ongoing race for their survival. The Water Wheel reports about efforts that are underway in the Kruger National Park to connect fish, rivers and people through the restoration of ecological infrastructure. Article by Jorisna Bonthuys.



Globally, migratory freshwater fish have been declining since 1970 throughout their distribution ranges at a staggering rate. Many species are now exposed to threats such as habitat change, climate change and pollution. A recent study found that populations of migratory freshwater fish have declined by 76% globally since 1970, with an even greater decline in Europe: a staggering 94%.

Experts indicate that this could be directly attributed to river fragmentation. Human-made impoundments are also creating problems. Artificial barriers, like dams and weirs, are one of the biggest threats to river ecosystems. They stop the natural flow

of sediments and prevent migratory fishes from travelling up- or downstream to complete their lifecycles.

Many of these concrete and earth barriers that block fish migration routes were constructed in the last century and are nearing the end of their concession, with increasing calls for their removal. This global movement towards re-establishing free-flowing rivers is also underway in South Africa's flagship nature reserve – the Kruger National Park (KNP).

Rivers in a sea of dams

The KNP is known internationally as a 'hotspot' for aquatic

biodiversity. It is home to 46 fish species, of which more than 20 are considered long-distance migratory species. The park has 600 km of perennial river systems and 30 000 km of seasonal and ephemeral streams (dry stream beds that flow as rivers or streams after rainfall periods). These waterways are crucial for maintaining biodiversity in the area. The benefits of these waterways extend beyond South Africa's borders, notes South African National Parks (SanParks) scientist: aquatic ecology, Robin Petersen.

Many rivers in the park are transboundary waterways that extend into neighbouring Mozambique, Botswana and Zimbabwe. In the Zambezi Lowveld eco-region, which covers most of the park, 22 fish taxa are long-distance migratory species that can travel more than 100 km. These migratory fish face several human-induced threats and physical barriers, such as dams and weirs, during their lifecycles.

In the KNP, conservation authorities are rolling out plans to do away with the unintended environmental consequences of decades of building a network of dams in the park. Between 1930 and 1990, the park established the artificial water-for-game programme where boreholes, troughs and concrete reservoirs and dams (concrete and earthen) were constructed to improve water availability and distribution across the park.

In 1931, the first concrete dam was constructed in the park. Since then, 53 concrete and earthen structures have been constructed along various watercourses in the KNP. With hindsight and the accumulation of knowledge through research, conservation authorities realised that this (historic dam building in the park) has led to ecological problems and landscape degradation. These barriers disrupt the natural river flow and migration

patterns, especially breeding fish and aquatic system processes.

In some cases, the provision of artificial water storage has also been to the detriment of rare herbivore species such as roan and sable antelope because of ongoing competition from other species and an increased predation pressure due to large concentrations of prey species around water. Other ecological consequences include serious erosion of dongas on sensitive soil, changes in grass and woody vegetation cover and species composition and an overall decline in biodiversity.

KNP's conservation units assist these ecological consequences in line with SANParks biodiversity values for managing the natural functioning of ecosystems in terms of landscape processes. They use a 'systems approach' rather than an 'issues-based' or 'species-based approach'. A systems-based approach necessitates flexibility and adaptation in conservation planning and management instead of specific issues and species.

Efforts are now underway to remove selected redundant and obsolete dams and weirs in the park and establish completely free-flowing catchments in the area.

"We want to ensure a near-complete free-flowing river situation within the KNP by removing some of these artificial structures," says Petersen. He adds that such free-flowing rivers provide many ecosystem services, including water purification and the delivery of nutrients and food. These rivers are also critical for the life history of migratory fish species that depend on river connectivity to access habitats necessary to complete their lifecycle.

A total of 21 dam structures have already been demolished in



A grey heron at Sunset Dam with its morning catch. The Kruger National Park's rivers are considered a 'hotspot' for freshwater fish biodiversity in South Africa.



The Kanniedood Dam before, during and after demolition in 2018/19. The dam was removed completely after the wall was breached by flood in 2013, causing the river to open a new channel bypassing the dam wall on the southern bank of the Shingwedzi River.

the KNP, including the Kanniedood Dam and the Mingerhout Dam, situated in the Shingwedzi and Letaba catchment areas. This has been undertaken in collaboration with the South African Defence Force (SANDF), which volunteered to assist with the removal of these structures.

To ensure the rivers or streams are returned to their most natural state, the Expanded Public Works Programme (EPWP) helps to rehabilitate the site by removing and reusing rubble. Thus, these projects also allow for much-needed job creation opportunities for neighbouring communities and artisan training. The beneficiaries are contracted to clear the site by hand, where rubble is sorted and then recycled for use in other projects such as stabilising gullies and landfilling in the park. This creates value-add for the rehabilitation effort.

These efforts also provide data that will inform further river restoration efforts in the region. The Kanniedood Dam has, for instance, had major ecological and physical effects on the river system. Petersen notes that fish species richness declined in the Shingwedzi River following the construction of the dam. "In 1988, 11 years after the dam was completed, 19 fish species were no longer to be found downstream. A total of 13 species were absent upstream."

Spotlight on the Letaba River

The Letaba River is one of five major rivers that flow throughout the year and forms part of the larger Olifants River system within the transboundary Limpopo River Basin. The river is also a vital hotspot for aquatic species, including more than 30 fish species.

Historically, the river was also affected by the historical water-for-game interventions. Park authorities constructed a series of broad, shallow impoundments along its watercourse within the KNP. Some of these had already been breached due to flood damages, for instance, at Shimuwini in 2001.

Several human-induced threats and physical barriers such as dams and weirs along the river negatively impact migratory fish during their lifecycles. More recently, protracted dry conditions following the drought of 2015/16 have been a significant challenge to sustain the river's flow through the park.

Whilst the river's Water User Association and the Department of Water and Sanitation have made a concerted effort to mitigate the impact of these dry conditions to meet environmental water requirements (a set of legal minimum flows for ecosystem services, under South Africa's National Water Act) the Letaba River remains a rather stressed river.

The KNP's team re-prioritised removing some of these structures that still exist in this river due to continued drought stress and restoring the aquatic connectivity of the system. This is so that the fish and other aquatic organisms can respond to environmental cues, especially in small early-season floods, which enable the spawning movement of fish. Some of the species in the river are of conservation concern.

Studies are underway to determine the ecological benefits of removing redundant dams and barriers on river connectivity, natural flow regimes, sediment and nutrient dynamics, and the possible re-colonisation of locally extinct species in this river. In collaboration with researchers from the University of Mpumalanga, SANParks scientists monitored the ecological impacts of this dam's removal to inform management actions.

Their findings confirmed suspicions that the dam was creating a disconnect in the river due to temperature changes upstream and downstream, affecting the natural cues for movement of tigerfish downstream in winter due to cooler waters in the system upstream. The researchers also spotted differences in species composition upstream and downstream of the dam, with only four species present upstream and 12 downstream of the structure.

As a result, the Mingerhout Dam was successfully removed in March 2021, albeit during extreme weather conditions

experienced during Cyclone Eloise.

Ecologists hope that the fish species composition will increase in the dam site's reaches upstream. In the process, the river's connectivity will be improved. Any changes will be tracked and documented as part of long-term monitoring efforts. "This is only the beginning of understanding the long-term changes for the betterment of the KNP ecosystem and the river system more broadly for those that depend on them downstream," Petersen says.

When dam removals are not an option, Petersen says fishways offer an alternative to improve river connectivity. Fish ladders (or fishways) enable fish to migrate beyond obstructions such as dams. Most fishways enable fish to pass around the barriers by swimming and leaping up a series of relatively low steps into the waters on the other side. There are now 16 fishways in the park, including the Engelhardt fishway along the Letaba River. These structures were built in the 1960s and 1970s. Many of them are not considered effective anymore.

Meanwhile, the new natural water distribution work in the KNP is yielding benefits for the ecosystem and abundant biodiversity it contains within the savanna landscape and its river systems.

Promoting river connectivity

The lack of consideration of river connectivity and fish migration management are shortcomings of the existing management approach for dealing with multiple freshwater stressors. This view was expressed by Dr Gordon O'Brien, an aquatic ecologist at the University of Mpumalanga's School of Biology and Environmental Sciences, during a recent online symposium.

In South Africa, legislation has established resource-directed measures to attain a sustainable balance between the use and protection of water resources. These procedures have been implemented in most of the country's nine water-management areas, resulting in new legislation to protect these resources. But, unfortunately, very little protection has been afforded to river connectivity maintenance and fish migrations, O'Brien pointed out.

Changes in land cover have resulted in the majority of all river types in South Africa now occurring in a threatened or unsustainable ecological state. In addition, many of the main-stem rivers are now also classified as being severely modified or critically endangered.

Water resources of the Upper, Middle and Lower Vaal, Olifants, Crocodile West, Limpopo, Luvuvhu and Letaba, Mvoti to Umzimkulu, Berg and Olifants-Doorn WMAs are, for instance, all heavily used and, as a result, highly threatened.



Rehabilitation underway following the demolition of the Kanniedood Dam.

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A free-flowing river occurs where natural aquatic ecosystem functions and services are largely unaffected by changes to connectivity and flows, allowing an unobstructed exchange of material, species and energy within the river system and its surrounding landscapes.

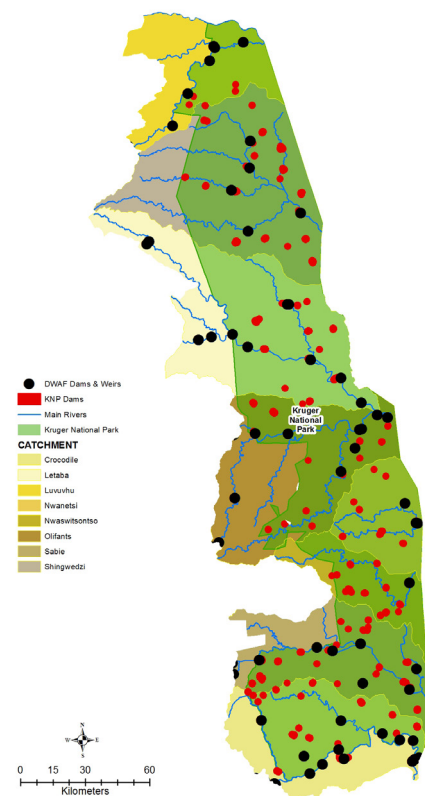
The growing demand for domestic, mining, agricultural and industrial water in the upper and middle reaches of the Olifants River have, for instance, progressively reduced flows in the river's lower reaches in the park. In addition, surface flows have ceased for short periods during recent dry spells.

There are still many challenges with human-made barriers to promote river connectivity and fish migration. For water storage and flow regulation for agriculture and other resource use activities, 610 formal dams and 1 430 gauging weirs have been constructed as partial or complete barriers to fish migration on river ecosystems in South Africa. Only 60 fish passage structures have been built, but many are not functional.

Decision-makers should elevate river connectivity and fish migration management practices, O'Brien highlighted. This can contribute to the sustainable use of water resources and ensure the resilience of fish populations in the region. More research is also needed to ensure science-based decision-making and natural resource management, he emphasised.

**Additional information for this article supplied by members of SANPark's freshwater research and conservation management team.*

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Decades of dam building have left concrete and earthen structures scattered all through the Kruger National Park.