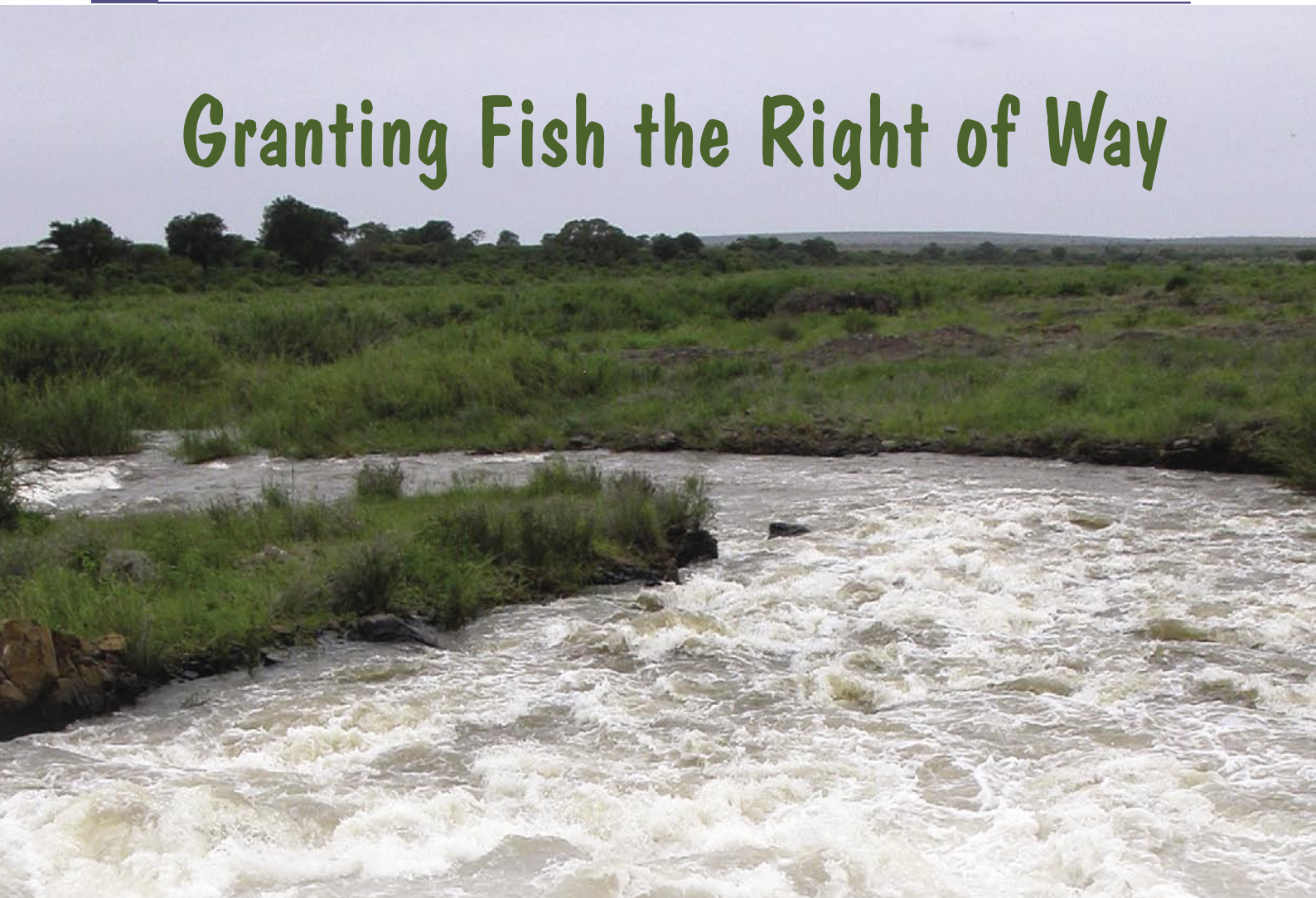
Granting Fish the Right of Way



The natural-bypass fishway at the lower Sabie after heavy rains. It is the only one of its kind in South Africa.

Collaborative efforts to determine the correct design of fishways for uniquely South African conditions are bearing fruit. Lani Holtzhausen reports.

Mangrove snapper, silver robber, bluespot mullet, thornfish, spotted grunter, longfin eel, mountain catfish, Lowveld suckermouth. These are but a few on a long list of fish species whose free movement has been impeded by man-made structures such as weirs, dams, levees and embankments. In fact, impassable fabricated barriers to migration have been cited as one of the main reasons, along with pollution and the introduction of alien species, for the threatened status of a number of red data species in southern Africa.

The harmful effect of barriers to migration is particularly severe on coastal rivers where a number of so-called catadromous species need to migrate from their marine or estuarine spawning grounds into freshwater reaches of rivers for feeding purposes. As these fish migrate upstream as small juveniles even low barriers of less than a metre can be impassable.

INEFFECTIVE STRUCTURES

To mitigate the situation, several fishways have been constructed in South Africa since the 1950s, some at great expense. Recent legislation stipulates that appropriate migration mitigation is required if any proposed in-stream structure obstructs the natural migration of indigenous aquatic species. However, of the 57 odd fishways that have been constructed to date, only 42 are functional to some degree.

The greatest reason for this is that most of these structures were neither designed for South African species nor for local river conditions. Rather, the technology used to construct the fishways was mostly modelled on European and North American structures, designed for large, strong-swimming adult salmonids (trout and salmon). In some cases in the past, fishways were included in a project as an

afterthought to satisfy some legal or social obligation.

Economic considerations also influenced fishway design and, to reduce costs, fishways were often shortened and made impossibly steep. Another mistake has been the incorrect placement of the fishway entrance. As these structures simply did not work, they were in the end a total waste of money.

COLLABORATIVE RESEARCH EFFORT

Only since 2000 has a serious research effort been undertaken to develop fishways in South Africa. Almost all of this research has been funded by the Water Research Commission (WRC). "While necessary, fishways can add huge costs to the construction of a dam or a weir, therefore it needs careful consideration, not only from an environmental point of view, but also from a financial and sustainability point of view," maintains Dr Steve Mitchell, Director: Water-Linked Ecosystems at the WRC. "It is for this reason that we have launched this multi-disciplinary effort to look at providing guidelines to establishing fishways designed to meet the requirements of indigenous species and to suit our environmental conditions." This collaborative effort includes input from hydraulic and design engineers, hydrologists and fish biologists.

Aquatic specialist Dr Anton Bok, who is participating in the research, reports that most countries in Europe, North America, as well as Australia appear to be at least a decade ahead of South Africa in terms of developing fishway designs suitable for their indigenous species and the hydrological conditions in their rivers. "These countries are also many years ahead of us in terms of implementing well-structured fishway monitoring programmes."

***Right**: Communities living near fishways are often not aware of their real purpose, resulting in fishways being used as bathing and fishing spots.*

***Below**: The Xikundu fishway, 40 km downstream of Nandoni Dam on the Luvuvhu River.*

***Below bottom**: A close-up of the Xikundu fishway.*

A close-up of an experimental sloping-baffle pool and weir fishway set up at the Dept. of Ichthyology and Fisheries Science at Rhodes University, Grahamstown.

This fishway implementation work often forms part of ambitious river rehabilitation and recovery programmes, undertaken as part of a broader integrated catchment management programme. Although South Africa simply does not have the financial resources to match these fishway and river rehabilitation programmes, it is thought that the country can certainly benefit from these countries' research findings and experience, and apply appropriate technology developed abroad to local conditions.

WHAT IS A FISHWAY?

A fishway, sometimes known as a fish ladder, is any natural or artificial device that enables fish to overcome structures in rivers that obstruct their natural migrations.

"The current research on fishways funded by the WRC is considered essential to enable a successful fishway implementation programme to be developed in South Africa," maintains Dr Bok. "We have already built far too many expensive, yet unsuccessful fishways in this country simply because overseas designs were blindly applied to our conditions, which are usually very different."

UNIQUE SOUTH AFRICAN CONSIDERATIONS

Unlike rivers in Europe and North America, many of South Africa's rivers are seasonal and flows naturally fluctuate widely at different times of the year. In addition, initial data from monitoring existing fishways in South Africa show that both juveniles as well as adults of some species migrate, with the small fish commonly migrating during low-flow conditions as well.

Thus fishways in South Africa need to operate effectively over a wide range of river flows, and must cater for a very wide size range of fish with different swimming abilities and behavioural preferences. It must also be remembered that it is not only fish which migrate. There are at least nine species of macrocrustacea (freshwater prawns and crabs) that are known to migrate between the sea or estuary and freshwater reaches.

The three most common types of fishways found in South Africa are the pool-and-weir type, the vertical-slot type, and 'natural' type by-pass channels and fish ramps (although there is only one of the latter to be found in the country). An assessment of all three types of fishways was undertaken to determine the suitability of each design for local conditions, reports Dr Ralph Heath, Executive Director of Pulles Howard & De Lange, who is partaking in the research.

While all types have their advantages and disadvantages, the vertical-slot design is thought to hold the most promise for South Africa. Fine-tuning of vertical-slot type fishway designs for the country is being researched in ongoing WRC sponsored fishway studies. "The fishway designs being used in South Africa at present are

FRESHWATER FISH IN SOUTH AFRICA

An estimated 220 freshwater fishes occur in South Africa, of which 21 are threatened. It is reported that about 60% of the primary and secondary freshwater fishes in southern Africa are endemic, which means they are found only within this region.

Among the Red Data species are the southern barred minnow; Clanwilliam rock catfish, Eastern Cape rocky, Vaal Orange Largemouth Yellowfish, Clanwilliam sawfin, white steenbras, Cape Galaxia, Namaqua barb, spotted rock catfish; Clanwilliam sandfish, and spotted killifish.

Most indigenous fish species in this country undertake annual migrations within river systems for a number of reasons, such as to optimise feeding, to promote dispersal, to avoid unfavourable conditions, and to enhance reproductive success. In addition, there are at least 24 marine-spawning and estuarine-spawning fish species that are known to migrate (mainly as post-larvae and juveniles) into freshwater zones of rivers along the south and east coasts of South Africa.

only a few of the possibilities, and further investigations are currently being undertaken in laboratory conditions to determine the optimal fishway designs for South Africa," reports Dr Heath.

Internationally, there is an increasing preference towards more natural alternatives for fish barrier mitigation. These include nature-like bypass channels, which consist of low-gradient rocky channels that mimic the natural rapids and riffles found in the particular river. In addition to allowing the free passage of a variety of aquatic organisms, they also provide important flowing water habitats and are often integrated into river restoration programmes.

Another unique South African aspect which has to be taken into account is communities' perception of fishways. For example, during monitoring of the Xikundu fishway, 40 km downstream of Nandoni Dam on the Luvuvhu River, the research team found the local community using the fishway to wash clothes; bathe themselves, and even using it as a diving platform. Men with casting nets were also spotted at the fishway.

A portable experimental fishway being set up on the Kowie River 'Ebb & Flow' Weir.

Locals believed crocodiles are unable to move into the structure and that they are therefore safe if they use the fishway. This despite the fact that crocodiles were observed at the entrance to the fishway on more than one occasion. Neither of the people interviewed knew what the real purpose of the fishway was. "This points out how important it is to make communities part of the decision-making process," notes Dr Heath.

Research is still ongoing, with the swimming abilities and behavioural characteristics of a selected number of key indigenous fishes being tested at present. It is anticipated that, once all the research has been completed, the results will be collected in a guideline book on how to design, monitor and maintain fishways for local conditions.

A series of regional workshops will be held later this year to introduce the latest South African fishway designs and protocols to regulators, design engineers, scientists and members of the public. The dates of these workshops will be announced on the WRC website, www.wrc.org.za.

FISHWAY DESIGNS IN SOUTH AFRICA

Pool and weir

This fishway comprises a sloping, usually rectangular channel, which is divided into a series of pools by the construction of weir walls across the full width of the channel. The weir crests can be notched and also low-level orifices can be incorporated in the weir walls. Variations in channel slope and the dimensions of the pools are obvious design features that influence the internal hydraulics within the fishway.

Vertical-slot fishways

These fishways have the same basic design as pool and weir fishways, except that the weir walls do not extend the full width of the channel. The water flows between each pool through a slot, which normally extends the full depth of each pool. The weir walls may have single or double slots, but in South Africa, where only ten vertical slot fishways have been constructed to date, only the single slot design has been used.

Pool and slot type vertical slot fishways

A number of pool and slot vertical slot fishways have recently been constructed by the Department of Water Affairs & Forestry at gauging weirs in the Kruger National Park, for example, the Riverside weir and Ten Bosch weir on the Crocodile River. These are combinations of the vertical slot and pool and weir design.

Natural by-pass channels

Low-gradient rocky channels that mimic the natural rapids and riffles found in the particular river.

FURTHER READING

- *Guidelines for the Planning, Design, and Operation of Fishways in South Africa* (WRC Report No 1270/2/04
- *Development of Criteria for the Design of Fishways for South African Rivers and Estuaries* (WRC Report No 1310/1/05)

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