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POLICY BRIEF

# ECOSYSTEMS

**An innovative fishway design specific to South African conditions and requirements has been successfully tested in the field.**

# Providing effective fishways in South Africa

## Impact of barriers to fish migration

The presence of existing barriers to migration in rivers (weirs, dams, road bridges, causeways, etc) is considered to be a major factor responsible for the reduction in numbers and range of many migratory fish and invertebrate species throughout South Africa. Most of the approximately 100 indigenous freshwater fish species undertake annual migrations within river systems for a number of reasons, such as to optimise feeding, to promote dispersal, avoid unfavourable conditions and to enhance reproductive success.

The harmful effect of barriers to migration is particularly severe in coastal rivers where a number of catadromous species (those which reproduce in the sea but spend most of their lives in fresh water) 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 meter can be impassable. Catadromous species include the threatened freshwater mullet ***(Myxus capensis),*** four species of freshwater eels and at least five species of freshwater prawns and crabs. These migratory species present a valuable resource (food, angling) and play a crucial role in the ecology of the coastal river systems.

There has been a worldwide increase in interest and research effort over the last 15 to 20 years on promoting free passage of aquatic organisms in rivers. Earlier fishways were designed to cater for strong-swimming adult

salmonids and have been found to be ineffective for passing juveniles or smaller fish species. The design limitations of these earlier fishways has resulted in a renewed research effort to develop designs for non-salmonid species by both hydraulic engineers and fish biologists in many countries around the world. This research has resulted in much-improved fishway designs that successfully pass a wide variety of fish and other aquatic migratory species.

## Legislative and research support

Environmental legislation promulgated in South Africa adequately protects riverine ecosystems from man-induced impacts. This legislation includes:

- The Environment Conservation Act, 1989 (No. 73 of 1989)
- The National Environmental Management Act (Act 107 of 1998)
- The National Water Act, 1998 (Act No. 36 of 1998)
- The National Environmental Management: Biodiversity Act, 2004 (Act 10 of 2004).

If correctly and strictly applied, this legislation should ensure that appropriate provision is made for fishways when in-stream barriers to fish migration are constructed.

Until recently, support for South African research to investigate fishways that would cater for indigenous species under local environmental conditions had been very limited. The situation changed after the Department of Water Affairs and Forestry (DWAF) recognised the need to determine fishway requirements in South Africa and, subject to these requirements, to develop the capacity to provide optimal, cost-effective fishway design criteria for South African rivers.

It was further considered important, following construction, to be able to evaluate the performance of fishways and to acquire the knowledge needed for maintaining fishways to ensure continued functioning.

Consequently, a series of research projects projects, funded by the Water Research Commission (WRC), has been undertaken to address the issues. Resulting research reports have contributed to the compilation of comprehensive guidelines for the planning, design and operation of fishways in South Africa.

The development of these guidelines has further been facilitated through a collaborative and consultative process with leading South African fish experts, ecologists, hydraulics engineers and hydrologists who gave up their time to participate in a series of workshops and reviews.

## The scope of the fishway guidelines

The guidelines contain the following information:

- Protocols to establish the need for a fishway and the priority for a fishway;

- A discussion of the advantages and disadvantages of various fishway types;
- Summaries of the swimming abilities of coastal and inland fishes in terms of fishway design parameters; and
- A presentation of hydraulic calculations required in the designing of fishways.

## Current status of fishway provision

In spite of the well-documented negative impacts of in-stream barriers on aquatic migratory species in South Africa, there has, to date, been very little effort to establish inventories of such barriers on a catchment basis and to prioritise them in terms of their ecological impact and hence the need for fishway provision.

**Currently there are about 57 fishways in South Africa, of which about 42 are functional to some degree.**

Many current fishways lack effectiveness for the following reasons:

- Poor placement of the fishway entrance is prevalent, resulting in fish having difficulty in finding the entrance;
- Many designs cater mainly for large fish;
- The fishway pools are often too short with excessive turbulence levels;
- Altered designs owing to construction problems frequently result in structures that are ineffective in passing the target species; and
- A lack of maintenance often results in debris blocking parts of the fishway. Regular maintenance, as well as designs aimed at keeping debris from entering the fishway, are essential to maintain long-term effectiveness.

In reality, the true effectiveness of most fishways is unknown because of a lack of monitoring. The need for monitoring fish movement through the fishway has often been overlooked during the design phase, making quantitative monitoring impossible after construction.

## An innovative fishway design

Very flat slopes (around 1:30) are required for fishways which have to accommodate the wide variety of fish sizes often found in southern African rivers. Such flat sloping fishways will be long, expensive and normally difficult to fit in at a barrier.

This constraint can be overcome by providing two fishways at a barrier: one, with small drops between small pools, aimed at small fish; and the other aimed at larger fish, able to cope with larger drops and requiring larger pools.

The large variation in water levels often experienced in South African rivers is adequately accommodated by adopting a vertical slot fishways design. The idea of containing both the small and the large fishways in one structure has led to the development of an innovative fishway design – the ***Twin Channel Vertical Slot Fishway***.

This design has been successfully tested in both the laboratory and in the field. With this design, fishways having a slope of 1:7 would allow the passage of fish having widely ranging size (from <40 mm up to 480 mm) and swimming ability (very weak to very strong).

## Recommendations

- There are strong indications that many South African fish species can overcome velocities and turbulence levels much higher than quoted in the literature. It is strongly recommended that the twin channel vertical slot fishway, constructed at a slope of 1/5, be built into a Crump weir in order to test its effectiveness under natural conditions. This fishway should be fitted with a properly designed monitoring system, and a detailed monitoring programme should be undertaken over a period of at least two years. If such a fishway proves successful it will open the way for cheaper fishway designs in South Africa.
- In order to successfully implement a fishway provision programme in South Africa, it will be necessary to quantify the extent to which natural migrations are already blocked by man-made instream structures. The protocols referred to earlier to establish the need for and priority of a fishway at an instream barrier could be used to help identify priority sites for fishway provision throughout the country.
- Research into the migratory needs of the weaker swimmers should be undertaken. Virtually all the species tested during the course of research to date proved to be relatively strong swimmers which would probably be able to cope with velocities and turbulences far exceeding the values encountered. The cost of a fishway is largely determined by the weakest swimmers to be catered for, and therefore the abilities of these weaker swimmers, as well as the necessity of these species to migrate, should be established as a matter of urgency.

**Further reading:**

*Guidelines for the Planning, Design and Operation of Fishways in South Africa* (**Report No: TT 287/07**)
*Twin-channel Vertical-slot Fishway Designs and Tests* (**Report No: KV 197/07**)
*Development of Criteria for the Design of Fishways for South African Rivers and Estuaries* (**1310/1/05**)
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