

The potential for a fish ladder to mitigate against the loss of marine–estuarine–freshwater connectivity in a subtropical coastal lake

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ABSTRACT

Increasing water demand in coastal regions has resulted in the construction of weirs and barrages in coastal freshwaters. These form barriers to migrations of estuarine and euryhaline marine fishes and crustaceans. This study assessed the impact of loss of marine–estuarine–freshwater connectivity caused by a weir at the outlet of Lake Mzingazi, a coastal lake on the subtropical east coast of South Africa. Facultative catadromous estuarine and euryhaline marine fishes were most affected by the weir, which blocked their upstream migration. These fishes were absent in the lake and were prevented from accessing potential nursery habitat. Crustaceans were less affected by the outlet weir. Salinity tolerances of most penaeid prawn species occurring in southern African estuaries prevent penetration into freshwater reaches of connected systems. Movements of palaemonid prawns which either spawn in or have larvae dependant on estuarine water, and the marine spawning brachyuran *Varuna litterata*, were not completely impeded by the weir. These species have larvae and juveniles that can climb over the weir in its present form. Historically, the lake served as an estuarine nursery and its physico-chemistry and habitats still offer viable and valuable habitat to estuarine species. There is therefore great potential value in installing a fish ladder at the lake outlet that can be used by juvenile fishes and crustaceans. Re-establishing marine–estuarine–freshwater connectivity here will reinstate a natural migration route that has been impeded for over 70 years and partially restore the ecosystem to its original state.

Keywords: Coastal lake, weir, migration barrier, fish, crustaceans, estuarine, *Varuna litterata*, fish ladder

INTRODUCTION

Human population growth and economic development has increased pressure on freshwater resources in many parts of the world. The main response to this has been the construction of dams. These often form impenetrable barriers to free movement of aquatic fauna in rivers, with consequent ecological implications. Impacts on migratory fish species are the most studied. Best documented are cases involving anadromous salmonids which undergo mass migrations from marine waters to spawning grounds in mountain reaches of rivers.

Fish ladders (or fishways) are structures that enable fish to migrate beyond obstructions such as dams. They have been used in northern hemisphere countries for centuries. Their primary application has been in rivers where barriers have blocked adult fish access to higher river reaches favoured for spawning. Cases where fishways have been used to promote upstream migration of juvenile fishes to nursery habitats are less well known, probably as a result of species involved having less economic significance in fisheries. However, the importance of managing natural resources at the level of ecosystem has become increasingly recognised (Skelton, 2000), and maintaining migration routes for fishes that are not necessarily of great

direct economic importance has been accepted as important for ecological integrity and maintaining biodiversity. The latter is a fundamental element of ecological goods and services (Millennium Ecosystem Assessment, 2005).

Dams in South Africa have severely impacted indigenous freshwater fish populations (Jubb, 1967). Although this has long been recognised, fish ladders are a relatively new development in the country (Davies and Day, 1998). The fact that fish conservation efforts initially focussed on alien sport angling species (Coke, 1988) has been largely responsible for this. Over recent decades considerable effort and expense has been invested in projects aimed at restoring natural migration routes of freshwater fishes (DWA, 1991; 1995). Most of this effort has been invested in inland regions.

Increasingly, however, municipal, industrial, mining and farming sectors in coastal regions are resorting to coastal freshwaters to meet their water requirements. On the east coast of South Africa, coastal lakes are increasingly targeted as sources of freshwater for human use. In many cases this results in the construction of weirs at their outlets to increase yields or prevent salt water penetration from estuarine headwaters. Being at the lower end of catchments, weirs on these systems have little impact on freshwater fish populations, and, as is the case in many other southern hemisphere countries, there are no anadromous species to be affected. Consequently, coastal weirs have received little environmental consideration. They do, however, form potential barriers to movement of marine and estuarine species. Fish species affected are euryhaline marine rather than freshwater forms, and are juveniles migrating to nursery

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Received 21 May 2013; accepted in revised form 17 December 2013.