






No-take estuarine-protected areas: The missing armour for the conservation of fishes



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The focus of conservation attention over the past few decades has been on marine-protected areas (MPAs) providing protection for heavily exploited marine fish species. Although some estuaries are included in most large MPAs, specific attention on the protection needs of fish species in estuaries has been lacking. Furthermore, many of the estuaries located within conservation areas are open to angling activities and this has been exacerbated by the proliferation of illegal gillnet fishing in many systems during recent decades. Three fish species, the dusky kob *Argyrosomus japonicus*, white steenbras *Lithognathus lithognathus* and spotted grunter *Pomadasys commersonnii* – are used as examples of estuary-dependent taxa whose populations have been decimated by fishing over-exploitation, as well as habitat degradation caused by various human activities. By having complete protection for vulnerable fish species in certain estuaries, the potential benefits of increased catches for both subsistence and recreational anglers along the entire South African coastline could be substantial. If such protection is not offered to these species, then the downward spiral in fish catches will continue, to the ultimate detriment of both the people who currently use these protein resources for food security and those who are part of the economically important recreational fishing industry.

Conservation implications: Based on collapsing populations of targeted fishery species in estuaries, there is an urgent need to implement no-take estuarine-protected areas in each of the biogeographic regions along the South African coast.

Keywords: estuarine fishes; threatened species; protected areas; conservation; fisheries management; environmental management.

Introduction

South Africa was one of the few countries that took an early initiative in declaring marine-protected areas (MPAs) for biodiversity conservation (Attwood et al. 1997a; Attwood, Harris & Williams 1997b). Support for these protected areas intensified when it became clear that they could assist in the recovery of depleted fishery resources (Attwood et al. 1997a; Buxton 1993). Although representation of biogeographic zones and habitats was recognised in 1995, the declaration of new MPAs at the end of that decade did not address the paucity of estuarine fish protection that was highlighted (Attwood et al. 1997b). Despite the fact that a number of marine fish species use estuaries as facultative or obligate nursery areas, there was little acknowledgement of this link in the proclamation of MPAs (Whitfield 1997), a situation that has not changed in the intervening decades (Whitfield & Cowley 2010). More recent studies in South Africa have provided further conclusive evidence of the benefits of no-take MPAs to harvested fish stocks (Kerwath et al. 2013; Maggs, Mann & Cowley 2013; Mann et al. 2016), including those found in estuarine-protected areas (Attwood et al. 2007; Da Silva et al. 2013; Hedger et al. 2010; Padare et al. 2020).

South African estuaries are home to 172 fish species (Whitfield 2019). Of these species, 37 (22%) are marine 'stragglers' and make very limited use of estuaries. Marine fish species that use estuaries as nurseries and/or foraging areas comprise 73 (42% of the total), but only 36 (21%) of these are closely associated with estuaries (Whitfield 2019). Fish species that are resident and breed within estuaries comprise 25% (43 species) of all the taxa recorded in these systems. There is a high level of endemism, with 38 fish species (22% of all estuary-associated taxa) occurring only in southern African waters (Whitfield 2019).

Why are estuaries important to fishes?

The importance of connectivity between marine and estuarine ecosystems is globally recognised (e.g. Able 2005). In recent years, two diadromous fish species have gone extinct (Allibone et al. 2010; Freyhof & Christian 2005), yet no fully marine fish species has gone extinct despite the latter being vastly more numerous and the target of industrial-scale fisheries speaks about the high risks confronted by estuary-dependent fish. Our local piscine extinction candidates are either estuarine or freshwater. Two species of sawfish *Pristis* spp. have disappeared from South African estuaries (Everett et al. 2015), and the estuarine pipefish *Syngnathus watermeyerii*, once thought to be extinct (Whitfield & Bruton 1996), is not far from that listing (Whitfield et al. 2017).

Estuaries are the conduits between marine and freshwater habitats – critical for the completion of life cycles of many fishes but threatened by land-based pollutants and growing numbers of catchment impoundments. Past MPAs did not factor in the important role of estuaries in the ecology of catadromous fish species, such as anguillid eels, whose glass eel larvae have to enter catchment rivers through estuaries (Bruton, Bok & Davies 1987). Although the eels spend more than a decade of development in the freshwater environment (McEwan & Hecht 1984), the ability of the adults to reach spawning grounds in the Indian Ocean (Tsukamoto, Aoyama & Miller 2002) is dependent on safe passage through healthy and protected estuarine environments.

Estuaries are possibly the most threatened habitat realm in the country. There are 22 estuarine types represented in South Africa and 86% of these are threatened (Van Niekerk et al. 2019, 2020). About one-third of South Africa's freshwater is abstracted for agricultural, industrial and domestic use before it reaches the sea. This alone has reduced estuarine habitat, but what remains has been degraded further by habitat modification and pollution (Van Niekerk et al. 2019). The loss of fish nursery habitat, including saltmarsh, mangroves and intertidal foraging area, has effectively reduced a large number of fish populations by suppressing recruitment.

Over-exploitation poses the single biggest threat to estuarine fish conservation (Whitfield & Cowley 2010; Table 1). Although more than 200 species are caught in South Africa's marine linefishery, very few species are targeted in estuarine fisheries, with the dominant species being the spotted grunter *Pomadasys commersonnii*, dusky kob *Argyrosomus japonicus*, leervis *Lichia amia*, white steenbras *Lithognathus lithognathus* and Cape stumpnose *Rhabdosargus holubi* (e.g. Baird, Marais & Daniel 1996; Cowley et al. 2004). The number of species targeted in subtropical estuaries is slightly higher (James et al. 2001) than those in the more temperate systems. With the exception of Cape stumpnose, the stock status of all the highly targeted species is considered to be either over-exploited or collapsed.

A pressing need for protecting estuaries resides with several iconic fish families that contain species targeted by recreational and subsistence fishers. The main use of estuaries by marine fish taxa in South Africa is as 0+ juveniles that usually spend between 1 and 3 years in these habitats (Wallace & Van der Elst 1975). Species belonging to the families Mugilidae, Sparidae, Haemulidae, Sciaenid and Carangid are particularly well represented in estuaries on the subcontinent. Members of these families are economically important and well represented in estuarine and coastal fisheries. The juveniles of most of these species are largely restricted to estuaries but make occasional forays into the open sea (e.g. Bennett et al. 2017; Dames et al. 2017; Grant et al. 2017). Once they approach adulthood, these individuals return to the sea on a more permanent basis, where they are targeted with a variety of fishing methods (e.g. Childs et al. 2015; Murray et al. 2018). These fish contribute more than 90% of the catch of South Africa's shore-based and nearshore marine fisheries (Lamberth & Tripe 2003).

Current protection status for fishes in South African estuaries

Over 3730 tonne of fish is caught annually in South Africa's estuaries, of which 2200 tonne (60%) is by the illegal gillnet fishery (Van Niekerk et al. 2019). These estimates are conservative as the combined legal and illicit catch in St Lucia alone may be over 300 tonne to as much as 800 tonne per annum (Mann 1995; Turipe et al. 2014). Of over 500 gillnets confiscated from estuaries throughout South Africa that had some degree of protection in the form of conservator or fishery patrols, 60% were retrieved before having caught any fish. This implies that even current low levels of protection (and support for conservators) are helping to keep estuarine gillnet catch from surging past 4000 tonne per year. Increasing the number of estuarine-protected areas, accompanied by well-trained, motivated staff would most likely reduce gillnet catch to even lower levels.

The latest assessment of the coverage of estuarine-protected areas (EPAs), of which several types exist, shows that 48% of estuarine habitat is protected, but that the vast majority of this protection is either partial or ineffective (Box 1; Van

TABLE 1: Estimates of the relative importance of current major fish conservation issues in (1) freshwater, (2) estuarine and (3) marine ecosystems in South Africa.

Conservation issue	Freshwater ecosystem	Estuarine ecosystem	Marine ecosystem
Habitat alteration	++++	+++	+
Fish exploitation	++	++++	++++
Alien invasives	++++	++	+
Translocation	+++	++	-
Genetic contamination	++	+	-
Parasite translocation	++	+	-

Source: Whitfield, A.K. & Cowley, P.D., 2010, 'The status of fish conservation in South African estuaries', *Journal of Fish Biology* 76(9), 2067–2089. <https://doi.org/10.1111/j.1095-8649.2010.02641.x>.

Note: Habitat alteration includes physical changes to both estuary and catchment, water pollution and alterations in freshwater inputs.

-, not significant, +, insignificant, ++, slightly significant, +++, significant, +++++, highly significant.

Niekerk et al. 2019). Turipe, Wilson and Van Niekerk (2012) modelled that 133 South African estuaries, including those already protected, would be required to meet defined biodiversity targets, including protection of fish. Of these, 61 should be fully protected no-take estuaries, whereas

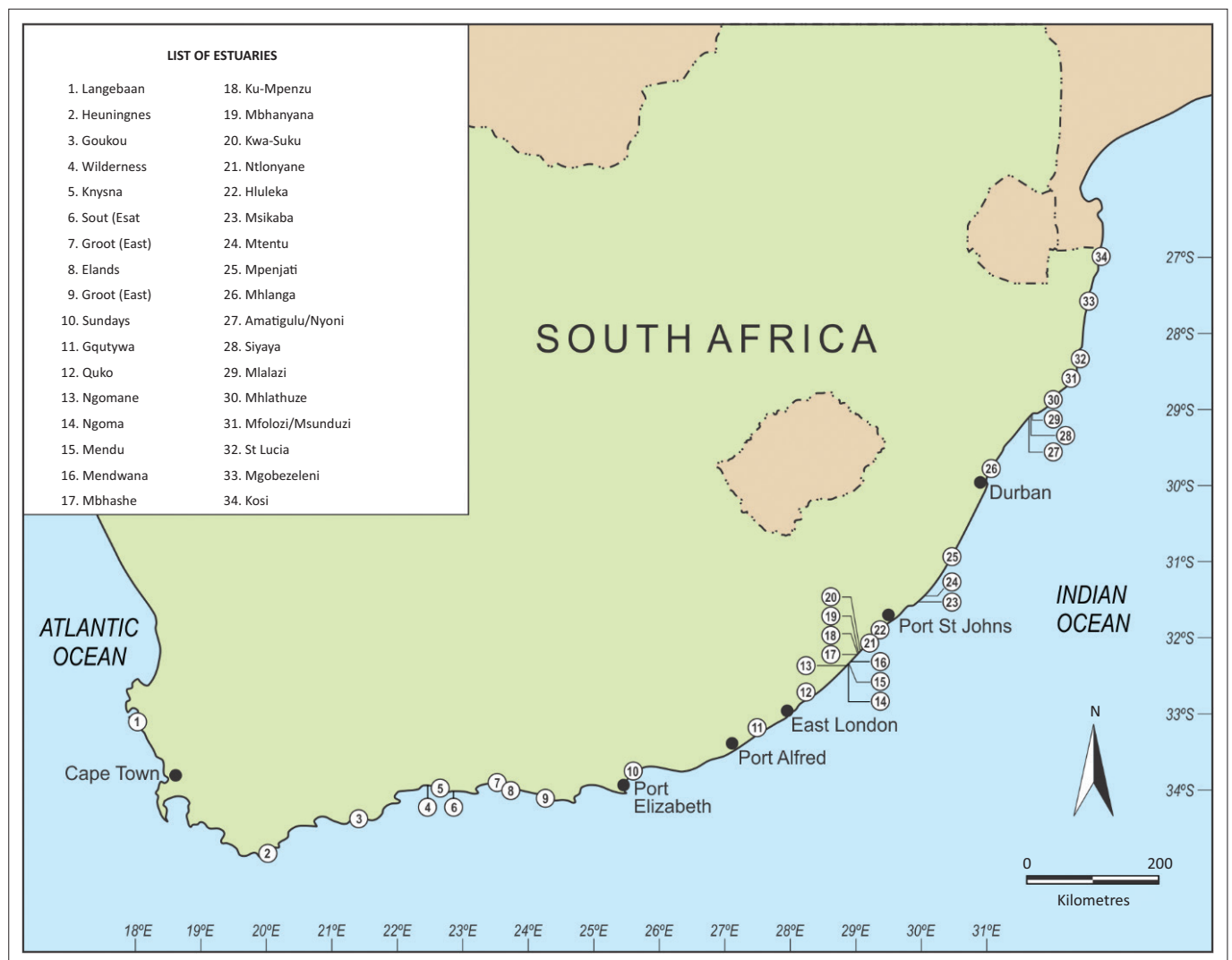
BOX 1: Steps required for recovery of over-exploited fish species in South African estuaries.

- Creation of a network of estuarine-protected areas (EPAs) for fishes, which will include 'no-take' areas.
- Fisheries regulations rigorously enforced by dedicated staff, especially the removal of all illegal gill nets from estuaries.
- Commercial and small-scale fishing restricted to line-fishing and traditional fishing methods at acceptable effort levels.
- Environmental legislation fully implemented by the relevant authorities.
- Developing protocols for the prevention of pathogen transfer between estuaries by vessels and fishing gear.
- Implementation of the Environmental Water Reserve for estuaries by the Department of Water and Sanitation (DWS).
- Estuary Management Plans (EMPs) that include no-take zones are prioritised and implemented for all major estuaries.
- Improved fisher awareness and compliance with regulations, including greater adoption of catch and release fishing within all recreational sectors.

Source: Modified from Whitfield, A.K., Lamberth, S., Cowley, P. & Mann, B., 2019, 'Fisheries in South African estuaries – Are we on the right road?', *The Water Wheel* 18(6), 12–15.

72 require partial protection, including zoned no-take areas. This represents 46% of estuaries and 79% of estuarine area. Consequently, all EPAs should be explicit in the individual Estuary Management Plans required in terms of the *Integrated Coastal Management Act* (Act 24 of 2008).

Current estuarine ecosystem protection levels are low, both in terms of number of types and in area. Overall, 82% (19 out of 22 types) of South Africa's estuarine ecosystem types are under-protected. Of estuarine area, less than 2% is well protected, 24% moderately protected, 63% poorly protected and 11% not-protected (Van Niekerk et al. 2019). Seventy-two estuaries are in terrestrial protected areas and flow into MPAs, but few have any no-take status. Only 25 (8%) of estuaries have no-take zones, representing less than 1% of total estuarine area. This is because of most of these being very small systems that fall entirely within an MPA (e.g. Klipdriftfontein in De Hoop) but make a minimal contribution to total estuarine fish biomass or productivity (these very small systems are excluded from Figure 1).



Source: Adapted from Whitfield, A.K., 2019, 'Fishes of Southern African estuaries: From species to systems', *Smithiana Monograph* No. 4, p. 495

FIGURE 1: Important South African functional estuaries (from a fish diversity and production perspective) that have a formally declared conservation status, even though fish stocks within these areas are often not protected from fishing activities. Very small protected estuaries and those larger systems that have only a minor portion of the water area conserved are not shown.

The inclusion of estuaries within an MPA, or other types of protected areas, does not imply that fish are protected, as recreational and subsistence fishing in protected estuaries is usually permitted, for example, Mbashe and Mbhanyana where angling effort is five times the national average. Many estuarine systems that have a national, provincial or municipal conservation status have management authorities that allow fishing, for example, Knysna and Goukamma. Langebaan is a Ramsar site and foundation of the West Coast National Park but supports a legal commercial gillnet fishery as well as commercial, small-scale and recreational line fishing. The combined catch exceeds 250 tonne per annum. Our concern is that the word 'protection' has been misapplied and that the two most common deficiencies in protected areas are the management of fishing and water quality (Van Niekerk et al. 2019).

Important estuaries (from a fish diversity and production perspective) currently situated in the footprint of conservation areas are concentrated in the eastern and south-eastern parts of the country (Figure 1). The largest and most important estuary in South Africa is the Lake St Lucia system, which covers almost 50% of the estuarine surface area in the country. Although forming a part of the World Heritage site and a Ramsar site of international importance, the fishes of the St Lucia system are not protected from fishing and illegal gill netting is common (Mann 1995, 2003). Furthermore, this system has been effectively closed to the sea since 2002, thus greatly reducing its nursery function for marine species (Vivier, Cyrus & Jerling 2010). Also part of the iSimangaliso Wetland Park is the large Kosi Estuarine Lake system that, in addition to recreational angling, permits the extensive use of modified traditional Thonga fish traps and is simultaneously plagued by illegal gill netting (Kyle 2013). Clearly, the conservation status of fishes within these key estuarine systems needs to be reviewed and elevated.

Fish species examples of why estuarine-protected areas are required

Why are effective EPAs for fishes such an urgent requirement for the sustainability of fish stocks all along the South African coast? Just three examples should provide ample evidence to support EPA proclamations, not as addendums to MPAs, but as fully protected areas in their own right. The first species is the dusky kob *A. japonicus*, a member of the Sciaenidae family, which is the primary target of most recreational and subsistence fishers in the subtropical and warm temperate regions (Cowley, Childs & Bennett 2013; Crook & Mann 2002; Mann, James & Beckley 2002; Potts et al. 2005). Dusky kob is now estimated to have a spawner stock biomass below 3% of their pre-exploitation biomass (Winker et al. 2015). The South African dusky kob is now considered to be endemic to the subcontinent and is genetically distinct from *A. japonicus* in the rest of the Indo-Pacific region (Barnes et al. 2016). An additional threat

is the reported hybridisation with the heavily depleted silver kob *Argyrosomus inodorus* (Mirimin et al. 2014).

The second example is the white steenbras *L. lithognathus* (Sparidae), which is targeted by fishers in warm- and cold-temperate regions. This large seabream had a spawner stock biomass < 6% of pristine levels in 1990 (Bennett 1993) and ongoing monitoring has suggested further declines since then (Mann et al. 2014, <http://dehoopfishmonitoring.uct.ac.za>). The discovery of a handful of 0+ juveniles in the Cunene Estuary on the Angola-Namibia border attests to what is left of a large historical West Coast spawning population depleted to near extinction by eight decades of intensive beach-seine netting straddling the late 19th and early 20th centuries. White steenbras bones and otoliths are a dominant fish component of archaeological middens on the West Coast (Poggenpoel 1996). By inference, it took just a few decades to nearly extirpate a population that had been in existence for more than 100 000 years.

The third example relates to a tagging study by Padare et al. (2020) on spotted grunter *P. commersonnii* (330 mm – 650 mm fork length) in the Goukou Estuary (Western Cape). The results of this study further confirm the high site and estuarine fidelity by spotted grunter and the potential value of estuarine no-take area closures as a management option. The high site fidelity suggests that the closure of even a section of an estuary has the potential to reduce the vulnerability to capture of a portion of the locally resident population. The vulnerability of this species to fishing pressure within estuaries was highlighted by the loss of 43% of the tagged fish. Whilst this study revealed the potential benefit of no-take EPAs, the possible capture of several tagged fish within the no-take zone suggests that compliance is low and that law enforcement is inadequate at the Goukou Estuary.

Some reasons why existing law enforcement measures are not working

Whilst in theory improved management of the above iconic species could be achieved by catch restrictions, or even a total moratorium on catches of these species, law enforcement, and hence compliance with fishing regulations, is very poor across the country (Bova et al. 2017). A recent detailed study conducted on the Sundays Estuary revealed that more than 90% of the targeting effort was levelled at only two species, dusky kob and spotted grunter (Cowley et al. 2013). A large portion of the dusky kob catch comprised fish with lengths below the minimum legal size limit (i.e. 60 cm total length). The high retention rate of undersized fish is a major cause for concern. Sixty-three per cent of dusky kob and all white steenbras catches were below the legal size limit of 60 cm, and 30% of spotted grunter were below the 40 cm size limit.

Size limits are a type of catch restriction that should become more effective as fishing pressure increases and reduces the average length of fish, but it still requires

effective enforcement. The other commonly applied catch restriction, namely, bag limits, is more problematic. This type of restriction becomes less effective as fishing pressure increases (Attwood & Bennett 1995), as the following evidence demonstrates. The daily bag limit (one fish per person per day) of legal-sized dusky kob in the Sundays Estuary was attained on only 2.6% of angler outings, whilst that for spotted grunter (five fish per person per day) was attained on only 0.1% of outings. No white steenbras larger than the legal size were captured (Cowley et al. 2013). The bag limits therefore have little practical value in these instances.

A detailed questionnaire survey revealed that most anglers were unaware of the fishing regulations pertaining to their targeted species and that only 71% of interviewees claimed to have a valid fishing permit (Cowley et al. 2013). The apparent lack of compliance can largely be ascribed to poor law enforcement. Most (59%) of the respondents had never had their catch inspected, whilst 11% had encountered a law enforcement officer on only one previous outing. It is our opinion that EPAs (in which some or all of the estuary is protected from fishing) would offer far greater protection to estuarine fishery species, as long as their formal declaration includes dedicated management (conservation staff and budgets), as has been accorded to other protected areas.

Not surprisingly, both dusky kob and white steenbras are now listed as critically endangered on the International Union for Conservation of Nature Red List (Fennessy 2020; Mann et al. 2014). Similarly, many estuary-associated marine fish species are on the World Wildlife Fund Southern African Sustainable Seas Initiative Red List for the restaurant or retail trade as these may not be commercially sold or bought in South Africa. These include leervis, tenpounder, kingfish species, spotted grunter, two stumpnose species, estuarine bream and mangrove snapper.

Conclusion

The current political and economic environment makes it difficult to restrict fishing activities in any estuaries that are currently open to this activity. Indeed, the trend in recent years has been to open up parts of MPAs to fishing that were previously closed to angling (Lombard et al. 2020). However, by having complete protection for vulnerable and over-exploited fish species in certain estuaries, the potential benefits of increased catches for both subsistence and recreational anglers along the entire South African coastline could be substantial. If such protection is not offered to these species, then the downward spiral in fish catches will continue, to the ultimate detriment of both the people who currently use these protein resources for food security and those who are part of the economically important recreational fishing industry. Indeed, the long-term survival of certain endemic species in estuaries on the subcontinent could well be threatened if these fish populations drop below critical levels, and the possibility then arises that recovery of the stocks becomes increasingly unlikely.

In conclusion, we recognise that the advantage of combining well-managed MPAs and EPAs is the complete protection of at least some vulnerable fish species in a particular area

during all stages of their life cycle. Examples of this are the Stilbaai MPA and Greater Addo NP, which include no-take estuarine areas, and substantial parts of the adjacent coast. Protected areas of this type, and community-based conservancies or stewardship initiatives, will greatly assist in achieving the recovery of over-exploited estuarine fish stocks and support the survival of critically endangered species, such as the estuarine pipefish. However, we also see a need to protect catchment connectivity, estuarine habitat and vegetation, which are all vital for young catadromous fish stages and the return migration of adult eels to the sea. To accomplish this, it will be necessary to declare additional EPAs and to substantially improve the management of existing EPAs to ensure that we have adequate protection of our essential fish nursery habitats.

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Ethical consideration

This article followed all ethical standards for a research without direct contact with human or animal subjects.

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