

Benchmarking knowledge-based adaptive management of estuarine fisheries in South Africa for sustainable development

Synopsis of project outcomes and management recommendations for estuarine fisheries

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A subsistence angler with spotted grunter caught in the Great Fish Estuary, Eastern Cape.

© Amber-Robyn Childs

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A subsistence fisher collects sandprawns from the banks of the Sundays Estuary. ©Paul Cowley



Executive summary

The dynamic South African coastline is over 3 000 km long and comprises 290 estuaries and 42 micro-estuaries. These biologically productive habitats provide fishery opportunities for both subsistence and recreational users, making these fisheries important for income creation and food security, especially for vulnerable coastal communities. Unfortunately, most of the sought-after, often large-bodied fish species that are caught in estuaries are overexploited, with some stocks considered as collapsed. The complexity of managing the estuaries in South Africa, together with illegal and unregulated fishing, climate impacts and increased anthropogenic pressures are threatening not only the fisheries but also the livelihoods, and food security in particular, of fishers and their communities.

For the past 20 years, researchers from the South African Institute for Aquatic Biodiversity (NRF-SAIAB) and the Norwegian Institute for Nature Research (NINA) have investigated the behaviour and vulnerability of prominent estuarine fish species to provide knowledge for improved sustainable management of the fisheries. However, these findings, although important, have had little direct influence on estuarine fisheries policies and regulations in South Africa. This was the impetus for the South Africa/Norway Cooperation on Ocean Research (SANOCCEAN) project **‘Benchmarking knowledge-based adaptive management of estuarine fisheries in South Africa for sustainable development’** financed by the South African National Research Foundation, the Research Council of Norway, NRF-SAIAB, NINA and the Institute for Coastal and Marine Research at Nelson Mandela University (NMU).

The project aims to develop recommendations for knowledge-based governance of estuarine fisheries in South Africa to aid sustainable development in this sector. To achieve this goal our interdisciplinary study of estuarine fisheries management included key researchers in the biological, socio-cultural and economic sciences from NRF-SAIAB, NINA, NMU and the University of Strathclyde. We adopt a socio-ecological systems approach that included novel methods that are inclusive of different knowledge systems. Through biological, socio-cultural and socio-economic research, the project aims to guide a more sustainable approach to estuarine management, blue economy policies, resource utilisation and improved resilience of ecosystem services. The purpose of this report is to guide coastal and estuarine managers with key findings and recommendations that will assist in setting fisheries regulations and manage these important systems that benefit communities directly, have high social and cultural value and contribute towards the blue economy in South Africa. With improved regulation and implementation, estuarine resources can be sustainably utilised more equitably and will aid in conserving the estuarine ecosystems and services.

This closeout report provides a summary of the findings of our SANOCCEAN project and provides recommendations for adaptive estuarine fisheries management that are knowledge-based and interdisciplinary.

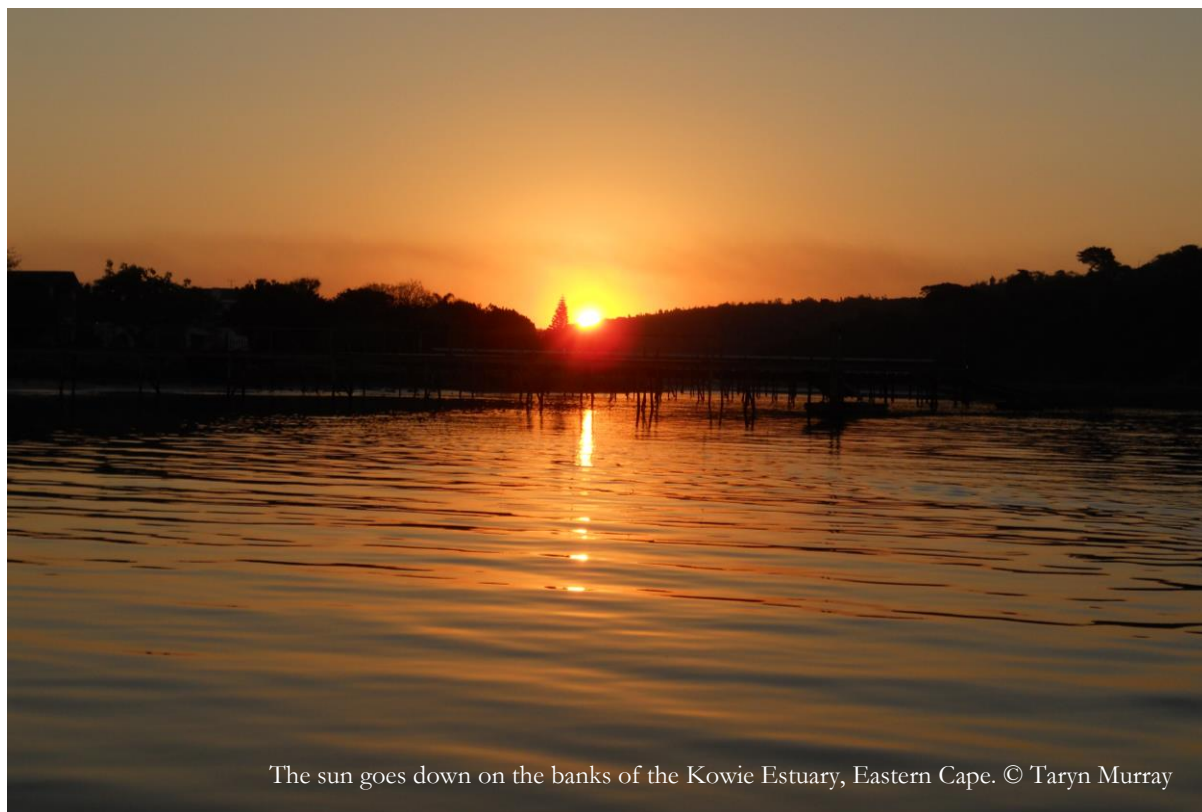


Estuarine fisheries cannot be managed in isolation by only taking resources and fishers into account. **Estuaries must be co-managed as socio-ecological systems that have critical linkages from their catchment areas to the marine environment.** A holistic approach to management, supported by multi-disciplinary research that is inclusive of all knowledge systems, is the only way to improve estuarine functioning and allow for the sustainable provision of goods and services.

Key areas that need to be addressed to improve management of estuaries and their resources:

- Consistent integration of scientific, practical, Indigenous and local knowledge systems and knowledge holders for an improved understanding of complex social-ecological estuarine ecosystems.
- Improved management and law enforcement through capacity development, integration of all stakeholder groups, increased financial resources and funding at all levels of governance.
- Strengthen current cooperative governance processes, including policy and legislative coherence to ensure a co-ordinated approach to estuary management.
- All stakeholders need to recognise and understand the complicated dynamics of socio-economic inequalities and apartheid legacy issues that continue to marginalise and exclude certain individuals and communities from equitable access to estuaries and their resources to enable a better response to resource use challenges.
- Stakeholder processes, methodologies and pathways need to be addressed to allow for users to contribute meaningfully to management processes and stewardship of estuaries. This will reduce tensions and conflict, and build trust.

- Inclusion and acknowledgement of multiple benefits and services in fisheries management within estuaries is essential. This would include cultural benefits and health.
- Manage and restore vital ecosystem functions through addressing water quality and quantity as a main driver. This could include wastewater treatment management and ecosystem restoration.
- Build capacity for research integration in estuarine management to adequately address and manage estuaries as complex socio-ecological systems.
- Effective implementation of the proposed new fisheries regulations and the establishment of Estuarine Protected Areas, in close collaboration with estuarine stakeholders, with linkages to the marine environment is essential for sustainable estuarine fisheries.
- Scenario planning and adaptive management approaches to address emerging serious threats to estuarine functioning posed by mining activities, both legal and illegal, and alien and invasive species.
- Ensure the development and implementation of estuary management plans, which provides a vital tool for facilitating the integrated management of estuaries as socio-ecological systems.
- A significant opportunity to enhance the protection of estuaries and their resources is provided in the proposed Estuarine Functional Zone expansion detailed in the 2018 National Biodiversity Assessment - Estuarine Realm.



The sun goes down on the banks of the Kowie Estuary, Eastern Cape. © Taryn Murray



The realisation that estuaries are complex systems linked to and affected by catchment and land-use activities, the coastal and marine environment, and human needs and activities, gave rise to the National Estuarine Management Protocol. The effectiveness of any management plan, however, depends on how well it is informed by a range of knowledge systems. A solid knowledge base provides for evidence-based decision-making, and perhaps more importantly allows for flexibility via adaptive management as more knowledge becomes available and/or situations change. This is the key as regime shifts, such as climate change together with ever-increasing demands for resources and other anthropogenic impacts require constant re-evaluation of management objectives and their implementation.

Therefore, the perceptions of role players with regards to current strengths and weaknesses of and solutions to estuarine management in general and estuarine fisheries in particular, were considered to be of key importance in laying the foundation for developing knowledge-based adaptive management recommendations.

Lessons learned:

- South Africa has good legislation related to estuary and fisheries management, but a combination of limited capacity (manpower, infrastructure, funding, knowledge) and poor governance (includes poor cooperative governance) mean that mandates and responsibilities are not fulfilled to their full potential.
- Non-compliance or lack of self-regulation across the board erodes management efforts.
- Estuary management plans (EMPs) are an essential enabler and provide a legally binding framework that facilitates cooperative governance to achieve the management of estuaries as complex socio-ecological systems. They should be simple, clear and concise and indicate the What, Who, Where, When and How of estuary issues and management interventions. As a lever for change, EMPs should be developed for priority systems identified in the National

Biodiversity Assessment - Estuarine Realm (NBA), and small rural systems with similar characteristics (physical, functional and socio-economic) can be clustered. In the absence of EMPs, protection of the Estuarine Functional Zone (EFZ) via the Environmental Impact Assessment (EIA) process and the use of tools such as the NBA to classify estuaries as Critical Biodiversity Areas or Critically Endangered Ecosystems will reduce the threat to health and functioning.

- The identification and appointment of key driven people in key positions (champions) is needed to prioritise and implement estuary management efforts.
- Estuaries are complex systems and management interventions, and research needs to adopt an integrated socio-ecological systems approach that takes connectivity (catchment to coast), ecological and biological interactions, and socio-cultural-economic values into account.
- Indigenous and local knowledge systems are under-utilised in developing knowledge-based management actions and this leads to the exclusion of communities and end users with the result that trust in government and management authorities is undermined.
- Weak institutional functioning resulting from governance challenges and limited capacity means estuary management is not prioritised, there is a lack of institutional memory, bureaucratic delays hamper management efforts and management bodies such as Estuary Management Forums and Coastal Committees are neither representative nor functioning optimally. Key to resolving this is the appointment of champions in key positions, the recognition of the socio-economic importance of estuaries and representative participation in management.
- Poor understanding of the importance of estuaries to biodiversity and, more importantly, to social well-being, means that management is not prioritised. Raising awareness amongst all role players via two-way communication and the integration of knowledge from all knowledge systems could help focus government efforts to manage estuaries and encourage compliance amongst end users.
- The impact of mining activities needs to be assessed and the environmental authorisation process revisited.
- Impacts from land-use and development, including mining, urban development, infrastructure and agricultural practices can be reduced by formal recognition of the expanded EFZ proposed in the NBA and strict application of the EIA process in the zone.
- Compliance with regulations and standards for improved water quality is essential. The reduction of contaminated agricultural return flows and discharges from wastewater treatment works alone will go a long way in improving the situation.
- The development and implementation of Resource Directed Measures for the NBA-prioritised estuaries should be a priority.
- Estuary mouth manipulation may only be done after authorisation of Mouth Management & Maintenance Plans, or under emergency situations. Making the EFZ a no-go area in terms of land-use and development would preclude the necessity or frequency of artificial breaching.
- Despite the pending kob species and estuary night-fishing ban, more stringent regulations for key linefish species are needed in combination with formal protected areas and no-take zones, established through meaningful stakeholder engagement processes. However, the efficacy of

these actions is reliant on enforcement, for which there is limited capacity, and compliance or self-regulation by end users, which is also in short supply.

- The extent of the impact of biological invasions needs to be brought to the attention of authorities so eradication measures can be implemented, and the aquaculture industry and aquarium trade must be better regulated.
- Thirteen management themes that encompass the levers for change to address the dominant challenges were identified, namely:
 1. Increase capacity to govern
 2. Improved compliance
 3. Effective governance
 4. Institutional functioning
 5. Enhanced knowledge sharing and communication
 6. Reducing impact of mining
 7. Amendment and improved implementation of legislation and frameworks
 8. Improved water quality and decreased pollution
 9. Water quantity
 10. Mouth manipulation
 11. Sustainable resource use
 12. Responsible land-use and development
 13. Control of invasive species.



A subsistence fisher with a dusky kob along the banks of the Great Fish Estuary. © Tor Næsje



The biological importance of estuaries cannot be overestimated, and immeasurable numbers of larval and juvenile fishes recruit and thrive in these systems. Amongst these are species valuable to estuarine subsistence, small-scale and recreational fisheries, with some being targeted more than others. Most species are distributed throughout South Africa, fall under various International Union for Conservation of Nature Red List categories, are in varying stages of collapse, and have their own management regulations.

The objectives of the estuarine fisheries resources studies have been to gain policy relevant knowledge to address the adaptive management needs of the important estuarine fisheries in South Africa. This has been done by evaluating a series of management options by quantifying patterns of movements, area use and seasonal distributions of fisheries species using data from previous and ongoing studies.

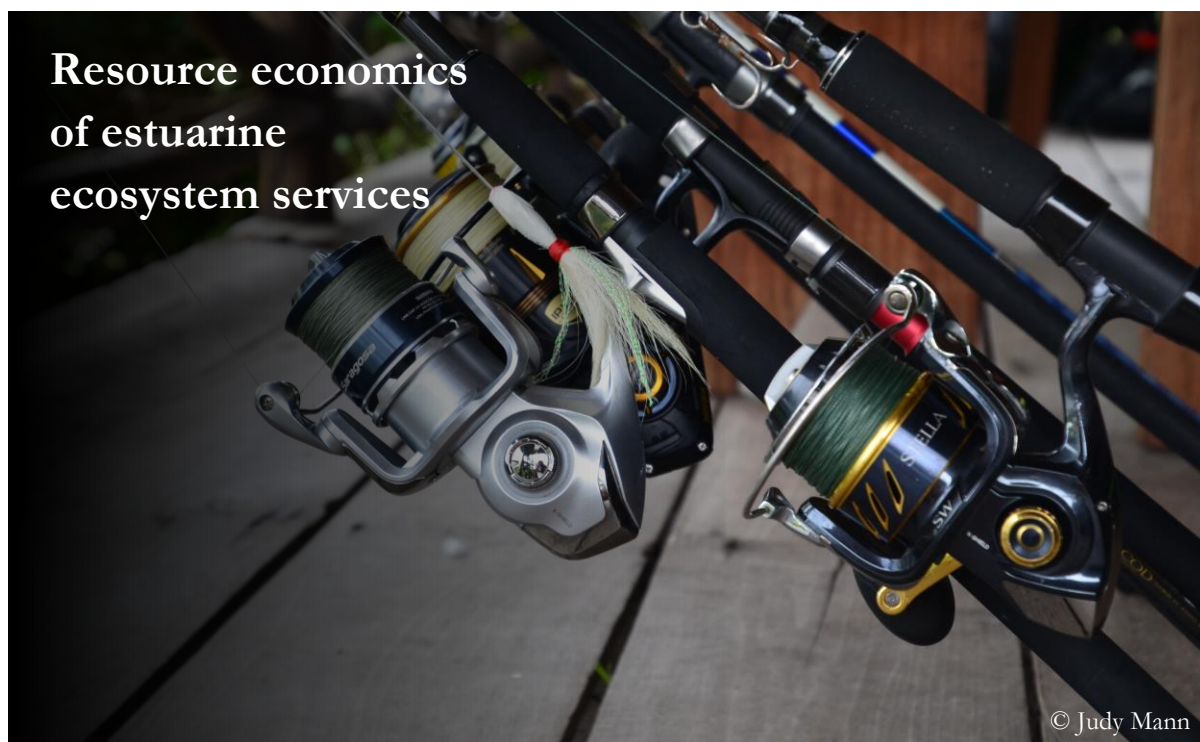
Lessons learned:

- South Africa has at least eleven important estuarine fishery species utilised in subsistence, small-scale commercial and recreational fisheries.
- Species composition and area use of the species varies among estuaries.
- Estuary-dependent fish species are important food and economic resources, which contribute significantly to the socio-cultural-economic sector.
- The present fisheries management of important estuary-dependent species must be improved to secure fish stocks and avoid further population depletion and worsened status.
- Most fishes targeted in estuarine fisheries are estuary-associated species, spending a large portion of their juvenile life in estuaries, showing a relatively high, but varying, degree of residency to specific estuaries.

- While in their estuarine nursery habitat, fish use varying lengths of the estuary with some species being more resident to certain areas (e.g. spotted grunter, Cape stumpnose, white steenbras) than others (e.g. dusky kob, leervis).
- Sub-adults and adults of estuarine fishery species, including dusky kob, spotted grunter and leervis, have all been shown to spend more time in estuaries than previously thought.
- Juveniles of most species show relatively high levels of residency to their tagging estuaries, with some actively moving between the estuary and adjacent marine environment, as well as to other neighbouring estuaries.
- Recaptures of tagged fish show that some of the species are heavily targeted in estuaries, and that fish below the legal size-limits were often retained.
- Effective and sustainable management regulations may vary for different species, and to some extent also among estuaries. Management regulations must therefore be tailor-made for the species in question and based on knowledge of the species behaviour and area use.
- The threatened status of some of the important estuary-dependent species calls for immediate implementation of effective regulations to secure sustainable use of these valuable resources.
- Without sustainable use, future fisheries resources are threatened, with especially severe implications for more marginalised and poor fisher groups.
- In the present situation with restricted law enforcement of, and compliance with, fisheries regulations, our studies indicate that no-take estuarine area closures are likely to benefit important coastal fishery species; at least the more resident species, during their obligatory estuary-dependent life-history phase. However, the size, proportion and part of the estuary closed to fisheries will determine the effectiveness of the protected area.



A juvenile white steenbras caught by a recreational fisher in the Kasouga Estuary. © Taryn Murray



Estuaries provide ecosystem services to humans. Ecosystem services are both material (provisioning ecosystem services) and non-material (cultural ecosystem services). Material benefits humans receive from estuaries include food, freshwater, and genetic resources, while the non-material benefits include recreation, aesthetic enjoyment, spiritual experiences, and physical and mental benefits. Fishing occurs in estuaries and sustains local economies and traditions as well as providing basic food. Estuaries also generate employment through tourists who are drawn to estuaries because of the aesthetics and the water sporting activities that they offer. The objective of this part of the project has been to assess the value of provisioning ecosystem services from the estuaries, including both bait collection and fishing by subsistence and recreational users.

Lessons learned:

- Estuarine ecosystem services face significant threats and challenges, the majority of which are caused by anthropogenic activities, while others are caused by climate change. Estuaries provide benefits to humans and help them maintain their livelihoods. These benefits can be monetary (provisioning ecosystem services) or non-monetary (cultural ecosystem services), which are valued for the contributions they make to livelihoods and societal well-being.
- Most of the research on the value of estuarine ecosystem services is conducted globally, with only a few studies conducted in South Africa, which highlights a significant research gap. This emphasises the importance of increased research effort into the value and conservation of the estuarine ecosystem services in understudied geographic areas.
- Our economic valuation estimates provide reliable examples of the economic benefits of keeping estuaries intact, and indirectly pinpoints the value of well-managed estuarine ecosystems to maintain or improve connectivity for fish populations and ecological production, in combination with sustainable utilisation of natural resources in estuaries.

Socio-cultural aspects of estuaries



Another important objective of the project has been to identify the constraints and enablers to management of estuarine fisheries as well as to identify and understand the socio-cultural components that impact the governance of these resources. Recognising that fisheries management is located within estuarine management, we acknowledge the need to approach this work with a social-ecological systems perspective. This component of the study responds to a lack of research on the social-cultural dimensions of estuarine management and aims to identify key social and cultural benefits of estuaries. To advance towards more integrated approaches to estuarine management, which acknowledges economic, social, and cultural priorities alongside biophysical and environmental objectives, this aspect of the research explores the opportunities for alternative knowledge integration into estuarine management, ensuring Indigenous and local knowledge systems inform future estuarine management processes and implementation.

Social-ecological systems approaches to environmental management highlights the need to identify and analyse the links between estuarine ecosystems, estuarine users and environmental challenges. We specifically focus on the specific estuarine resource users and estuarine uses, and their interlinkages with estuarine resources and ecosystems.

Lessons learned:

- Estuarine fisheries management is informed primarily by scientific knowledge (over other knowledge systems). Estuarine fisheries systems, as complex social-ecological systems, require a consistent integration of different knowledge systems and knowledge holders to manage them effectively, adaptively and sustainably including not only scientific knowledge, but practical, Indigenous and local knowledge.
- Resource users' connections with estuarine fisheries are complex, multidimensional and often overlap to the extent that understanding users goes beyond the simplified motivations of subsistence or recreation.
- Socio-economic inequalities and apartheid legacy issues continue to exclude certain users from equitable estuary access and use. Estuary management needs to recognize and understand these complicated dynamics in order to better respond to resource use challenges.
- Structural racism within government institutions and society more broadly, continues to constrain estuarine management measures and sometimes leads to marginalisation and exclusion of certain individuals and communities.

- It is at times challenging for local estuarine managers to fulfil their mandates due to limited capacity, executive sponsorship, leadership and poor communication from superiors.
- There is a lack of realistic opportunities and support from authorities for estuarine users to engage meaningfully in the management process. Users feel sidelined, which erodes confidence in government and management interventions and processes.
- The strong cultural connections that users have to estuaries must be acknowledged, understood and viewed holistically with other uses in order to better inform management.
- Social science data fails to inform estuarine management processes and policy due to limited capacity and knowledge flow structures to integrate such data.
- There are limited governance structures and capacity to engage stakeholders in a meaningful and inclusive way, which can result in increased social tensions rather than shared knowledge, trust and stewardship of estuaries.
- Meaningful and inclusive stakeholder engagement is hampered by bureaucracy and ineffective knowledge flow structures, leading to social tensions, lack of knowledge sharing and the inability of estuarine fisheries users being able to contribute to the management process.

Subsistence fishers along the Banks of the Great Fish Estuary, Eastern Cape. © Tor Næsje



Recommendations

The detailed analysis of all levers for change for the primary challenges identified by this interdisciplinary project and experts' opinions have allowed for the development of the following recommendations. The prioritized actionable recommendations for national, provincial, and local government, all tiers of government (co-responsibility), multiple role players and research institutions are listed (and colour-coded) below, and separated according to the entities responsible for their implementation.

National Government

Department of Forestry, Fisheries and the Environment (DFFE) to legislate a Community Based Natural Resource Management (CBNRM) model for estuary management under the National Environmental Management Act with links to the Marine Living Resources Act (MLRA) for subsistence and small-scale fishing areas.

Revise estuarine fisheries management regulations of an estuary-specific basis, with a focus on the various fisheries and fish resources as a part of estuary management plans.

Enhance the Environmental Impact Assessment (EIA) process to specify in-depth socio-economic, cultural and environmental evaluation aspects through thorough, timely, vernacular and meaningful stakeholder engagements.

The DFFE to recognise a category for subsistence fishers so they can be individually licenced and compliant.

Functioning and representative Coastal Committees and Estuary Management Forums (EMFs) to facilitate cooperative governance; the DFFE to amend the National Estuarine Management Protocol (the Protocol) to improve and clarify the definition of what equitable representation at local and provincial level should be as well as provide guidelines.

The DFFE to develop and implement a dynamic socio-cultural-economic value framework for ecosystem goods and services that can be applied to specific contexts as part of a socio-ecological systems (SES) approach to estuary management.

Provincial Government

Develop a strong provincial management authority to drive the estuary management plan (EMP) process and functioning of the Provincial Coastal Committees (PCCs) to ensure authorities are held to account and mandates are fulfilled.

Ensure effective and representative EMFs with links to Coastal Committees as they are key to facilitating cooperative governance and meaningful participation by local role players.

Local Government

Estuary-related management issues at local government level to be prioritised in IDPs, SDFs and Coastal Management Programmes (CMPs) for funding allocation and planning.

Local government to develop effective partnerships with research institutions, non-governmental organisations and community-based organisations to improve estuarine governance and awareness raising.

Local government to encourage and protect ‘Environmental Defenders’ from local community backlash by providing them with agency and legitimacy, e.g. facilitate appointment as HFCOs.

All tiers of government

Ensure meaningful input from all stakeholders towards the co-development of EMPs and the DFFE should amend the Protocol to stipulate that ILKS are used to inform the EMPs themselves and not just during the scoping phase.

Develop and implement more EMPs that are context-specific (estuaries managed as SES), collaborative, clear, simple and concise with regards objectives, issues and mandates and incorporate into planning or management frameworks.

Strengthen the implementation of estuarine management within existing governance structures and frameworks.

Research Institutions

Researchers and knowledge brokers to continue to raise awareness amongst the authorities, landowners, aquaculture industry and aquarium trade of the extent of the problem and severity of impacts related to invasive species.

Institutions to empower researchers on how to get science/research findings included in policy.

Investigate the feasibility of CBNRM to alleviate capacity issues in government departments – limited application to subsistence and small-scale fishing areas.

National Government & Research Institutions

Institutions must freely share information from public funded research and monitoring programmes.

National & Provincial Government

The Protocol must be amended to include spatial mapping of socio-cultural priorities and relations as a requirement for EMPs.



Researchers on the hunt for juvenile dusky kob in the Sundays Estuary. © Tor Næsje



Prof. Amber-Robyn Childs surgically implants an acoustic transmitter into a juvenile dusky kob caught on the Sundays Estuary. © Tor Næsje

Table of contents

Executive Summary	v
List of Acronyms	xxi
Foreword	xxii
Acknowledgements	xxiii
1. INTRODUCTION	1
2. CURRENT APPROACH TO ESTUARY MANAGEMENT	4
Relevance in terms of National Priorities	6
3. DEFINITION OF FISHERIES RESOURCE USERS	7
4. FISHERIES RESOURCES: Species estuary use with relevance for management	8
4.1 Background	8
4.2 Materials and Methods	11
4.3 Findings	11
4.4 Conclusions	24
4.5 Lessons learned	24
5. THE RESOURCE ECONOMICS OF ESTUARINE ECOSYSTEM SERVICES	26
5.1 Background	26
5.2 Materials and Methods	26
5.3 Findings	28
5.4 Lessons learned	35
6. SOCIAL AND CULTURAL ASPECTS OF ESTUARINE FISHERIES MANAGEMENT	37
6.1 Background	37
6.2 Materials and Methods	38
6.3 Findings	42
6.4 Lessons learned	55
7. PRESENT MANAGEMENT	60
7.1 Background	60
7.2 Materials and Methods	61
7.3 Findings	62
7.4 Lessons learned	64
8. CONCLUSIONS	66
9. RECOMMENDATIONS	68
10. REFERENCES	79
11. APPENDICES	84



List of acronyms

ABPR	Arts-based Participatory Research
CBNRM	Community-based Natural Resource Management
CBO	Civics Based Organisation
CMP(s)	Coastal Management Programme(s)
COGTA	Ministry of Cooperative Governance and Traditional Affairs
CS	Consumer Surplus
DFFE	Department of Forestry, Fisheries and the Environment
DMRE	Department of Mineral Resources and Energy
DWS	Department of Water and Sanitation
EFZ	Estuarine Functional Zone
EIA	Environmental Impact Assessment
EMF(s)	Estuary Management Forum(s)
EMP(s)	Estuary Management Plan(s)
FCO(s)	Fisheries Control Officer(s)
HFCO(s)	Honorary Fisheries Control Officer(s)
ICMA	National Environmental Management: Integrated Coastal Management Act (Act 24 of 2008)
IDP(s)	Integrated Development Plan(s)
ILKS	Indigenous and Local Knowledge Systems
IUCN	International Union for Conservation of Nature
KZN	KwaZulu-Natal
MLRA	Marine Living Resources Act (Act 18 of 1998)
MPA	Marine Protected Area
MPRDA	Mineral and Petroleum Resources Development Act (Act 28 of 2002)
NBA	National Biodiversity Assessment (Estuarine Realm)
NCC	National Coastal Committee
NDP	National Development Plan 2030
NGO	Non-governmental Organisation
NINA	Norwegian Institute for Nature Research
NMBM	Nelson Mandela Bay Municipality
NMU	Nelson Mandela University
NRF-SAIAB	National Research Foundation-South African Institute for Aquatic Biodiversity
PCC(s)	Provincial Coastal Committee(s)
SAMPAN	South African Marine Protected Area Network
SANOCEAN	South Africa/Norway Cooperation on Ocean Research
SANParks	South African National Parks
SDF(s)	Spatial Development Framework(s)
SEA	Strategic Environmental Assessment
SES	Socio-ecological Systems
SETA	Sector Education and Training Authority
SSF	Small-scale fishers
WG7	Working Group 7
WWTW	Waste-water Treatment Works

Foreword

This closeout report is the culmination of 20 years of research associated with the investigation of the behaviour and vulnerability of prominent estuarine fish species in South Africa, all with the ultimate aim of providing knowledge for improved sustainable management of estuarine fisheries. However, considering these findings alone have had little direct influence on estuarine fisheries policies and regulations in South Africa, a new approach to estuarine fisheries management is needed, taking all available information into consideration – fishery resources, the environment and the people. This was the impetus for the SANOCEAN project **“Benchmarking knowledge-based adaptive management of estuarine fisheries in South Africa for sustainable development”**.

The report is broken down into several chapters, each addressing the work covered by each component or project work package. The first chapter introduces the concept of socio-ecological systems, and how the overarching aim of the greater project fits into this. The second chapter summarises the current approach to estuary management in South Africa, and includes a useful graphic related to the current management process. Chapter 3 defines fisheries resource users, including recreational fishers, small-scale fishers and subsistence fishers. The fisheries resources are addressed in Chapter 4, highlighting the considerable amount of acoustic telemetry research conducted on estuary-associated species in South Africa. This includes work done on the degree of residency to estuaries, estuary use of the estuary in which they were tagged, multiple estuary use (i.e. visits to other estuaries), the influence of environmental variables and climate change on estuary movements, and fishery-related mortalities. The resource economics of estuarine ecosystem services is discussed in Chapter 5, providing the overall economic value of the Swartkops and Sundays estuaries situated within Algoa Bay, Eastern Cape. Chapter 6 covers the social and cultural aspects of estuarine fisheries management, and details the constraints and enablers to the management of estuarine fisheries, as well as identifying and understanding the socio-cultural components that impact on the governance of fishery resources. To complement the economic work conducted in Chapter 5, a multi-method approach consisting of semi-structured interviews, photovoice and digital storytelling, multi-stakeholder workshops and participatory community mapping was undertaken with the communities around the Swartkops and Sundays estuaries. This provided estuary users the opportunity to classify enablers and constraints to estuarine fisheries management, identifying alternative knowledge systems that should be integrated in future management. Present management of estuaries is covered in Chapter 7, and covers the inputs and opinions of local, provincial and national government authorities, non-governmental organisations, management forums, conservancies, consultants and researchers. Once again, this process highlighted the need for estuaries to be managed as complex socio-ecological systems within an effective cooperative governance framework. The conclusions are presented in Chapter 8, and the recommendations, classed either as actionable or unachievable under the current governance regime, are listed in Chapter 9.

In conclusion, estuarine fisheries cannot be managed in isolation by only taking fishery resources and fishers into account, but need to be co-managed as socio-ecological systems with critical links from their catchments to coasts.

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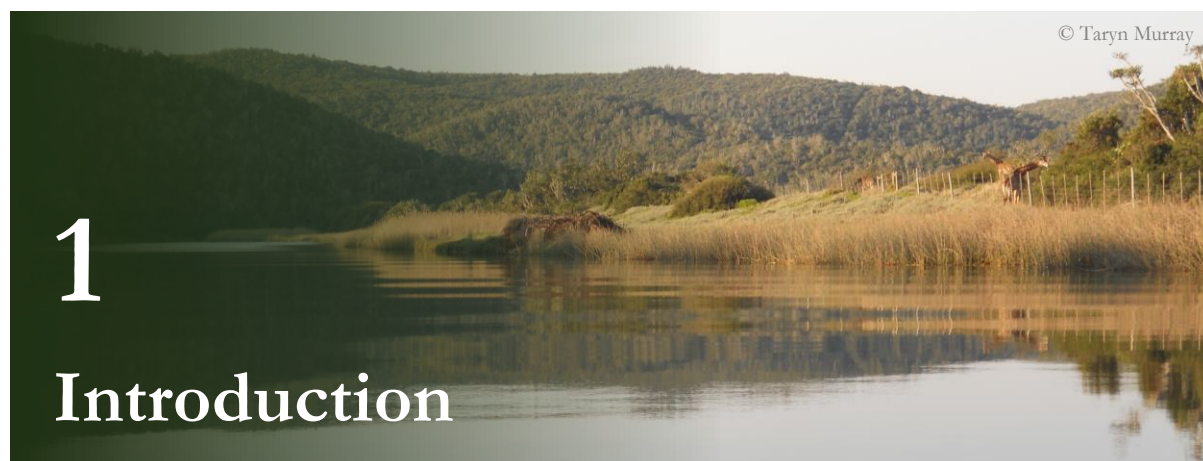
But first, we would like to express our sincere thanks to Jan Haakonsen for being a great inspiration for our South Africa – Norway collaboration, and for all personal support given during the two decades of collaborative work. You have been important for making our projects and the SA-Norway programmes a success! Thank you for all your effort!

Chapter 4: *Researchers and students from published manuscripts, reports and theses:* Amber-Robyn Childs, Tony Booth, Warren Potts, Eva Thorstad, Finn Økland, Rhett Bennett, Bronwyn Maree, Audrey Terörde, Alan Whitfield, Sven Kerwath, Ola Diserud, Vuyolwethu Mxo, Bantony Ziko, Godfrey Padare. *Other assistants with fieldwork:* Rupert Harvey, Tia and Hendrik Swart, Don Reynolds, Simon Daniel, Lloyd Gillespie, Ryan Palmer, Peter Watt-Pringle, Tanith Grant, Jill Sheppard, Derrick Gordon, Brad Ripley, Sherman Ripley

Chapter 5: Members of The Rod Club, Sundays River Angling Club, Mackay Bridge Angling Club and the Hook and Reel Angling Club for participating in the online survey.

Chapter 6: *Researchers:* Athabile Xuba, Meredith Fernandes, Obrukevwe Okuah, Anne Lemahieu. *Co-researchers and workshop participants:* South African Environmental Observation Network; Swartkops Conservancy; Eastern Cape Khoisan Small-scale Fishers Coop; bait collectors and subsistence fishers from the Swartkops Estuary; Indigenous Khoisan Chiefs, traditional healers, representatives, youth representatives and religious leaders and recreational ocean users from Algoa Bay; members from Colchester and Cannonville communities adjacent to Sundays Estuary; spiritual healers living adjacent to Swartkops Estuary; research assistants from the Institute for Coastal and Marine Research at NMU; arts-based expert from Durban University of Technology; SANParks – Greater Addo Elephant National Park: Marine Unit; Eastern Cape Parks and Tourism Agency; NMBM; South African National Biodiversity Institute; World Wide Fund for Nature – South Africa; DFFE - offshore sources of marine pollution.

Chapter 7: *Workshop participants and interviewees:* DFFE; National Estuaries Task Team; SANParks; KwaZulu-Natal Department of Economic Development, Tourism and Environmental Affairs; Eastern Cape Department of Economic Development, Environmental Affairs and Tourism; Western Cape Department of Environmental Affairs and Development Planning; Northern Cape Department of Agriculture, Environmental Affairs, Rural Development and Land Reform; CapeNature; Eastern Cape Parks and Tourism Agency; Ndlambe Municipality; Council for Scientific and Industrial Research; Oceanographic Research Institute; NMU; Centre for Estuarine Research and Conservation; Anchor Environmental; Swartkops Conservancy; Bushmans-Kariega Estuary Care Management Forum; Lower Breede River Conservancy Trust; Kowie Bunga Ocean and River Adventures; recreational anglers from the Swartkops and Kowie estuaries; subsistence fishers from the Kowie and Great Fish estuaries.



1

Introduction

Socio-ecological systems (SES; Ostrom 2009) are defined by the integrated concept of 'humans-in-nature' and are characterised by the interconnected and co-evolving links between social, economic, ecological, cultural, political and technological components (Petrosillo et al. 2015). Due to the myriad goods and services provided by SES that contribute to livelihoods and societal well-being, such as food, water, recreational activities, and spiritual and cultural practices, they have increasingly become the focus of scientific research and policy development (Petrosillo et al. 2015).

Estuaries are important SES (Figure 1.1), yet these systems are heavily under pressure due to industrial, recreational and residential use (Whitfield & Adams 2020). There are increasing demands placed on these SES resulting in estuaries being impacted upon by multiple stressors, including climate change and environmental variability, pollution and overutilisation of resources (Adams et al. 2020), which impact on their ability to deliver cultural benefits and provisioning ecosystem services.

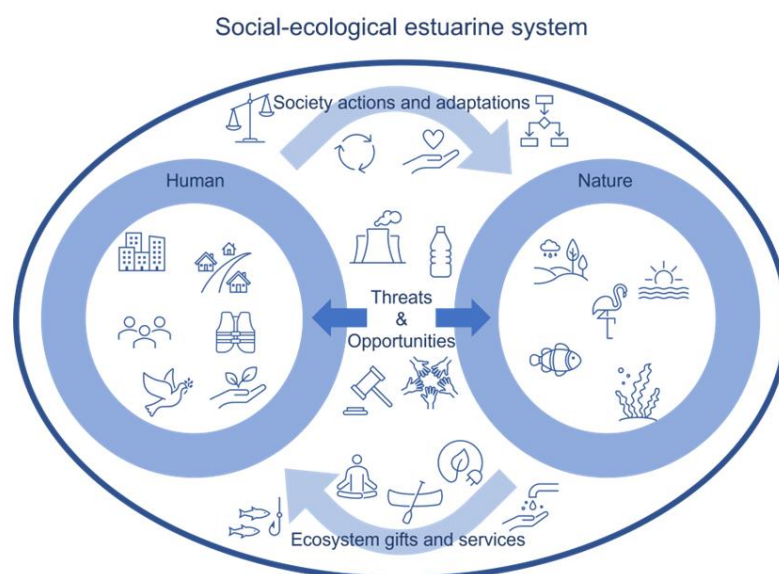


Figure 1.1. Graphic showing the complex interlinkages between social and ecological processes in a socio-ecological systems approach.

In South Africa, many are calling for integrated management approaches to understand aspects such as estuarine fisheries management in connected SES (Adams et al. 2020; Strydom & Kisten 2020). This has been echoed by managers across scales in our research. Estuary management plans gazetted under the National Environmental Management: Integrated Coastal Management Act (Act 24 of 2008) further stress the need to view estuaries as interconnected systems.

Estuarine governance in South Africa is complex, with implementation of legislation often limited and uncoordinated, and at times legal instruments that are failing (Adams et al. 2020), further supporting the need for SES research that is transdisciplinary. The recent Draft White Paper on the Conservation and Sustainable Use of South Africa's Biodiversity (DFFE 2022; the White Paper), which will inform environmental management moving forward, speaks to a "Systems Approach", where components of SES are considered, not as separate elements, but holistically and recognised as being interrelated and interdependent. The initial challenge, however, will be adopting the White Paper as policy, translating it to inform new, or amend existing legislation, and then implementing it within the government framework.

Estuarine fisheries
management further
requires a coordinated,
interdisciplinary approach
to understand and
manage river-estuarine-
coastal connectivity and
fish life histories.

(Strydom & Kisten 2020)

The South Africa/Norway Cooperation on Ocean Research (SANOCHEAN) project 'Benchmarking knowledge-based adaptive management of estuarine fisheries in South Africa for sustainable development', recognising that fisheries and fisheries resources cannot be managed in isolation, or divorced from context, has adopted a socio-ecological lens, and comprises five work packages that have generated biological (fish), socio-cultural and socio-economic data and findings to inform estuarine fisheries management. Work packages one and two present collated fisheries resources data collected on estuarine dependent juvenile and adult fishes tagged in South Africa over the past 18 years. These data describe the dominant behavioural patterns and fishery related vulnerability of the studied species at different life-history stages. Work package three focuses on the dynamics of estuary resource economics and has collected, analysed and presents key estimates of provisioning and cultural ecosystem services. Provisioning services were analysed using data on the local economic impacts of fisheries. Work package four investigated the socio-cultural aspects of estuaries in Algoa Bay with a focus on how Indigenous, traditional and local knowledge systems can be integrated into adaptive management of estuaries and the coastal zone in South Africa. This work package also investigated the social dynamics that impact on and are impacted by adaptive management of estuarine fisheries in the country. Work package five considered present management and generated additional knowledge on the strengths, weaknesses and potential solutions for estuarine and fisheries management through a series of engagements with key role players. This work package finally integrates the knowledge gained from work packages one to five into holistic, knowledge-based, adaptive management guidelines for sustainable estuarine fisheries

in South Africa. This approach conforms to the guiding principles of the White Paper (DFFE 2022), which states that decisions for sustainable use (of biodiversity) must be evidence-based and integrated with scientific, traditional and other forms of reliable knowledge.

The research outcomes from the interconnected work packages, lessons learnt and recommendations detailed in this report recognise that fish resources provide multiple benefits to a variety of user groups (see Chapter 3 for definitions of resource users) and that the fish resources are impacted by multiple stressors, including ecosystem degradation and increased fishing pressures (Adams et al. 2020; Strydom & Kisten 2020). Overall, this project addresses one of the goals of the White Paper (DFFE 2022), which is to “ensure the protection, conservation and sustainable use of marine, estuaries and coastal ecosystems and their natural resources.

Port St Johns at the mouth of the Mzimvubu Estuary. © Tor Næsje





Estuary management is addressed under the National Environmental Management: Integrated Coastal Management Act (Act 24 of 2008) and the associated National Estuarine Management Protocol (the Protocol). The Protocol provides the minimum requirements for an estuary management plan (EMP) as well as the procedure for its development, including the management authority with the responsibility of developing the EMP, which for the most part is the Provincial Departments of Environmental Affairs. Once developed, an EMP must be approved by either the Member of the Executive Council (Province) or Minister (National) for Environmental Affairs – this depends on which management authority was involved in development. Once approved, EMPs must be integrated into either a Municipal, Provincial or National Coastal Management Programme or a Protected Area Management Plan and into Municipal Integrated Development Plans where appropriate.

Provincial and Municipal Coastal Committees serve as the forums for monitoring implementation of EMPs, and Estuary Management Forums are considered to be informal advisory bodies that assist with implementing specific plans identified in an EMP and facilitate ongoing stakeholder engagement (Figure 2.1).

Effective cooperative governance is the key to successful implementation (Müller 2009; Goble et al. 2014; Sowman & Malan 2018; Van Niekerk et al. 2019). Different elements of an EMP will fall within the mandate of different government institutions or departments, and in some cases, responsibility may be devolved from a higher level to a lower level, e.g. National to Provincial; Provincial to District or Local Municipality. Departments from all spheres of government that are most commonly involved include Forestry, Fisheries and the Environment; Agriculture, Land Reform and Rural Development; Water and Sanitation; Mineral Resources and Energy; Public Works and Infrastructure; and Tourism. However, depending on system-specific characteristics and requirements, other departments that could be involved include Social Development; Sports, Arts and Culture; Transport; Small Business Development; Human Settlements; and Cooperative Governance and Traditional Affairs.

Heading photograph: Co-researcher, Siyasanga Ntabeni, overlooks the Swartkops Estuary, Eastern Cape. © Siyasanga Ntabeni

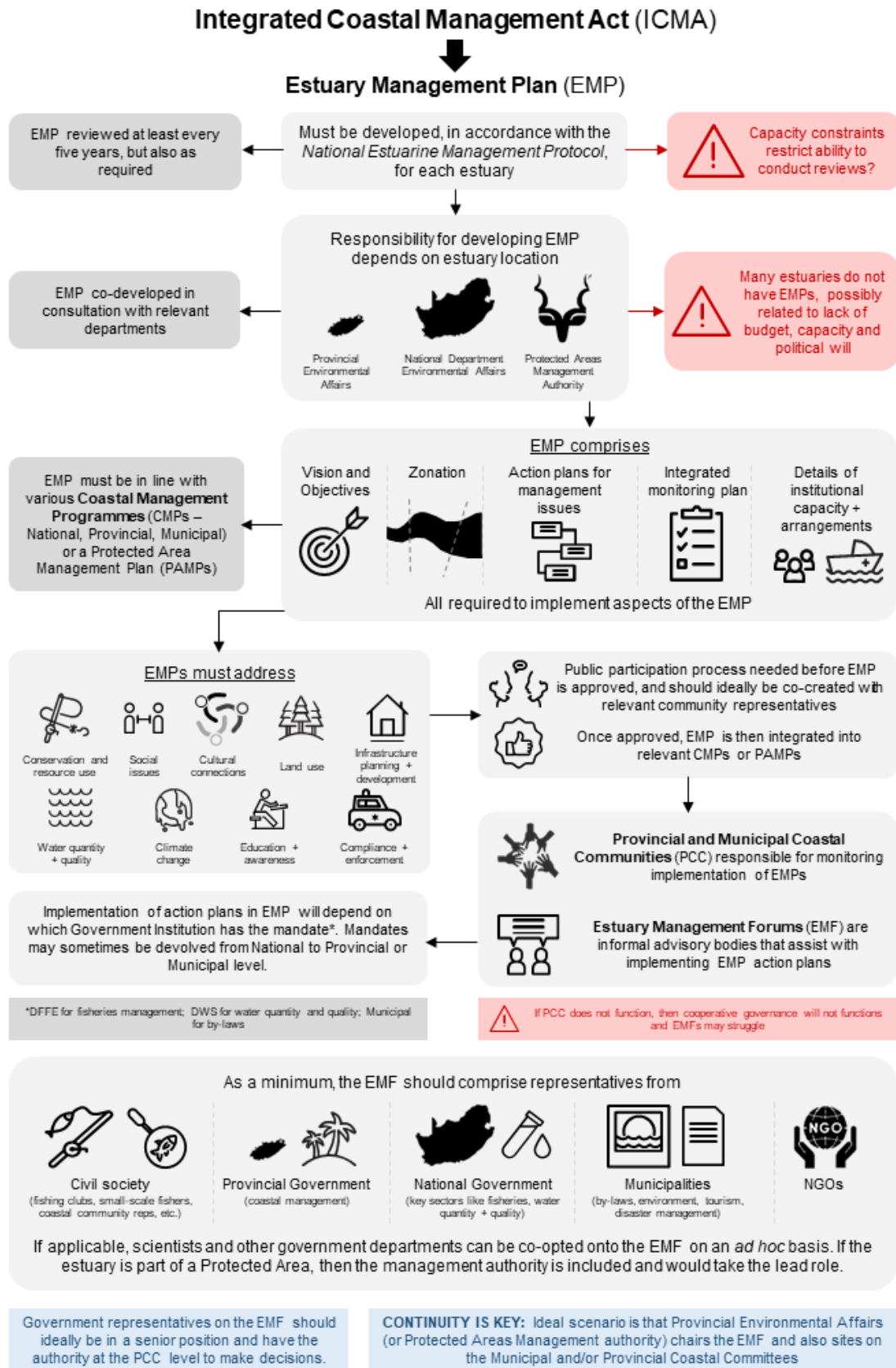


Figure 2.1. The estuary management process.

While the design of the process is sound, the failure to develop, approve and implement EMPs comes down to ineffective implementation at various stages due to insufficient human and financial capacity, a breakdown in cooperative governance efforts, and limited executive sponsorship or support (Van Niekerk & Taljaard 2003; Sowman & Malan 2018; Taljaard et al. 2019). At the national level, there is the National Estuaries Task Team, within Working Group 7, which addresses estuary-specific issues, but at provincial level, there is no estuary-specific entity, only coastal management entities. At the municipal level, estuary management issues are dealt with by a variety of departments linked to the environment, including community protection, town planning and infrastructure, and efficacy is directly related to capacity (manpower and funding) and executive sponsorship (Taljaard et al. 2019).

Relevance in terms of National priorities

In order to address the triple challenges of unemployment, poverty and inequality, the South African government employs policy levers to promote employment creation and improve the socio-economic conditions of citizens. The most recent of these is the Draft White Paper on the Conservation and Sustainable Use of South Africa's Biodiversity (DFFE 2022; the White Paper). Policy development must be evidence-based and any new or amended policies must first be analysed for likely impacts, costs and benefits, and risks, and should address national priorities as stipulated in the National Development Plan 2030 (National Planning Commission 2012). In this context, the White Paper was developed to achieve, amongst other things, a re-imagined and context specific localised approach to addressing the aspirations and needs of South Africans; and equitable socio-economic development based on South Africa's rich biodiversity and the broad values and benefits from ecosystem services for the well-being of people and their livelihoods. In other words, addressing national priorities in the context of the National Development Plan.

How will the triple challenges be affected by collapsed estuarine fisheries?



Unemployment: Reduced or collapsed fisheries will negatively impact the South African economy and increase unemployment. Fishing is one of the most popular activities taking place on estuaries. The activity supports a variety of retail (bait and tackle, boats, 4x4 vehicles, petrol) and tourism-related (accommodation, boat hire, charters, guiding) industries which provide employment for many people.



Poverty: Reduced or collapsed fisheries will negatively impact livelihoods and nutritional well-being. Estuarine communities and users (e.g. subsistence fishers and bait collectors) rely on estuaries as a source of food and income.



Inequality: Reduced or collapsed fisheries will further exacerbate inequality in South Africa. Long-term sustainable fisheries have the potential to provide equal opportunities, whether in terms of access to the resource or the ability to provide basic needs. In the absence of fisheries, the more resilient members of society have other alternatives to recreation or nutrition, but less resilient and marginalised members do not. This will further exacerbate inequality in South Africa.



Within the SANOCLEAN project, we worked with three categories of estuarine fishers, namely recreational, small-scale and subsistence¹. Defining these categories is not without its complexity in a South African context, and various documents (Marine Living Resources Act of 1998; European Inland Fisheries Advisory Commission Code of Practice for Recreational Fisheries [FAO 2008]; Policy for the Small-scale Fisheries Sector in South Africa 2012; Marine Living Resources Amendment Act of 2014; The National Freshwater [Inland] Wild Capture Fisheries Policy for South Africa 2021) and conversations with fishers themselves, were used to develop these definitions.

Recreational fisher in this report is defined as “An individual who participates in the activity of fishing for sport, consumption or a variety of social and cultural reasons that contribute to their well-being, and who may not sell, barter or trade their catch.”

Small-scale fisher (SSF) in this report is defined as “An individual that fishes to meet basic food and livelihood needs or are directly involved in harvesting/processing or marketing of fish, traditionally operate on or near shore fishing grounds, predominantly employ traditional low technology or passive fishing gear, usually undertake single day fishing trips, and are engaged in the sale or barter of fish or are involved in commercial activity.” Small-scale fishers are usually, but not always, members of small-scale fishing cooperatives.

Subsistence fisher in this report is defined as “An individual who primarily catches fish for consumption using rod and line, handline or traditional methods and who may also sell or barter bait organisms and excess catch but does not engage in the sale of fish and bait on a substantial commercial basis.” Subsistence fishers are individuals who may or may not be members of a recognised small-scale fishing community, and who are not part of a cooperative but operate as individuals to meet basic livelihood needs. The difference between subsistence fishers and SSF is therefore not easily delineated, and they sometimes overlap as user groups. Many subsistence fishers have joined small-scale fishing cooperatives to gain fishing rights and some SSF are not fishing for subsistence reasons and therefore are not identifying as subsistence fishers.

¹ The project acknowledges that there is a commercial gill net fishery operating in the Olifants Estuary in the Western Cape, with the catch being dominated by southern mullet (*Chelon richardsonii*) and a small by-catch of some important linefish species. The scope of this project only investigated recreational, small-scale and subsistence fishers).



4.1 Background

Estuaries are highly productive habitats which serve as important nursery areas for juveniles of many estuary-associated fish species worldwide (Beck et al. 2001, Gillanders et al. 2012, Whitfield 2019). In addition, adult individuals seek these protected habitats for, amongst others, feeding and predator avoidance. Estuaries also contribute significantly towards coastal fisheries production, and therefore have considerable socio-economic value (Baird et al. 1996, Lamberth and Turpie 2003, Olds et al. 2017). The importance for juvenile fish production has been evident for years, and the importance for adults of estuary-associated species is also becoming more apparent. As such, estuary-associated species across all life-history stages form the base for estuarine fisheries. Because of estuary status and importance, surviving the estuary phase represents a bottleneck in the life history of estuary-associated species. However, estuaries are threatened by numerous anthropogenic impacts, such as overfishing, pollution, habitat degradation and coastal infrastructure development (Vasconcelos et al. 2007, Whitfield and Cowley 2010, Van Niekerk et al. 2019). Appropriate management of both the species and the estuaries in which they occur are of utmost importance if estuarine fisheries are to be sustained. Should this not occur, the sustainability of the fisheries and the socio-economic sector will be severely impacted.

South Africa has 290 estuaries and 42 micro-estuaries which are diverse in both form and function (Van Niekerk et al. 2019), and although they are biologically productive and sheltered habitats along an exposed coastline, estuaries may also be unpredictable environments for fishes to occupy. Fish species differ in their requirements and adaptations to abiotic and biotic environments. Hence, estuaries' species composition and abundance, and their utilisation of estuaries, varies locally and along the South African coastline. Estuary-associated fish species are a limited fisheries resource and sustainable management of important species is currently not in place in South Africa. Due to the different habitat requirements and use, and different life history of fish species, some management regulations may work for certain species, but not for others. Therefore, effective management regulations need knowledge-based decisions based on studies of the targeted species.












The biological importance of estuaries cannot be overestimated, and immeasurable numbers of larval and juvenile fishes recruit and thrive in these systems (Whitfield 2019). Amongst these are species valuable to estuarine subsistence, small-scale and recreational fisheries, with some being targeted more than others. These include dusky kob *Argyrosomus japonicus*, spotted grunter *Pomadourys commersonnii*, leervis *Lichia amia*, white steenbras *Litognathus litognathus*, Cape stumpnose *Rhabdosargus holubi*, springer *Elops machnata*, estuarine bream *Acanthopagrus vagus*, bartail flathead *Platycephalus indicus* and mullet species (including, but not limited to, southern mullet *Chelon richardsonii*, striped mullet *Chelon tricuspidens*, and flathead mullet *Mugil cephalus*) (Table 4.1). Most species are distributed throughout South Africa, fall under various International Union for Conservation of Nature (IUCN) Red List categories, are in varying stages of collapse, and have their own management regulations. For an overview of the species see Table 4.1.

The objectives of these studies of estuarine fisheries resources have been to gain policy relevant knowledge to address the adaptive management needs of the important estuarine fisheries in South Africa. This has been done by evaluating a series of management options by quantifying patterns of movements, area use and seasonal distributions of fisheries species using data from previous and ongoing studies.

A large adult dusky kob tagged with an acoustic transmitter in the Breede Estuary about to be released back into the estuary. © JD Filmalter



Table 4.1. Distribution, IUCN Red List category, stock status and current management regulations for important estuary-associated fishery species targeted for fisheries in South Africa. Size limit = minimum size an animal needs to be for a licensed angler to retain it (TL – total length); bag limit = the total number of fish per species a licensed angler can retain per day (pppd – per person per day); R = recreational fishers; S = subsistence fishers. *Fish images provided courtesy of the South African Institute for Aquatic Biodiversity © NRF-SALAB.*

Species	Distribution	IUCN Red List	Stock status	Management regulations in SA
Dusky kob 	South African population occurs along the southeast coast from Cape Agulhas to northern KwaZulu-Natal	Endangered	1-4.5% Collapsed	Size limit \geq 60 cm TL, bag limit 1 pppd (R+S), commercial = unlimited BUT all sectors may only be in possession of one kob > 110 cm TL pppd
White steenbras 	Endemic; Langebaan Lagoon to Wild Coast (former Transkei), but core is located inshore and in estuaries along the Eastern Cape and Western Cape coast	Endangered	6% Collapsed	Size limit \geq 60 cm TL, bag limit 1 pppd (R+S), commercial = prohibited
Leervis 	South African population distributed from Orange River to Cape Vidal	Least Concern	14% Collapsed	Size limit \geq 70 cm TL, bag limit 2 pppd (R+S), commercial = prohibited
Spotted grunter 	South African distribution along the entire eastern seaboard (Heemstra and Heemstra 2004)	Least Concern	35% Over-exploited	Size limit \geq 40 cm TL, bag limit 5 pppd (R+S), commercial = prohibited
Cape stumpnose 	Endemic; from St Helena Bay to southern Moz (Heemstra and Heemstra 2004)	Least Concern	Unknown Not assessed	Size limit \geq 20 cm TL, bag limit 5 pppd (R+S), commercial = prohibited
Springer 	Indo-West Pacific; South African population distributed from Breede Estuary north-eastwards to KwaZulu-Natal (KZN)	Least Concern	Unknown Not assessed	Size limit – none, bag limit 5 pppd (R+S), commercial = prohibited
Estuarine bream 	Widespread; South African population distributed from Knysna, Western Cape to southern Mozambique	Vulnerable	24% Collapsed	Size limit \geq 25 cm TL, bag limit 5 pppd (R+S), commercial = prohibited
Bartail flathead 	South African population distributed from Mossel Bay, Western Cape to southern Mozambique	Data Deficient	Unknown Not assessed	Size limit – none, bag limit 10 pppd, commercial = prohibited
Southern mullet 	Northern Cape to KZN, with density decreasing from west to east	Not Evaluated	Unknown Not assessed	Size limit – none, bag limit = 50 pppd (R+S), commercial = unlimited
Striped mullet 	Southern Africa endemic, Namibia to southern Mozambique	Not Evaluated	Unknown Not assessed	Size limit – none, bag limit = 50 pppd (R+S), commercial = unlimited
Flathead mullet 	Cosmopolitan including along the entire South African coastline	Least Concern	Unknown Not assessed	Size limit – none, bag limit = 50 pppd (R+S), commercial = unlimited

4.2 Materials and methods

Over the past 20 years, the movements and estuary use of five of the most targeted estuary-dependent species (dusky kob, spotted grunter, leervis, white steenbras and Cape stumpnose) have been studied in multiple South African estuaries (Breede, Goukou, Sundays, Bushmans, Kariega, Kowie, East Kleinemonde, Great Fish; Figure 4.1), and to some extent in the sea, using acoustic telemetry (see Appendix 11.1 for publications). With this method, a uniquely coded acoustic transmitter is surgically implanted into a fish. On release, the transmitter emits a signal, which is then detected (along with the date and time) and recorded by acoustic receivers deployed either in estuaries or the inshore marine environment. This tagging method provides high-resolution data, shedding new insights into fish movements in estuaries, habitat utilisation, activity patterns, home range size, connectivity with the marine and other estuarine environments, and the factors influencing these movements.

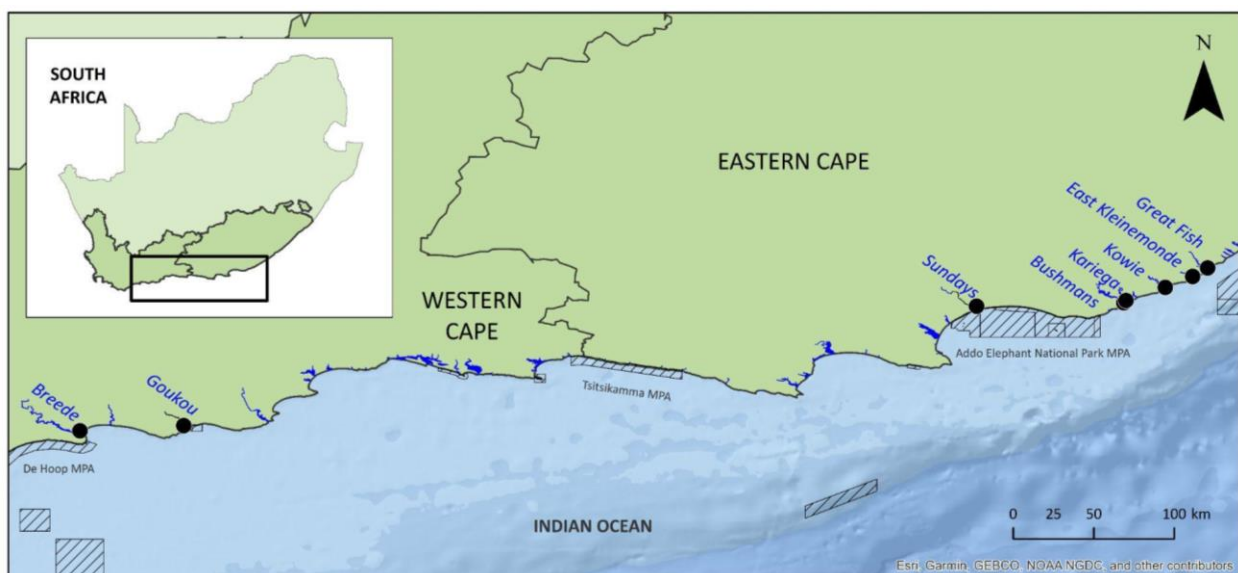


Figure 4.1. Map showing the locations of the eight studied estuaries in South Africa (represented by black dots), in which acoustic telemetry studies were conducted to assess the movements of five estuary-dependent fishery species.

4.3 Findings

Estuary-associated species make use of estuaries as nursery habitats during their juvenile life-history phase. This changes as juveniles mature, with some species (e.g. spotted grunter, leervis and dusky kob) still readily using estuaries as adults, and others (e.g. Cape stumpnose and white steenbras) undergoing an ontogenetic shift in habitat use, moving to the marine environment where they generally remain as adults. In order to develop appropriate management regulations for estuary-associated species, one needs to understand the following:

- How much time the species spend in estuaries as both juvenile and adults (time in estuaries vs time at sea)?
- When in an estuary, what is the species' general movement behaviour (estuary use)?
- Do species mostly use a single estuary, or do they move between multiple estuaries (multiple estuary use)?

4.3.1 Time in estuaries vs time at sea (juveniles)

Juveniles of estuary-associated species are generally highly resident to the estuaries in which they were tagged; despite this estuarine residency period, many species undertake trips to sea, returning up to >100 days later. Both inter- and intraspecific differences in both residency and sea trips are evident.

The movements of juveniles of the abovementioned five estuary-associated species (dusky kob, spotted grunter, leervis, Cape stumpnose and white steenbras) were assessed in six estuaries (Goukou, Sundays, Kariega, Kowie, East Kleinemonde, Great Fish) between September 2003 and January 2015. Average time spent by tagged juveniles in estuaries ranged from 38% (leervis in Goukou Estuary, Murray 2016) to 100% (white steenbras in Kariega Estuary, Bennett et al. 2015). Estuarine residency was generally high amongst all species, ranging from 67% for spotted grunter in the Great Fish Estuary (six months study, Childs et al. 2008a), to 100% for white steenbras in the Kariega Estuary (twelve months study, Bennett et al. 2015) (Figure 4.2). Estuarine residency was lowest for leervis, ranging from 38% in the Goukou Estuary (13 months study) to 56% in the Kowie Estuary (13 months study, Murray 2016). Despite relatively high residency to estuaries shown by all tagged species, all species were also recorded undertaking sea trips (see multiple estuary use section 4.2.5 below for more).

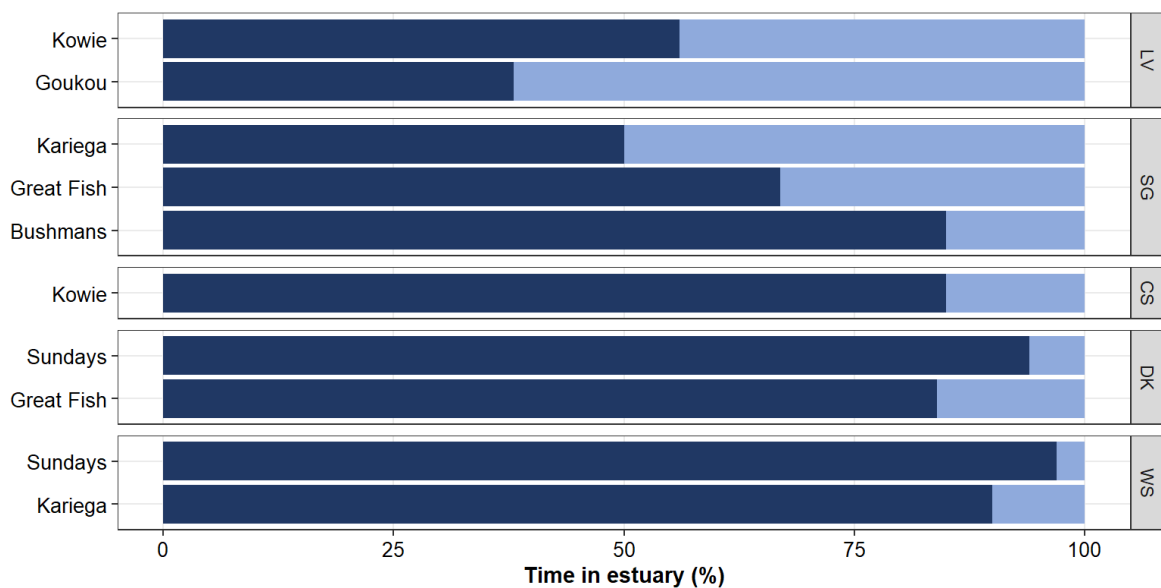


Figure 4.2. Juveniles of estuary-associated fishery species spend significantly more time in their tagging estuaries (black bars) relative to other environments (i.e. marine or riverine, blue bars). LV – leervis; SG – spotted grunter; CS – Cape stumpnose; DK – dusky kob; WS – white steenbras.

4.3.2 Time in estuaries vs time at sea (adults)

Even though adult estuary-associated species make extensive use of the marine environment, they have also been recorded spending large proportions of time within estuaries, highlighting the importance of these environments to all life-history stages of estuary-associated fishery species.

Estuaries are important nurseries for juvenile estuary-associated species, evident from their high estuarine residency. In recent years, adult dusky kob, leervis, white steenbras and spotted grunter have also been acoustically tagged, allowing assessment of the importance of estuaries to these larger adult fish. Adult dusky kob (>1 m total length) tagged in the Sundays Estuary were recorded spending varying amounts of time in the estuary, ranging from 3% of a ~3-year monitoring period in the estuary (Childs 2013), to multi-year (seven years) of seasonal residency during autumn to early spring (NRF-SAIAB, unpublished data). Similar multi-year results have been obtained from large adult dusky kob (1140 to 1720 mm TL) tagged in the Breede Estuary, with tagged fish returning to the estuary every year for at least five years between autumn and mid/late spring (NRF-SAIAB, unpublished data). Adult spotted grunter tagged in the Kariega and Bushmans estuaries spent 55% and 85% of the three and a half years study period within their respective tagging estuaries (Dames et al. 2017). Similarly, adult spotted grunter tagged in the Breede Estuary spent 83% of their three and a half years monitoring period within the estuary, showing relatively high residency to their sites of release (Ziko et al. in prep). Leervis, an estuary-associated species thought to be primarily marine during its adult life-history phase, was recorded in the Mzimvubu Estuary where they were tagged between May and November for three consecutive years (Mxo 2022).

4.3.3 Estuary use (juveniles)

While in estuaries, species have different behaviours, ranging from resident, stationary behaviour, to mobile wide-ranging behaviour.

While in estuaries, contrasting patterns in interspecific area use were evident. The larger juveniles of both dusky kob and leervis are predatory piscivores, feeding primarily on fish, and exhibited wide-ranging behaviour, using a large portion of the studied estuaries (Næsje et al. 2012, Murray 2016). This ranging behaviour is thought to be related to the dynamic distribution of their mobile prey (such as mullet species) and the influence of the tide (Næsje et al. 2012). In contrast, the macrophytic grazer Cape stumpnose, and the two benthic invertebrate feeders, spotted grunter and white steenbras, displayed resident behaviour, showing fidelity to their capture and release sites irrespective of where they were tagged in the estuary (Bennett et al. 2012, 2015, Grant et al. 2017a, Ziko et al. in prep). White steenbras also displayed resident behaviour, but with a strong affinity for sandy habitats in the lower reaches of estuaries (Bennett et al. 2012, 2015). This resident behaviour was consistent in three estuaries (East Kleinemonde, Kariega and Sundays) with very different flow and physico-chemical characteristics (Bennett et al. 2015).



Two mullet caught by researchers in the Kowie Estuary, Eastern Cape. © Dinah Mukhari

4.3.4 Estuary use (adults)

Adult individuals tagged in estuaries and the sea may have very different behaviour. While in estuaries, species display different behaviour, ranging from resident, station-keeping behaviour, to mobile wide-ranging behaviour.

From our studies, it has become evident that many of the estuary-associated species comprise different contingents, with fish tagged in estuaries spending more time in these environments compared to their sea-tagged counterparts. For example, sub-adult and adult leervis tagged in estuaries between 2012 and 2020 were more strongly associated with these environments compared to those tagged at sea (Mxo 2022). This has also been observed in dusky kob, where fish tagged in the Sundays Estuary and fish tagged in the adjacent marine environment between

May 2008 and June 2010 displayed considerably different behaviour, including the amount of time spent in the estuary (94% in estuary-tagged fish, 2% in marine-tagged fish) (Childs et al. 2015). While in the estuary, some species make extensive estuarine movements, for example, adult leervis tagged in the Breede Estuary spent almost a full year in the estuary, making regular movements up and down the estuary (NRF-SAIAB, unpublished data).

4.3.5 Multiple estuary use

Fish actively move in and out of their tagging estuaries, with the number of sea trips and time spent in the sea varying among species and individuals. Additionally, more mobile species frequently move to other estuaries.

To map estuary use and movements between an estuary and the sea, and between estuaries, our studies highlight the need for both long-term monitoring of fish movements and assessment of movements at the individual level. There was interspecies variability in the proportion of fish that undertook sea trips, as well as number of sea trips and duration of trips. For example, a single (5% of total fish tagged) Cape stumpnose tagged in the Kowie Estuary undertook at least one sea trip between October 2014 and January 2015 (Grant et al. 2017a). In contrast, 81% of Kowie-tagged and 76% of Goukou-tagged leervis undertook a total of more than 300 sea trips between January 2013 and February 2014, with durations ranging from 1 to 131 days (Murray et al. 2018). Interestingly, intraspecific differences in sea trip number and duration were also evident, and dependent on the estuary in which fish were tagged. For example, of 65 dusky kob tagged in the Sundays Estuary, 40% made at least one return sea trip, ranging in duration from 1 to 68 days (Childs et al. 2015). In the Great Fish Estuary approximately 130 km east of the Sundays Estuary, 64% of the 25 tagged dusky kob made one or more return sea trips (Næsje et al. 2012) with a mean duration of 3.5 days (Cowley et al. 2008).

Overall, roving foraging predators, like leervis, have been shown to move more between the tagging estuary and the sea (Murray et al. 2018; Mxo, unpublished data) than ambush predators, like dusky kob (Childs et al. 2015) or the more resident species, like Cape stumpnose (Grant et al. 2017a). The greater connectivity between estuaries and the sea of some species, such as leervis, is more likely linked to their foraging preferences. Leervis is a highly mobile, visual, diurnal piscivore (Murray et al. 2018), in comparison to the dusky kob that is a nocturnal piscivore, with an ambush predator style (Childs et al. 2015). Additionally, other species like Cape stumpnose and white steenbras generally have lower connectivity in terms of return sea trips due to these species undergoing ontogenetic shifts in habitat, moving from the estuary to sea with an increase in length and age. The higher estuarine-marine connectivity displayed by spotted grunter (80% tagged in Kariega Estuary, 75% tagged in Great Fish Estuary, 57% tagged in Breede Estuary, 45% tagged in Bushmans Estuary), despite its relatively resident behaviour, may be due to a large proportion of the tagged fish being adults (Childs et al. 2008b, Dames et al. 2017). This suggests that some excursions may have been related to spawning activity or spawning migrations.

In addition to return sea trips, where fish depart from and return to their tagging estuaries, species were recorded moving to other estuaries, but to varying degrees. For example, only 3% of dusky kob tagged in the Sundays Estuary were recorded in other estuaries (Kariega and Gamtoos)

between May 2008 and June 2010 (Childs et al. 2015). Contrastingly, of tagged spotted grunter that moved to sea, 60% of Bushmans-tagged fish and 93% of Kariega-tagged fish were recorded in other estuaries (Dames et al. 2017). These included the Swartkops, Sundays, Bushmans, Kariega, Kowie and Great Fish, which ranged from 108 km west to 51 km east from the tagging estuaries (Dames et al. 2017). Similarly, 71% and 76% of leervis tagged in the Kowie and Goukou estuaries, respectively, moved to other estuaries. These included the Kromme, Gamtoos, Swartkops, Sundays, Bushmans, Kariega, Great Fish, Keiskamma and Tyolomnqa for Kowie-tagged fish (251 km west to 78 km east of the Kowie), and the Breede, Gouritz and Knysna for Goukou-tagged fish (61 km west to 197 km east of the Goukou) (Murray et al. 2018).

4.3.6 Influence of environmental variables and climate change

One or more environmental variables can influence the movements of fish in an estuary, as well as drive movements between an estuary and the adjacent marine environment. Changes in water temperature largely influenced the movements of almost all estuary-associated species in some way.

Despite the acknowledgement that estuaries are ideal nurseries for estuary-associated species (high abundance of food, shelter, and protection from predators), they are exposed to fluctuating environmental conditions, including salinity, temperature and turbidity, on an almost hourly basis. As such, fish react to these changes either by adapting physiologically, or by moving to more suitable areas, which essentially results in changes in the position, area use or mobility of fish within an estuary. This is exemplified by juvenile leervis tagged in the Kowie Estuary that had seasonal changes in area use, shifting closer to the estuary mouth during the winter months, and as water temperatures increased in spring, the fish re-expanded their area use to the middle and upper reaches of the estuary (Murray et al. 2018). Contrastingly, spotted grunter in the Great Fish Estuary (Childs et al. 2008b) and Cape stumpnose in the Kowie Estuary (Grant et al. 2017b) were observed shifting further downstream during the summer months, a behaviour that is possibly linked to warmer summer temperatures in the upper reaches being less favourable or exceeding a tolerance threshold for these species. As such, these fish were forced to shift further downstream where temperatures may be buffered by the effects of sea temperature, and thus more tolerable (Grant et al. 2017b).

Changes in environmental conditions can also drive movements from estuaries into coastal habitats. Storm weather events, and associated rapid decreases in barometric pressure, tended to drive fish out of estuaries, although this effect appeared to differ among species. For example, 40% of spotted grunter tagged in the Bushmans and Kariega estuaries moved into the marine environment after a rough sea event in December 2008 (Cowley et al. 2014). The same rough sea event resulted in 40% of tagged dusky kob in the Sundays Estuary moving into the adjacent marine environment (Cowley et al. 2014). Similarly, although to a lesser degree, 12.5% of white steenbras tagged in the temporarily open/closed East Kleinemonde Estuary moved to the marine environment when the estuary opened due to a rough sea event in September 2008 (Cowley et al. 2014).

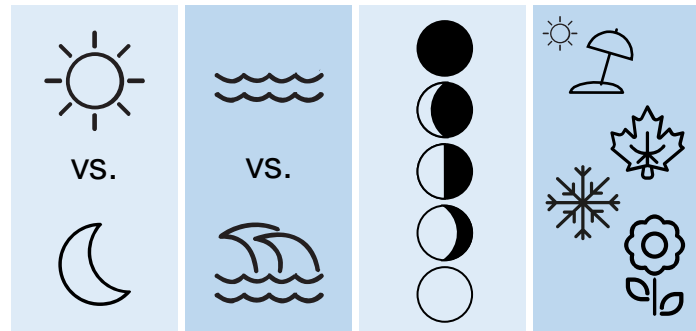


Dusky kob (top) and leervis (bottom) are two sought-after estuarine fishery species due to them attaining a large size and putting up a good fight. © JD Filmlalter (dusky kob) and Paul Cowley (leervis).

4.3.7 Temporal variation in movement behaviour

The movements of estuary-associated fish within and between estuaries and the sea can be driven by time of day, tidal phase, lunar phase and season. This is, however, species- and estuary-dependent.

In addition to environmental variables influencing the movements of fish while in estuaries, movements of both individuals and a species in general can also be influenced by geophysical cycles, including diel, tidal, lunar, and seasonal cycles.



Diel behaviour

Some species display changes in position in the estuary on a micro scale, as opposed to longer longitudinal movements along the estuary. White steenbras in the Kariega Estuary have been observed displaying repetitive patterns linked to the diel cycle, with certain individuals using shallow parts of the estuary at night, and deeper parts during the day (Bennett et al. 2012). Cape stumpnose in the Kowie Estuary were recorded doing the opposite, predominantly occupying the shallow littoral zone during the day (Grant et al. 2017b). In contrast to this micro scale shift in movement, leervis in both the Kowie and Goukou estuaries undertook major longitudinal shifts in these estuaries, moving further upstream during the day, and returning downstream during the night (Murray 2016). Dusky kob have been observed moving during both day and night; however, in contrast to leervis, upstream movements occurred most frequently at night, with downstream movements occurring more during dawn and dusk (Næsje et al. 2012).

Tidal-associated behaviour

The tide can drive observable patterns in the movements of many estuary-associated species. Dusky kob in the Great Fish Estuary were observed changing their behaviour from station-keeping to more mobile behaviour following the ebb and flow of the tide (Næsje et al. 2012). Similarly, leervis in both the Kowie and Goukou estuaries also shift with the tide, moving further upstream with the incoming tide, and back downstream during the outgoing tide (Murray 2016). Cape stumpnose movements in the Kowie Estuary were also linked to the tide, although no significant upstream or downstream movements were undertaken, suggesting that tide influences their movements on a micro scale, with more habitat in tidal creeks becoming available during high tide (Grant et al. 2017b).

Lunar-associated behaviour

The estuarine excursions and departures to the Sundays Estuary of sub-adult and adult dusky kob tagged in the marine environment adjacent to the estuary, appeared to be driven by moon phase, when fish entered and departed the estuary primarily during the new moon (Childs 2013). Similarly, adult white steenbras tagged near the mouth of the Great Fish Estuary were recorded moving into the estuary during spring tide (full and new moon) (NRF-SAIAB, unpublished data). While these movements more than likely were a result of the available marine environment extending into the

estuary mouth on the incoming spring tide, this nevertheless shows how a species that was assumed to be entirely marine-dominated during their adult life-history phase (Bennett and Lamberth 2013) still makes use of estuaries with movements being driven by lunar phase. For other species moon phase has not been identified as a primary factor driving movements within estuaries or between estuaries and the sea. For example, departures and arrivals of juvenile leervis tagged in the Kowie and Goukou estuaries, as well as juvenile dusky kob tagged in the Sundays Estuary were not influenced by lunar phase. Similarly, the timing of sea trips for spotted grunter tagged in the Breede Estuary was uninfluenced by lunar phase.

Seasonal movements

The changing seasons bring variations in environmental variables (see Section 4.3.6 above). As such, fish generally adapt to these changes by moving in some way. This can result in a change in the way fish use estuaries. For example, juvenile leervis tagged in the Kowie Estuary displayed a major retraction in the proportion of the estuary used during the cooler winter months (Murray 2016). Similarly, juvenile leervis tagged in the Goukou Estuary displayed the same behaviour, but many fish were recorded leaving the estuary entirely, rather remaining in the more temperature-stable adjacent marine environment (Murray 2016). Seasonality can also drive the timing of movements into estuaries. Adult dusky kob tagged in the Sundays Estuary were recorded entering the estuary between August and October, and one fish returned to the estuary in April, and remained there until September for seven consecutive years (NRF-SAIAB, unpublished data).

4.3.8 Fishery mortality

Estuary-associated species are heavily targeted in estuaries, with reported fishery-related mortality ranging between <5% to >50%.

All transmitters, prior to implantation into fish, were equipped with ‘Reward’ stickers (with contact details) to promote reporting of recaptures (i.e., fish that were recaptured and retained by fishers). While fishery-related mortality varied considerably among species and estuaries (Figure 4.3), it was unexpectedly high for juvenile dusky kob in the Sundays Estuary (35%), juvenile leervis (38%) in the Kowie Estuary, and juvenile dusky kob in the Breede Estuary (64%). Recapture rates were lowest for Cape stumpnose (<5%) in the Kowie Estuary and white steenbras (~6%) in the Sundays Estuary (Figure 4.3). Recapture rates were also high for adult dusky kob tagged in the Breede Estuary (22%) (NRF-SAIAB, unpublished data).

The high mortality rate for dusky kob, particularly juveniles, may reflect either the low population size, or that this is one of the most heavily targeted species in many of South Africa’s estuarine fisheries (Cowley et al. 2013, NRF-SAIAB, unpublished data). Contrastingly, the low mortality rate of Cape stumpnose is likely due to relatively higher densities of this species in estuaries compared to the other species. However, the low recapture rates for white steenbras may be influenced by fear of prosecution, as all tagged fish were well below the legal minimum size limit (60 cm TL). We also acknowledge that all recaptured fish may not have been reported.

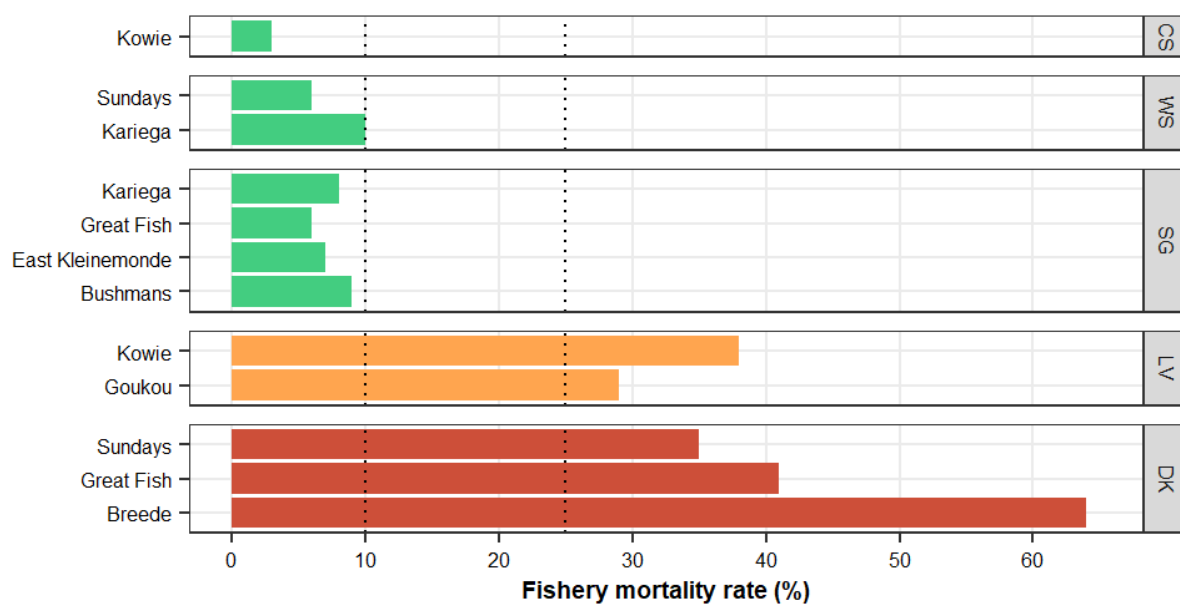


Figure 4.3. Fishery mortality rates (% , proportion of tagged fishes recaptured and killed) for five estuary-associated fish species, acoustically tracked in a range of estuaries. Acoustic transmitters were inscribed with a telephone number and “Reward”, encouraging return after recapture. Vertical dashed lines separate groups at 10% and 25% recapture rates. CS – Cape stumpnose; WS – white steenbras; SG – spotted grunter; LV – leervis; DK – dusky kob.

4.3.9 Management implications to protect against overfishing

The key words for successful sustainable fisheries management are implementation, control and compliance, but also regulations that are effective and will benefit threatened species. Ultimately, effective management regulations need knowledge-based decisions based on studies of the targeted species. The past 20 years of movement studies on important estuary-associated species has provided a solid knowledge base from which management regulations can be formulated. Certain management regulations currently exist, but how effective are they, and how effective might other proposed management regulations be? However, it must be stressed that applicable and effective management regulations may vary among species and estuaries.

To optimize the effect of (fishery) regulations, for both fishers and fish resources, ideally regulations must be tailor-made for each estuary separately.

Size and bag limits

Size and bag limits do not work in isolation.

Estuarine fisheries are currently managed using minimum size and maximum bag limits. These vary per species (see Table 4.1) and are generally based on length-at-50% maturity. However, these regulations, while observed by some fishers, have been shown to be largely unsuccessful. Cowley et al. (2013) found that a high proportion of the catch by fishers on the Sundays Estuary comprised

juvenile fish of which many were retained. Additionally, fishers seldom reached the bag limit for many of the species, bringing into question the larger bag limit for some species such as spotted grunter and Cape stumpnose. Additionally, these regulations cannot be enforced given limited law enforcement, no fishery monitoring, ill-informed fishers and no public awareness campaigns; issues which are not limited to the Sundays Estuary. As such, these regulations alone have failed to arrest the decline in many important fishery species.

Night bans

Night bans will provide some protection for nocturnal feeding species, such as spotted grunter and dusky kob, as long as fishers comply with regulations.

Of all estuaries in South Africa, only the Breede Estuary in the Western Cape, a system recognised as one of the last ecological strongholds of dusky kob in South Africa, has a night fishing ban implemented, with the formal Government Gazette (No. 37047) stating that: “No person shall, except under a permit for scientific research, fish or attempt to fish, from either a vessel or the shore in the Estuary, between the hours of 20H30 of any day and 05H00 of the following day.”

While this management option might reduce the fishing effort and reduce the catches of those species moving/feeding at night (e.g. spotted grunter and dusky kob), the enforcement of this management option across multiple estuaries will be difficult (given the already limited capacity), and is currently proving difficult in the only estuary in which it is currently implemented.

Estuarine protected areas

Estuarine protected areas may work from a fish protection perspective; however, the exclusion of users from various backgrounds might be challenging.

Estuarine protected areas have been championed as the latest conservation option to protected estuary-associated fishery species (Whitfield et al. 2020). The movement data collected over the last 20 years lends itself well to the designation of such areas; however, the results highlighted in the time in estuaries vs time at sea and estuary use sections of this chapter show that residency to estuaries and area use can differ not only between species (species-specific), but also between the same species studied in different estuaries (estuary-specific). For example, relatively small, closed areas could be sufficient to protect resident adult and juvenile spotted grunter, and juvenile white steenbras and Cape stumpnose. Wide-ranging species, such as leervis and dusky kob, are less suited to protection by small area closures. As such, at the very least, knowledge of the fish species present in a given estuary is required, along with basic environmental variable measurements of that estuary. From this, certain deductions could be made given prior knowledge on the movements of certain species. While EPAs may be the preferred management option moving forwards, this may result in the exclusion of certain user groups with limited access to estuaries, which combined with the already limited law enforcement and lack of monitoring capacity across the vast majority of South African estuaries, will arguably increase the levels of illegal fishing already taking place. However, overall fishing effort and catch per unit effort within estuaries with protected areas may be reduced.

Zonation of fishing activities

In theory, this may be the most practical solution; however, implementing this option would prove difficult under the current circumstances of limited enforcement capacity.

An option to consider moving forwards may be to implement zoned fishing, where certain areas of the estuary deemed most important for fishery species may be closed to all fishing and bait-collecting activities (no-take estuarine protected area), others could allow fishing but exclude bait collection, and vice versa, and small sections (perhaps the most easily accessed) could be open to all types of extractive use. An example of an estuary currently operating at this level of management (including traditional regulations of size and bag limits) is the Goukou Estuary in the Western Cape Province. Once again, this option would need to be estuary-specific due to the differing species composition between estuaries.

Seasonal closures

Seasonal closures, as opposed to or in conjunction with EPAs, will provide protection for several species exhibiting strong seasonal presence in estuaries during certain times of the year.

The level of habitat connectivity (see multiple estuary use section in this chapter) has implications for the vulnerability, management and resilience of a species. Highly resident species, and those individuals that spend most, or all, of their time within a single estuary (e.g. juvenile white steenbras and Cape stumpnose), are vulnerable to localised depletion, yet are simultaneously well-suited to protection through area closures or estuarine protected areas. Wide-ranging species (e.g. leervis and spotted grunter) which are less suited to protection by area closures, are more resilient to localised depletion and to habitat perturbations, as they have the ability to move to more favourable (or less disturbed) environments. Because some species show strong seasonal presence in estuaries (e.g. dusky kob in the Sundays Estuary, leervis in the Goukou Estuary), seasonal closures, as opposed to or in conjunction with EPAs, will be appropriate, and provide protection to several species during certain times of the year. For example, closures in the Mzimvubu Estuary between June and October to protect sexually mature leervis and resident spotted grunter; closures in the Sundays Estuary between May and September to protect large adult dusky kob frequenting the estuary during this time of year, which would also protect smaller resident dusky kob, spotted grunter, white steenbras, Cape stumpnose and leervis at the same time.

Complete fishing ban on selected estuaries

While a complete fishing ban will arguably be effective in terms of management of the fishery resources, the consequences of this for both recreational and subsistence fishers might be severe.

If priority estuaries were able to be selected based on fishery species abundance and perceived importance in terms of nursery areas and adult use, then the most drastic management intervention

could be a complete closure of all fishing and bait collection activities within these priority estuaries.

Self-regulated fishery

A social norms approach, together with education campaigns, could prove effective.

Fisheries managers have generally always approached improving compliance of a fishery by either increasing the level of enforcement (which is already limited in South Africa), or by increasing the penalties for breaking regulations. Both actions have proven to be ineffective due to high levels of non-compliance. A social norms approach has been suggested by Bova et al. (2017) as being a potential management option for, at the very least, the recreational shore fishery in South Africa, where people generally conform to certain social norms (belief about others) to avoid the disapproval of others.

Recreational fishers fish from small-motorised boats on the Sundays Estuary, Eastern Cape. © Paul Cowley



4.4 Conclusions

Ultimately, a ‘one size fits all’ approach is not applicable for managing all estuary-associated fishery species in all estuaries. Tailor-made regulations would be the most appropriate, but these would be difficult to enforce given the already existing limited management capacity. Irrespective of the management option, the consequences for the fishes, fishers and fisheries need to be balanced. Firstly, we suggest identifying priority estuaries which will be selected based on fishery species abundance and composition, and perceived importance of these estuaries in terms of nursery areas, adult use and recruitment. These systems as a whole should be managed more effectively, building on the estuary management plans already in place. This should also include other anthropogenic challenges such as regulating water abstraction and habitat destruction. Managing these systems will, in turn, improve recruitment of fishery species into estuaries. Secondly, crucial estuaries which need to be managed for the survival of key fishery species (e.g. Breede and Sundays estuaries for dusky kob) should be identified, and more stringent fishery regulations imposed on these systems. Lastly, estuary-specific regulations need to be implemented in estuaries that serve multiple functions for important fishery species; for example, estuaries that are recognised nurseries as well as have extensive use by large adults e.g. dusky kob in the Sundays and Breede estuaries and Knysna Estuary for spotted grunter where a spawning aggregation has been identified in the estuary (Butler et al. 2022).

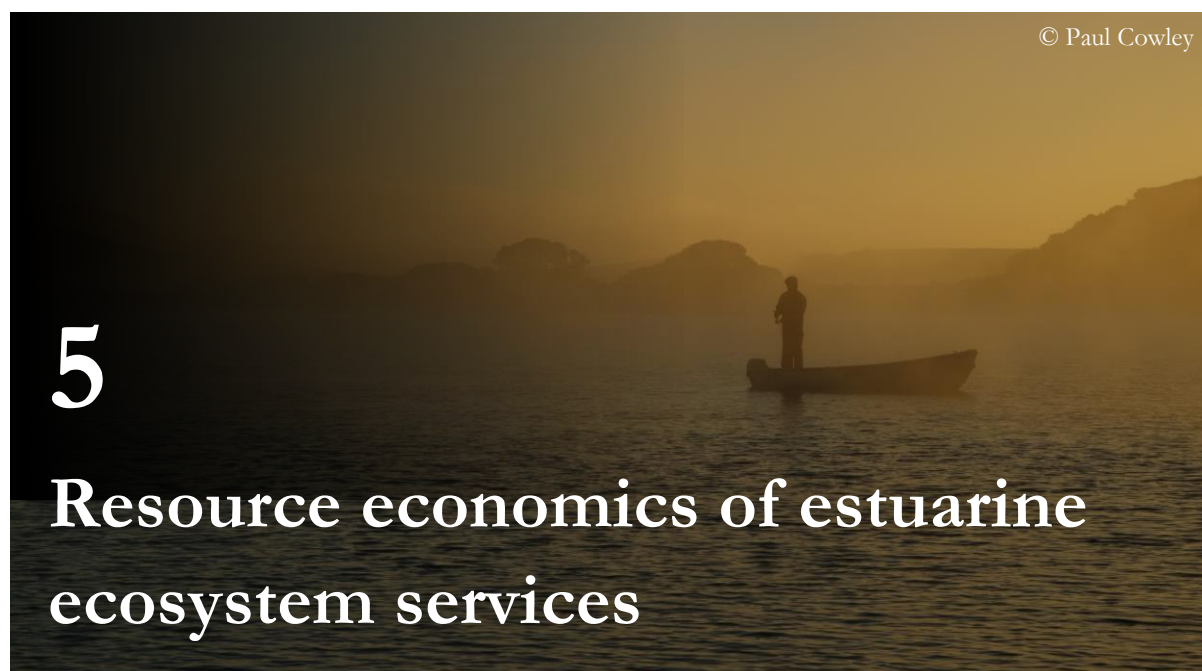
4.5 Lessons learned

- South Africa has at least eleven important estuarine fishery species utilised in subsistence, small-scale commercial and recreational fisheries.
- Species composition and area use of the species varies among estuaries.
- Estuary dependent fish species are important food and economic resources, which contribute significantly to the socio-cultural-economic sector.
- The present fisheries management of important estuary dependent species must be improved to secure fish stocks and avoid further population depletion and worsened status.
- Most fishes targeted in estuarine fisheries are estuary-associated species, spending a large portion of their juvenile life in estuaries, showing a relatively high, but varying, degree of residency to specific estuaries.
- While in their estuarine nursery habitat, fish use varying lengths of the estuary with some species being more resident to certain areas (e.g. spotted grunter, Cape stumpnose, white steenbras) than others (e.g. dusky kob, leervis).
- Sub-adults and adults of estuarine fishery species, including dusky kob, spotted grunter and leervis, have all been shown to spend more time than previously thought in estuaries.
- Juveniles of most species show relatively high levels of residency to their tagging estuaries, with some actively moving between the estuary and adjacent marine environment, as well as to other neighbouring estuaries.
- Recaptures of tagged fish show that some of the species are heavily targeted in estuaries, and that fish below the legal size-limits were often retained.

- Effective and sustainable management regulations may vary for different species, and to some extent also among estuaries. Management regulations must therefore be tailor-made for the species in question and based on knowledge of the species behaviour and area use.
- The threatened status of some of the important estuary dependent species calls for immediate implementation of effective regulations to secure sustainable use of these valuable resources.
- Without sustainable use, future fisheries resources are threatened, with especially severe implications for more marginalised and poor fisher groups.
- In the present situation with restricted law enforcement of, and compliance with, fisheries regulations, our studies indicate that no-take estuarine area closures are likely to benefit important coastal fishery species; at least the more resident species, during their obligatory estuarine-dependent life history phase. However, the size, proportion and part of the estuary closed to fisheries will determine the effectiveness of the protected area.

Juvenile white steenbras. © Tor Næsje





5.1 Background

Estuaries provide ecosystem services to humans. Ecosystem services are both material (provisioning ecosystem services) and non-material (cultural ecosystem services). The non-material benefits humans receive from estuaries include (1) recreation, (2) aesthetic enjoyment, (3) spiritual experiences, and (4) physical and mental benefits, while material benefits include (1) food, (2) freshwater, and (3) genetic resources (Booi et al. 2022). Fishing occurs in estuaries and sustains local economies and traditions as well as providing basic food (Potts et al. 2021). Estuaries also generate employment through tourists who are drawn to estuaries because of the aesthetics and the water sporting activities that they offer. Here, we assess the value of provisioning ecosystem services from the estuaries, which include both bait collection and fishing by subsistence and recreational users.

The aim of the economic component was to collect, analyse and present key estimates of provisional and cultural ecosystem services. Provisional services were analysed using data on local economic impacts of fisheries in the subsistence-dominated Swartkops Estuary and the recreational-dominated Sundays Estuary (see Figure 6.1), while the cultural ecosystem services are outlined in the literature review by Booi et al. (2022)

5.2 Materials and methods

A triangulation approach, summarised in Table 5.1, was used to collect the required data, and to determine the economic value of estuarine services.

Table 5.1. Sources of information used in this resource economics chapter.

	Literature review paper (n = 61 studies)	Booi et al. (2022) Ecosystem services: a systematic review of provisioning and cultural ecosystems services in estuaries. <i>Sustainability</i> , 14: 7252. https://doi.org/10.3390/su14127252
	Survey: Evaluating provisional and cultural ecosystem services in two contrasting estuaries in Gqeberha, Eastern Cape: <ul style="list-style-type: none"> • Swartkops Estuary: 131 respondents • Sundays Estuary: 113 respondents 	Over 5 months (Dec 2021–Apr 2022) Characterised by <ul style="list-style-type: none"> • Restrictions: COVID-19 • Rainy season
	Compare economic impacts to previous studies (updated values to real terms)	<ul style="list-style-type: none"> • Past studies • Current survey

5.2.1 Survey data collection

The study was conducted over the period December 2021 – April 2022 (peak season based on Cowley et al. 2009) during Level 1 Covid-19 restrictions, which entailed limited gatherings of no more than 50 people. As a result, most of the respondents were locals from within the Algoa Bay area. A total of 244 respondents were engaged: 131 from Swartkops Estuary (3.1% from outside the Algoa Bay area) and 113 from Sundays Estuary (all local). The final list of respondents was as follows (Table 5.2):

Table 5.2. List of respondents to the surveys conducted on the Swartkops and Sundays estuaries between December 2021 and April 2022.

Estuary	No. informants	Online	Weekends & Public holidays	Weekdays
Swartkops	131	29 (22.14%)	20 (15.27%)	81 (61.83%)
Sundays	113	18 (15.93%)	95 (84.07%)	-

Sundays Estuary users are mainly formally employed or engaged in business, hence access to the estuary is during weekends and public holidays. Swartkops Estuary users; the Swartkops Estuary has a greater number of subsistence fishers who rely on fishing for their livelihood and who therefore visit the estuary on most days. Field observations point to an average of 47 users per day on the Sundays Estuary and 65 users per day on the Swartkops Estuary. Estuary specific questions were developed for Swartkops Estuary to include bait collection activities. The analysis focused on the topics provided in Table 5.3.

Table 5.3. The main topics used in the analysis of value creation from estuaries.

Topic	Analysis technique	Purpose
Demographics	Descriptive statistics	Profiling estuary users
Motivation for visits and primary activities	Descriptive statistics	Assessing use of estuary
Expenditure and number of visits	Descriptive statistics Travel Cost Method - consumer surplus	Economic value
Ecosystem services	Descriptive statistics	Provisional and cultural uses/benefits
Assessment of quality of the estuary and management	Descriptive statistics Narrative	Sustainability of the resource

5.2.2 Travel Cost Method

This is one of the many methods of measuring fisheries benefits to society, and the most preferred as it is based on revealed, rather than perceived preferences (see Appendix 11.2). All costs related to a single trip are summed up per estuary user, to obtain daily trip costs. These costs include transportation/fuel to get to the estuary, food, and activity consumables at the estuary (e.g. bait). Capital expenditures like boats and reels, and annual fees such as club membership and licences were excluded. The data are used to compute consumer surplus (CS), which is defined as the excess of the amount that consumers are willing to pay for a product (visit the estuary) and the amount they actually pay for it (daily travel costs). When visitors are willing to spend more than they do, there is CS. A higher value of CS signifies greater valuation of the resource by visitors, and such can demonstrate room for additional costs, levies and other charges than can be included without affecting the number of times an estuary is visited.

5.3 Findings

First, we present the main findings from literature studies of ecosystem services from within the Eastern Cape of South Africa. We then present our estimates of the economic value of the recreational and subsistence fisheries in the Swartkops and Sundays estuaries, Eastern Cape.

5.3.1 Ecosystem services

Cultural services

The natural and manmade characteristics of estuaries provide cultural ecosystem services such as physical and mental benefits and leisure activities, which are valued by humans.

Whereas some consider cultural ecosystem services as neglected and ignored because they do not have a market value and cannot be sold, they argue that it is easy for people to overexploit and degrade them because they know they do not have a market value and do not pay for them. Some authors stress the importance of estuaries to people, and as a result, they are prepared to pay a specific sum as a solution to some estuarine management challenges.

Provisioning services

Provisioning ecosystem services are under threat from anthropogenic activities which may lead to loss of estuarine functioning and further decline of fish populations.

Estuaries provide water, food (e.g. fish, crustaceans and bivalves) and medicinal resources such as medicinal plants. Several threats to water quality and quantity have been identified in estuaries, namely overconsumption of water, where lack of inflow can lead to sediment deposition, and water quality degradation related to industrialisation or pollution from population increase (Figure 5.1). Overexploitation of fishery species or illegal activities (e.g. using gillnets) negatively affects estuarine fish populations, and may be a threat for provisioning ecosystem services in the long run.



Figure 5.1. Pollution in the Swartkops canal running through Motherwell Township. © Sipesihle Booii

5.3.2 User surveys - Descriptive analysis

Middle-aged male users (36 to 45 years) dominate both estuaries, with black/African and Caucasian adults dominating the Swartkops and Sundays estuaries, respectively. Recreational fishing dominates both systems and there is a higher incidence of subsistence fishers on the Swartkops Estuary. Fisherfolk may be land-based or boat-based, with the latter group comprising boat owners and those that hire vessels or use charter operators. The proportion of land-based fishers has increased recently due to escalating fuel and maintenance costs for boats.

Figure 5.2 presents the distribution of the sample, comparing the two estuaries. Note that data were collected between December 2021 and April 2022 while COVID-19 restrictions were still in force.

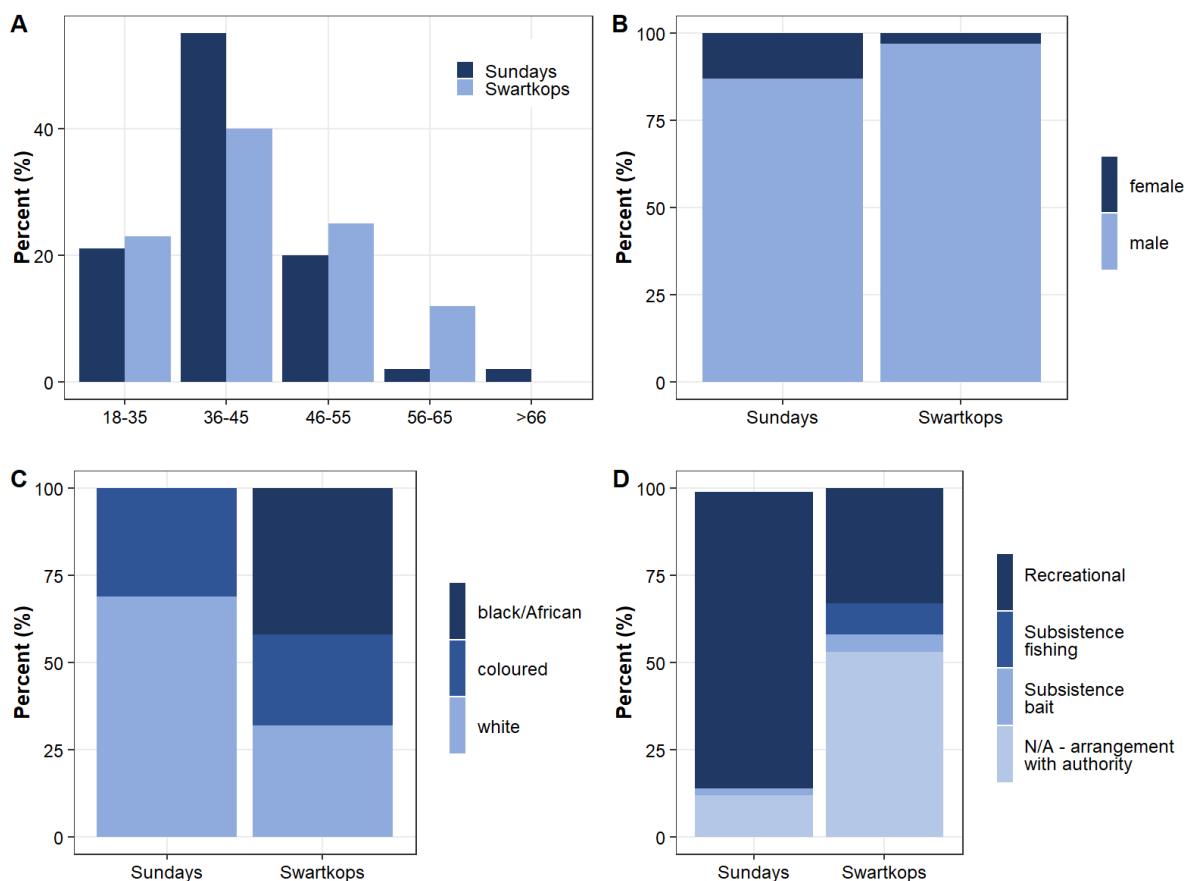


Figure 5.2. a) Distribution of age groups, b) gender, c) race and d) type of permits in the Sundays and Swartkops estuaries.

The 36-45 age group dominated in both estuaries (Figure 5.2a), with only 2% over the age of 66 on the Sundays Estuary. Females were in the minority, with 3% on the Swartkops Estuary and 13% on the Sundays Estuary (Figure 5.2b). Most of the users on the Swartkops Estuary were black/African (42 %), while the Sundays Estuary was dominated by whites (69 %) (Figure 5.2c).

Recreational permits dominated on the Swartkops Estuary (33%), while 9% held a subsistence permit, 5% bait collection permit and the rest (53%) were on arrangement with local authorities for permit waiver². On the Sundays Estuary, recreational fishing dominated (85%), followed by 12% on waiver, and 3% bait collection (Figure 5.2d).

When it comes to use of the estuaries, the primary activities undertaken were as follows: recreational fishing dominated both estuaries with 59% on the Sundays Estuary and 50% on the Swartkops Estuary (Figure 5.3). There was a higher proportion of subsistence fishing on the Swartkops Estuary (12%) compared to the Sundays Estuary (4%). We found a higher share of other recreational activities on Sundays Estuary (38%) compared to Swartkops Estuary (4%). Subsistence bait collection was only recorded on the Swartkops Estuary (34%).

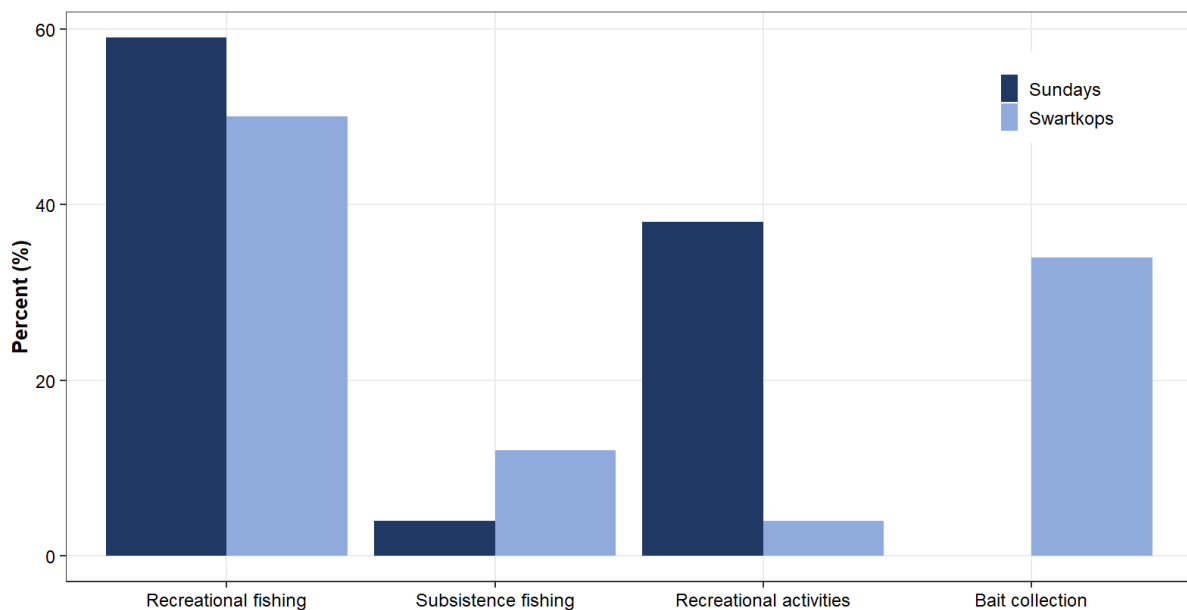


Figure 5.3. The primary activities on the Sundays (107 respondents) and Swartkops (129 respondents) estuaries.

It was evident that the Swartkops Estuary was dominated by subsistence fishers, while the Sundays Estuary was dominated by recreational fishing (Figure 5.4). There was, however an interdependence between the activities, as even though there is little subsistence fishing on the Sundays Estuary, the users do purchase some products from subsistence fishers (e.g. primarily mud prawn as bait). In the Swartkops Estuary, 15% of the users reported selling their catch, while on the Sundays Estuary, among those who purchased bait from subsistence users ($n = 34$), it was primarily mud prawn (79%) and bait fish (15%).

² Local authorities (Ward Councillor) negotiate for access by indigent members of the community. The Councillor provides a motivation which is taken to the licensing authority (Post Office), and the approved ones are provided with a letter to use in lieu of a permit.



Figure 5.4. Land-based (left) and boat-based (right) recreational angling on the Swartkops Estuary. © Syden Mishi

Three types of anglers visit estuaries: bank fishing or land-based anglers, charter fishing boat users, and boat owners. On the Swartkops Estuary, the majority were bank fishing anglers, some of whom used to be boat-based but are now land-based as a result of increasing fuel costs. This is a significant caveat, especially in the context of the travel cost method, namely that due to the benefit of the estuary, substitution effect has taken place with a change in the mode of transport and fishing rather than choosing not to ‘consume’ the product. Cost will not easily deter visits to the estuary, but can only affect the nature of expenditure. This implies that, even though the consumer surplus is possible, it is not a case of tapping into the full surplus, as the consumers are mindful of total costs, willing to substitute products to maintain a particular level of expenditure. In contrast, the Sundays Estuary is dominated by boat-based fishing.

5.3.3 Provisioning and cultural ecosystem services

Food is the dominant provisional ecosystem service for both the Sundays and Swartkops estuaries although a large proportion of users also claim to derive no benefit. A large majority of users derive cultural benefits from both systems, where most enjoy physical and mental benefits, quality of life and spiritual experiences.

Figure 5.5 summarises the cultural and provisional ecosystem services derived by estuarine users. For Swartkops Estuary users, food (which is based on the subsistence element) was the primary provisioning benefit, followed by medicinal resources and water, with about 25% deriving no provisioning benefit. On the other hand, the Sundays Estuary had almost equal proportions of those that benefited from food and those deriving no benefit; some derived benefits from the water (e.g. drinking, washing), but the share was lower than for the Swartkops Estuary (Figure 5.5).

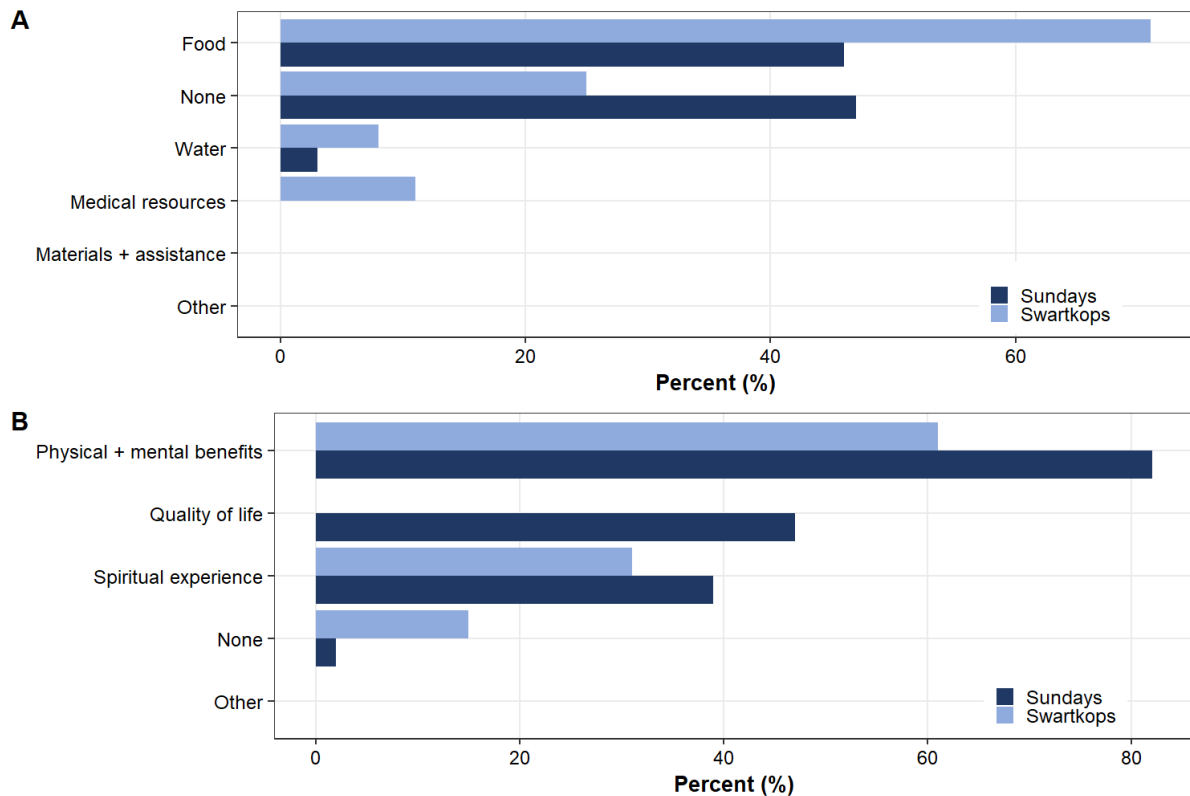


Figure 5.5. Frequency of provisioning (A) and cultural ecosystem services (B) from the Swartkops (light blue) and Sundays (dark blue) estuaries.

In terms of cultural benefits, the Sundays Estuary dominated the Swartkops Estuary in all categories with regards to physical and mental benefits, quality of life and spiritual experience, which resonates across all user groups and especially recreational based fishing (Figure 5.5).

5.3.4 Quantifying economic benefits

Quantifying economic benefits attempts to account for the money exchanging hands as a result of access to and use of estuaries. The monetary value of activities based on the expenditure approach uses the average expenditure (per user) multiplied by number of visits per year to provide the total money spent on estuary activities. This is an injection into local economic activities, and therefore the contribution to the local economy by estuaries, and could not have happened had there been “no” estuaries. As such, money continues to exchange hands in a cycle of transactions within the local community, for example, a recreational fisher spends R50 to pay for bait collected by a bait collector; the bait collector buys a loaf of bread for his/her family; the shop that sells bread pays its employee; the employee spends wages on transport to work etc.; and the cycle continues. This phenomenon is understood by the economic concept of an economic multiplier which is based on the number of times each R1 that is spent changes hands within the local cycle of transactions. Based on past studies (Neethling and Grobler 2022) we used a multiplier of 1.6 for Algoa Bay, which means that each R1 initially spent by an estuary eventually translates into a contribution of R1.60 to the local economy due to the cycle of transactions as explained earlier.

Benefit to the local economy through expenditure

Using 1.6 as an economic multiplier, the Sundays Estuary contributes R3 525 053 to the local economy annually compared to the R7 534 753 generated annually by the Swartkops Estuary. Actual and potential annual expenditures on the Sundays Estuary were estimated to be R 15 489 260 and at least R 5 654 121 per year respectively, and R4 609 820 and between R 17 302 404 and R 26 221 169 per year respectively for the Swartkops Estuary. The Sundays Estuary has a higher consumer surplus (CS) of R 1 000 per trip when compared to the R 333 per trip for the Swartkops Estuary.

Estuary users spend money to visit estuaries and for the time they are there. This expenditure can take the form of transportation, food, fishing equipment, consumables (e.g. bait) and accommodation, among others. This expenditure is then received by other economic actors as income (the fuel station, the taxi industry, the local shop, etc.). On average, Swartkops Estuary users spent R430 per trip per person, while Sundays Estuary users spent R722 on average per trip per person. In almost all cases for this study, these were one-day long trips. By computing total trips made by an individual user in a period (such as a year), we can estimate the total expenditure over that period. This is money injected into the economy only because there is an estuary to visit. While it is imperative to note that such money could have been spent elsewhere, e.g. on alternative entertainment to recreational fishing, it is worth acknowledging that an estuary is a critical resource that presents a unique opportunity for individuals to visit and which cannot be substituted in equal measure by another activity or experience. The general operation of an economy is that, when R1 is spent, once received by the other person as income, it can also be spent by this second person on other third parties (such as employees, suppliers of stock, etc.). This concept is known as an economic multiplier; in simple terms, R1 spent ends up being more than just a R1 within that economy. For the Nelson Mandela Bay economy, the value of that multiplier is considered to be 1.6 (Neethling and Grobler 2022), implying for every R1 spent, it ultimately contributes R1.60 within the local economy. When a multiplier effect is considered, the values of the Sundays and Swartkops estuaries can be calculated (Table 5.4), demonstrating the estimated current contribution of the estuaries to the community.

Using different methods to estimate the economic contribution from the estuaries provided varying results (each result is based on specific assumptions or scenarios as noted). The annual economic contribution from the Sundays Estuary ranged between R916 358 – R2 203 158, and including rippling effects, the economic contribution was estimated to be R3 525 053 when using 1.6 as a multiplier. The actual expenditure by those users who were surveyed (members) was estimated to be R15 489 260 per year and the potential expenditure was at least R5 654 121 per year.

For the Swartkops Estuary, the economic contribution ranged between R2 318 879 – R4 709 108 per year, and including rippling effects, the economic contribution was estimated to be R7 534 753 per year based on 1.6 as a multiplier. The actual expenditure by the surveyed users was R4 609 820 per year (note the opposite pattern compared to the Sundays Estuary) and the potential expenditure by the surveyed users ranged between R17 302404 and R26 221 169 per year.

Table 5.4. Economic contribution of the estuaries to the local community.

Indicator	Description	Sundays	Swartkops
On average daily expenditure (excluding capital expenditure and license fees; sunk costs)	Spent by 47 vs. 65 individuals in a year	R916 358	R2 318 879
Total expenditure: SURVEYED number is the only number throughout the year	Multiply total days by daily average expenditure	R2 203 158	R4 709 108
With multiplier (1.6)	Reference from Neethling and Grobler (2022)	R3 525 053	R7 534 753
Expenditure by the SURVEYED (ACTUAL)	Each respondent indicated the number of days they visit estuary in a year; adding all days from the surveyed individuals gives us total visits by the SURVEYED Compared to using average days; this is the actual days reported	R15 489 260	R4 609 820
Expenditure if registered members utilise the estuary, each average of days visits/year (POTENTIAL EXPENDITURE)		R5 654 121	R17 302 404 – R26 221 169
Consumer surplus	Additional cost the user is prepared to incur and still visit the estuary as many times as currently. The difference in costs between what the user actually incurs and what user is prepared to pay	R1000	R333

For the Sundays Estuary, we found a higher CS (R1 000, which is 39% of the current average daily expenditure of R722), compared to the Swartkops Estuary (R333, which is -23% of current average daily expenditure of R430). In fact, the CS was 3 times higher on the Sundays Estuary. A high CS value either indicates room for additional charges like entrance fees, levies and licences without significantly reducing the use of the estuary, or it shows that the consumer is prepared to incur additional costs to gain access to estuarine services, implying greater value put on the resource by the user. Users on the Sundays Estuary were prepared to spend an additional R202.27 on average per trip (whole day in our study) to access and use the estuary, while for the Swartkops Estuary users were, on average, willing to spend an extra R72 per trip. The difference is due to the nature of activities and general differences in income levels between the users of the two estuaries as reported in the descriptive analysis section above.

5.4 Lessons learned

- Estuarine ecosystem services face significant threats and challenges, the majority of which are caused by anthropogenic activities, while others are caused by climate change. Our review has shown that estuaries provide benefits to humans and help them maintain their livelihoods. These benefits can be monetary (provisioning ecosystem services) or non-monetary (cultural

ecosystem services), which are valued for the contributions they make to livelihoods and societal well-being.

- Most of the research on the value of estuarine ecosystem services is conducted globally, with only a few studies conducted in South Africa, which highlights a significant research gap. This emphasises the importance of increased research effort into the value and conservation of the estuarine ecosystem services in understudied geographic areas.
- Our economic valuation estimates provide reliable examples of the economic benefits of keeping estuaries intact, and indirectly pinpoints the value of well-managed estuarine ecosystems to maintain or improve connectivity for fish populations and ecological production, in combination with sustainable utilisation of natural resources in estuaries.

A cruise boat slowly making its way up the Sundays Estuary. © Nina Rivers



6

Social and cultural aspects of estuarine fisheries management

6.1 Background

Another important objective of this research has been to identify the constraints and enablers to management of estuarine fisheries as well as to identify and understand the socio-cultural components that impact on the governance of these resources. Recognizing that fisheries management is located within estuarine management, this research component acknowledges the need to approach this work through a Social Ecological Systems lens. As much of the existing literature on estuarine fisheries management prioritises fishery science, knowledge and policies (Olisah and Adams 2021), this component of the study responds to a lack of research on the social-cultural dimensions of estuarine fisheries management and aims to identify key social and cultural benefits of estuaries and estuary fisheries resources. Finally, to advance towards more integrated approaches to fisheries management (in light of a social-ecological systems lens, see Chapter 1), which acknowledges economic, social and cultural priorities alongside biophysical and environmental objectives, this aspect of the research explores the opportunities for alternative knowledge integration into estuarine management, ensuring Indigenous and local knowledge systems inform future estuarine management processes and implementation.

Social Ecological Systems approaches to environmental management highlights the need to identify and analyse the links between estuarine ecosystems, estuarine users and environmental challenges. This chapter specifically expands on the specific estuarine resource users and estuarine uses, and their interlinkages with estuarine resources and ecosystems. An important aspect of this work discusses who have historically been resource users, who are currently resource users and who will or might be future resource users.

Specifically focusing on two estuaries in and around Algoa Bay in the Eastern Cape Province, the Swartkops and Sundays Estuaries (Figure 6.1), the study has collated in-depth research, knowledge,

stories and lived experiences of estuarine users and uses, as well as social and cultural benefits of estuarine ecosystems. Furthermore, the research identified constraints and enablers to estuarine fisheries management, and alternative knowledge systems that should be integrated in future estuarine management. The research finds that there are multiple overlapping uses of the estuaries, which proves important to recognize when making management decisions and recommendations. For example, the research finds that many estuarine fishers, whether recreational, small-scale or subsistence, have strong cultural connections to the estuaries, and this impacts the ways in which they use, relate to and value estuaries and the fishery resources they provide.

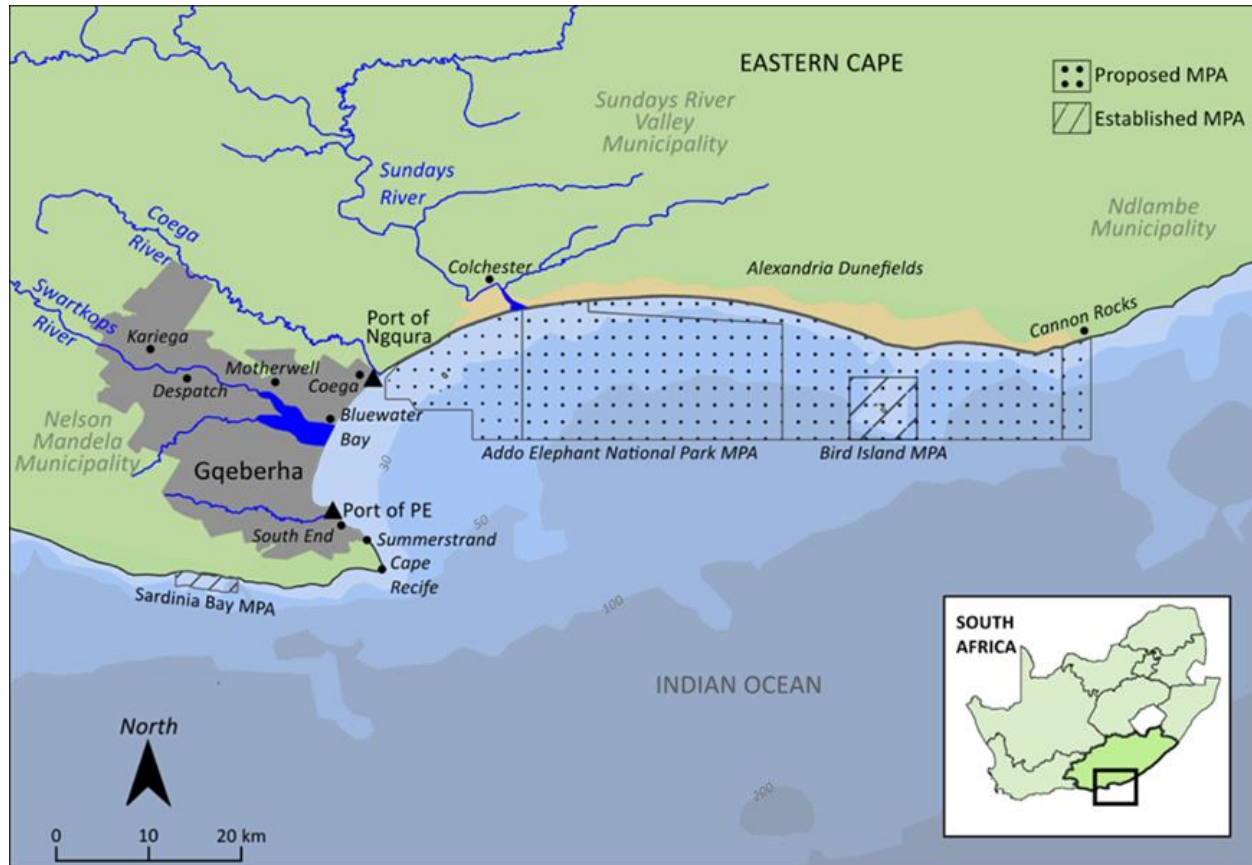


Figure 6.1. Map of Algoa Bay, showing Swartkops Estuary to the left and Sundays Estuary in the centre (Map copied from Strand et al. 2022a with permission).

6.2 Material and methods

The study adopts a qualitative multi-methodology approach (Table 6.1), including a systematic literature review, semi-structured interviews, arts-based participatory research in the form of photovoice and digital storytelling, a multi-stakeholder workshop with estuarine and coastal users and coastal authorities and participatory community mapping to map the cultural components of past and current estuary use.

Table 6.1. Summary of research studies, methods and number of research participants informing the findings in this section

Study	Name of study	Methodologies	Number of data points/research participants
Honours	Socio-cultural dynamics of the Sundays Estuary: knowledge to inform adaptive management of estuaries	One-on-one in-depth Interviews	8 research participants (2 fishers (1 rec, 1 subsistence), 2 tour operators; 2 coastal authorities; 2 Sundays River residents (numbers were low due to Covid restrictions))
Honours	Different Knowledge Systems for Knowledge-Based Adaptive Management in Estuarine Management in South Africa: A Case Study of the Sunday's Estuary	Systematic literature review	23 documents (grey literature, peer-reviewed papers; estuary management plans)
Masters	Exploring indigenous and local Knowledge systems in estuarine management	Interviews; Transect walks; Participatory Community Mapping	17 one-on-one research participants; 40 workshop participants
PhD	Arts-based knowledge co-production for more inclusive and equitable area-based ocean management in South Africa	Arts-based participatory research (In-depth Interviews; Transect walks; Workshops)	24 research participants (Algoa Bay residents)
Postdoc	1. Tracking the co-development of a marine social plan for Algoa Bay: Social factors mediating the governance of marine environments 2. Integrating indigenous and local knowledge systems into area-based ocean management	One-on-one semi-structured Interviews multi-stakeholder workshop	9 coastal and marine authorities; 31 workshop participants
Knowledge broker/ WP1, 2 and 4 lead	Coordination across the project's disciplines	Workshops; one-on-one in-depth interviews	36 workshop participants; in-depth interviews with 2 DFFE managers, 2 tourism operators, 9 subsistence fishers (Great Fish and Kowie estuaries), 60 recreational anglers (Swartkops and Kowie estuaries)

6.2.1 Systematic literature review

As a first step to understand if any alternative knowledge systems (e.g. Indigenous, traditional or local knowledge) inform estuarine management, a systematic literature review was employed to answer the primary research question: “How, if at all, are different knowledge systems used in current management systems of the Sundays Estuary?” A systematic literature review is a replicable methodology for the selection, extraction and analysis of textual data and makes use of the most relevant and up-to-date available information and data (Kitchenham 2004). The primary research aim was to identify relevant literature regarding estuarine management and knowledge systems in a South Africa context as well as to identify knowledge gaps (for the detailed systematic strategy or protocol refer to Nonyane 2020). A combination of 24 peer-reviewed articles and grey literature (e.g. estuary management plans) were reviewed that had relevance to the Sundays Estuary.

6.2.2 Semi-structured interviews with coastal managers and authorities

Semi-structured in-depth interviews were conducted with 11 local, provincial and national coastal managers, authorities and implementers over a period of several months in 2020 and 2021 (across the honours, post-doctoral and knowledge broker research projects) to tease out what the primary challenges and opportunities are to estuarine management specifically and ocean and coastal governance more broadly. Research participants were also asked how they overcome these (pathways they use to work around these) as well as to identify current and future pathways to integrate Indigenous and local knowledge and knowledge holders into coastal management. All interviews were conducted via Zoom due to social distancing Covid-19 regulations.

6.2.3 Arts-based participatory research

Arts-based methods involve knowledge creation processes where art forms, such as drawing, photography, music, dance and storytelling, play a central role (Barone and Eisner 2012). In this research, art in the form of photography and storytelling has been used to elevate Indigenous and local knowledge of the ocean, coast and estuaries, and people’s connections to and uses of their natural surroundings. The research has used arts-based participatory research (ABPR), with an emphasis on participatory, where research participants are recognized as co-researchers as they take part in developing the methodology, developing and presenting their own photographs and stories, and analysing the results (see Strand et al. 2022a). The ABPR approach has been found to create ownership of the knowledge production process, challenges hierarchical research methods and allows for different understandings and knowledges of estuarine management and importance (Strand et al. 2022b). The project specifically recognizes a pluriversality of knowledges, as opposed to one knowledge claiming universality.

The specific research steps can be summarised as: i) initial outreach; ii) photography and storytelling workshops; iii) field visits and in situ photography and storytelling; iv) analysis workshops and participatory community mapping; v) multimedia exhibition showcasing the final photostories; and vi) a multi-stakeholder workshop exploring pathways to better integrate Indigenous and local

knowledge systems in ocean and coastal management, including estuaries (see Strand et al. 2022a and Strand et al. 2022b for detailed research steps).

6.2.4 Multi-stakeholder workshop

In order to collaboratively identify and build consensus around pathways to integrate Indigenous and local knowledge systems (ILKS), we carefully designed and facilitated a one-day, multi-stakeholder workshop with 31 ILKS holders and coastal governance authorities and practitioners through three sessions. In Session 1, participants were invited to engage with the photographic exhibition to see what kind of ILKS are present in Algoa Bay. In Session 2, participants were asked to identify current and future pathways to integrate ILKS into ocean governance and in Session 3, we used a nominal group technique (Gaskin 2003) to build consensus on policy recommendations to inform a co-authored policy brief (see Rivers et al. forthcoming) and inform future work for integrating ILKS and knowledge holders into coastal and marine governance (see Rivers et al. 2023 for detailed methodology). The policy recommendations and interview data were thematically coded into 29 sub-categories which were then collated into five broad categories of knowledge integration pathways. The broad themes and subthemes were coded a second time (double-coded) by another researcher/co-author to ensure rigorous and consistent findings.

6.2.5 Participatory community mapping workshops

Participatory community mapping was employed to map the cultural components of past and current estuary use in the Sundays and Swartkops estuaries. Participatory community mapping is a research approach that “provides the opportunity to create a tangible display of people, places and experiences that make up a community” (Fang et al. 2016: 223), and which is shaped by principles of equity and is a community-based participatory research method that enables co-researchers (research participants) to define what is important to them in terms of estuarine use and cultural ecosystem services (Corbett 2009, Basupi et al. 2017).

Co-researchers created a list of estuarine cultural and recreational use categories and then marked these uses on printed street-view maps of the case study areas (Figure 6.2). These categories included: Cultural Heritage and History; Peace/Calm/Escape; Spiritual and Religious Connections; Observations of Change; Learning; Recreation/Fun; Healing and Livelihoods/Subsistence and Future Uses. These maps were then digitised by a GIS specialist and taken back to the respective communities for them to confirm the accuracy of these versions. If co-researchers were satisfied with the maps, they were shared with community participants for their own purposes, as well as to inform project findings, and if there were amendments to be made then these were done with the guidance from the participants.



Figure 6.2. Participatory community mapping in Cannonville, Sundays Estuary. © Nina Rivers

6.3 Findings

The overarching results from the socio-cultural research processes can be grouped as follows: 1) estuaries as complex socio-ecological systems (SES) and the need for alternative knowledge integration for management; 2) limited understanding of estuaries as SES; 3) overlapping estuarine resource users and uses; 4) socio-economic disparities and inequalities resulting in lack of access to and exclusion from estuary areas; 5) historical and continued structural and societal racism; 6) local management under-capacitated and limited support from high level government; 7) limited local stewardship opportunities; 8) limited understanding of cultural connections and overlapping benefits of estuaries; 9) limited government capacity and knowledge flow structures to incorporate social science in estuarine management and planning; 10) breakdown in cooperative governance and limited structures for meaningful stakeholder engagement; 11) ineffective knowledge flow structures between high level government and resources users (see Table 6.2).

6.3.1 Estuarine fisheries management informed primarily by scientific knowledge

Estuarine fisheries systems, as complex social-ecological systems, require a consistent integration of different knowledge systems and knowledge holders to be managed effectively, adaptively and sustainably, including not only scientific knowledge, but practical, Indigenous and local knowledge.

The systematic literature review (see Section 6.2.1) identified that three different types of knowledge systems inform current estuarine management in the Eastern Cape: **Practical, scientific and local knowledge.**

Practical knowledge is “Knowledge which includes resource managers, government bureaucrats, decision makers, and personnel in NGOs, development agencies, and civil society groups” (Erickson and Woodley 2005). Scientific knowledge “Involves observing changes in the environment, plus the provision of hypotheses to explain why things happen the way they do and testing how true the suggested hypothesis is” (Erickson and Woodley 2005). Local knowledge: “Refers to place-based experimental knowledge, this knowledge is largely oral and practice-based in contrast to knowledge that is acquired by formal education or book learning” (Erickson and Woodley 2005: 90). Indigenous knowledge refers to “values, beliefs and culture of communities that identify with the original inhabitants of a specific area, and often have different cultural identities than the rest of the given society in which they exist” (Strand et al. 2022b: 2).

Current estuary management plans rely heavily on scientific knowledge (e.g. biological, biophysical, environmental science, conservation etc.) compared to other knowledge systems, especially with little inclusion of local knowledge, local communities or other knowledge systems (Nonyane 2020). One of the reasons for this is that local knowledge is often not easily accessible because it has not been recorded or practically integrated into management plans. Nonyane (2020) argues that one of the ways to remedy this, and to efficiently manage and understand the state of knowledge and management in estuaries, is to first conduct a knowledge audit. A knowledge audit is the first step in a knowledge management process and can help to identify knowledge gaps, assess what kind of knowledge is available and how it can be used (Maponya and Ngulube 2006). Several of the publications reviewed recommended the inclusion of different disciplines of knowledge to inform estuary management plans.

6.3.2. Overlapping estuarine resource users and uses

Estuarine resource users and different uses often overlap, and people's connections to the fisheries are more complicated and multidimensional than the simplified understandings of fishers' motivations as either subsistence, livelihood or recreation (Figure 6.3).

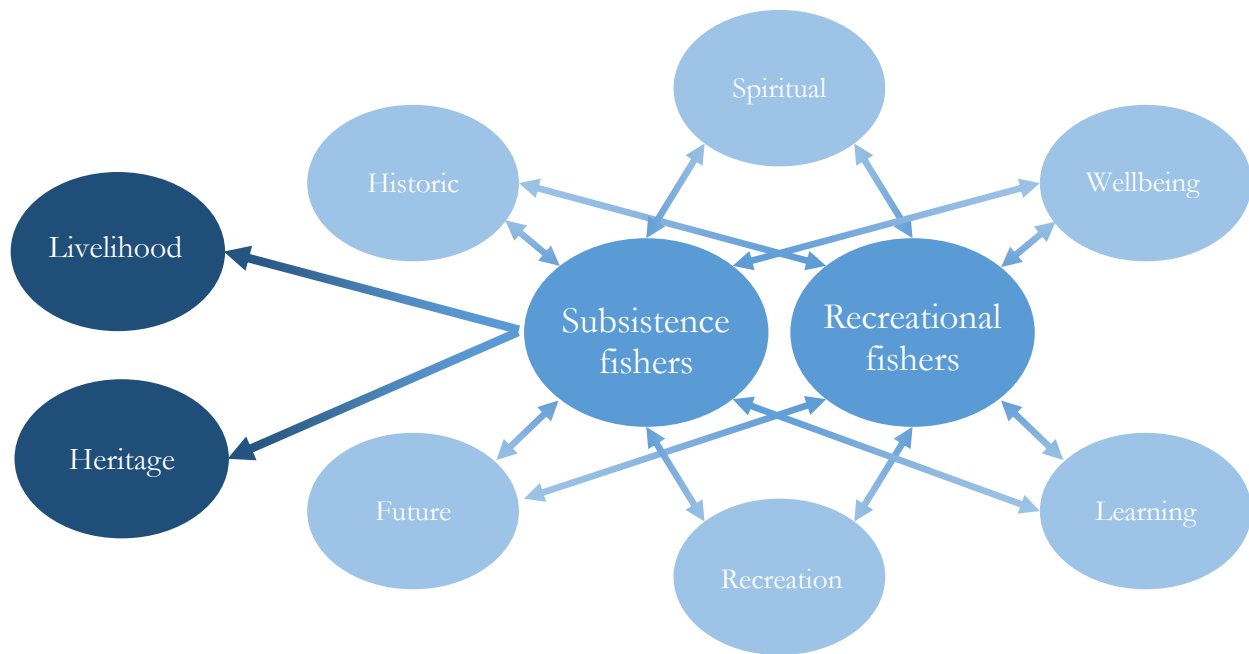


Figure 6.3. Interconnections and interrelations between different uses of the estuaries, using the examples of subsistence fishers and recreational fishers in Algoa Bay estuaries (Figure developed by Mia Strand).

Our studies have identified several estuarine fisheries resource users and broader estuarine uses. The specific users can be summarised as follows:

- Local residents (low, middle and upper income earners)
- Recreational users (and fishers)
- Subsistence users (and fishers)
- Commercial users (tour operators, fishers etc.)
- Cultural users (ceremonies, heritage etc.)
- Spiritual/religious users
- Tourists (local and international)
- Past and future users (past because some areas are off limits now and future because some users seek future access to certain areas)

The identified uses can be summarised as follows:

Recreation:	Fishing, swimming, walking, sandboarding, camping, boating, canoeing, water skiing, mountain biking, bird watching, tourism, braaing
Subsistence:	Fishing, bait collecting
Cultural heritage:	Ceremonies, Indigenous connections and heritage
Spiritual/religious:	Praying, singing, baptisms, connections with ancestors
Livelihood:	Tourism, conservation agencies, monitoring work
Learning:	Environmental education, learning about ecosystems and connectivity, observations of social-ecological change
Historical:	Generational, pre-Apartheid regulations
Future:	Next generation, hopes for better access, improved fishery regulations

The above uses are supported by other studies on estuaries, including Bowd et al. (2012) and Hartmann (2021).

Recognizing subsistence fishers

Based on the present project we recommend the recognition of subsistence fishers in addition to small-scale fishers (SSF; see Chapter 3 for definitions of fisheries resource users). Although this project recognizes the interlinkages between and interdependence of marine, coastal and estuarine systems, and therefore the necessity to also recognize SSF in integrated policies (such as the National Environmental Management Act), this research mainly considers estuarine fisheries users and therefore only refers to recreational and subsistence fishers.

6.3.3. Socio-economic disparities and inequalities result in lack of access to and exclusion from estuary areas

Socio-economic inequalities and apartheid legacy issues continue to exclude certain users from equitable estuary access and use. Estuary management needs to recognize and understand these complicated dynamics in order to better respond to resource use challenges.

Research in both Swartkops and Sundays estuaries highlighted marked disparities and inequalities between estuary-adjacent communities and residents, due in large part to South Africa's apartheid history of racial segregation and social and spatial engineering. Recreational and subsistence fishers are often separated and distinguished along other lines of societal disparities and inequalities, such as income, race, livelihood options, households and gender (McGrath et al. 1997; Hauck et al. 2002; Sowman 2006; Baust et al. 2015; Potts et al. 2022). Our observations supported this, specifically with regards to the predominantly white, middle to upper income earning Cannonville community and the

predominantly black and coloured lower income earning Colchester community living adjacent to the Sundays Estuary, there are significant disparities and inequalities between the two communities as a result of not only socioeconomic standing but also historical racial segregation which impacts upon who has access to the estuary and therefore opportunities to identify and operate as either a recreational, small-scale or subsistence estuary fisher. This finding is supported by studies by Cowley et al. (2013), Quesada et al. (2018) and Hartmann (2021).

Research in the Sundays and Swartkops estuaries identified that the exclusionary legacy of conservation measures as well as structural racism in the country resulted in the forced removals of certain communities for conservation purposes and privatisation of land near estuaries, which continues to directly affect people's access to and exclusion from estuary areas and uses (Connor 2007; Rivers 2015). For example, the access to the Sundays Estuary is blocked by fences and a paygate at a privately owned resort. This means that neighbouring community members, just like visiting tourists, need to pay a daily sum of R78 to enter. As noted above, some estuary-adjacent communities are socio-economically marginalised so this paywall directly excludes access for many individuals. Furthermore, access to several areas along these estuaries are limited due to private property owners constructing private jetties on river banks, therefore limiting people's access to fish from the river bank. Participatory community mapping with communities living in Colchester showed that they have extremely limited access to areas of the Sundays Estuary due to the above-mentioned reasons. This finding is supported by current literature (Fielding 2011).

6.3.4 Historical and current structural racism

Structural racism within government institutions and society more broadly, continues to constrain estuarine management measures and sometimes leads to marginalisation and exclusion of certain individuals and communities.

Several research participants or co-researchers (Figure 6.4) as well as local managers noted that they experienced both structural racism³ and individual racism in their day-to-day jobs and activities around estuaries. As noted above, due to South Africa's apartheid history, economic inequalities often run along racial lines between the "have" and the "have-nots". This economic marginalisation often then translates into social marginalisation (Nattrass and Seekings 2001; Seekings 2000). While performing participatory community mapping workshops with the majority black and coloured communities of Colchester near the Sundays Estuary, community members noted that they often felt marginalised, unwelcome and squeezed out of certain areas of the estuary which they attributed to racism. This played out in being ushered or chased away from certain areas by authorities or having to pay hefty entrance fees to private areas to gain access to larger stretches of the estuary, which they cannot afford. Colchester community members said they felt unwelcome in many parts along the river and were

³ Structural racism can be defined as "a system in which public policies, institutional practices, cultural representations, and other norms work in various, often reinforcing ways to perpetuate racial group inequity. It identifies dimensions of our history and culture that have allowed privileges associated with 'whiteness' and disadvantages associated with 'colour' to endure and adapt over time" (Shim 2021: 592)

unable to fish off jetties along the banks of the river, which are by law, not privately owned. These findings are supported by Hartmann (2021).

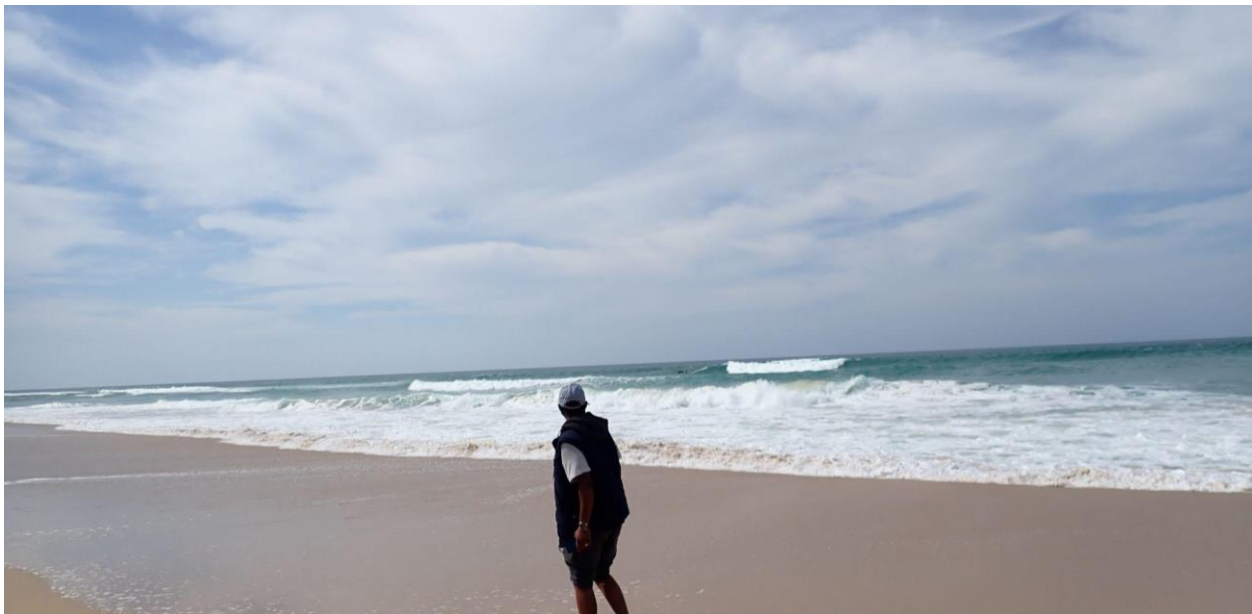


Figure 6.4. Co-researcher at Sundays Estuary mouth. © Mia Strand (from Strand et al. 2022a with permission)

Several residents of local communities living adjacent to Sundays Estuary express disappointment that there is limited access for them to the estuary and beaches. This is particularly due to fencing and paywalls to enter.

Structural racism also plays out in white individuals having preferential treatment with regard to monitoring and compliance. For example, a young white male living in the predominantly white middle class area of Cannonville along the Sundays admitted to some white local authorities turning a blind eye to his transgression of entering and fishing in a restricted area on the estuary. Black and coloured Colchester community members, on the other hand, argued that they were usually chased away from certain areas if they were merely walking in the vicinity and not even within the restricted areas themselves. This incident demonstrates the privilege enjoyed by some, usually white, recreational users. However, as social dynamics are always layered and complex, this is not always the case in all instances and community members of all race groups in the area (black, coloured and white) have reported the strict monitoring and enforcement by some South African National Parks officials, irrespective of race.

A history of racism in South Africa also means that estuarine monitoring and compliance situations can quickly turn into a racial situation even if it is not intended to be, which makes it difficult for coastal compliance officers to ensure coastal users of all race groups are complying with coastal use rules and regulations. As one local coastal compliance officer noted: *“And I’m being frank with you now,*

being a white male, going to a group of, say black harvesters or traditional healers collecting stuff turns upside down into such a massive racial thing and it's certainly not our intention whatsoever”.

Entrenched and structural racism was also reported by local managers as well as organisations working closely with high level government officials, creating chasms between people in management and government and further constraining estuarine management. One coastal expert noted about a colleague “...now all through the last two years, he knows about organisation*⁴ we were going to set up. He's been informed and I've told him about the project. And this is the project with community working and the MPA. Yeab, he says to me, ‘As long as your white boss deals with my white boss, I will sabotage organisation*’ ”. Another local government official noted about racism in his institution, “*Its politics...it's destroying South Africa. It's separating people, it's keeping racism alive*”. Given South Africa’s long, violent and oppressive apartheid past, it is understandable that people are still angry. As argued by Sunde and Erwin (2020) racism is still deeply embedded in our institutions and social structures and this impacts upon how decisions are made and actions implemented with regards to natural resources management.

6.3.5 Local management under-capacitated and limited executive sponsorship

It is at times challenging for local estuarine managers to fulfil their mandates due to limited capacity, executive sponsorship, leadership and poor communication from superiors.

Capacity challenges and lack of support from high-level management and government is a prevalent issue noted by local level estuarine and coastal managers and on-the ground control officers that work for Nelson Mandela Bay Municipality (NMBM) and by South African National Parks (SANParks), the country’s national conservation agency (managing Sundays Estuary). Capacity issues play out in the form of lack of funds, infrastructure, skills and staff, and lack of communication. In terms of infrastructure, some compliance units had no boats or vehicles to patrol their areas and one municipal manager, at the time of interviewing in 2021, had not had internet in his office since 2019.

In terms of lack of staff, when the Greater Addo Elephant National Park Marine Protected Area was proclaimed in 2019, it expanded the SANParks management area from 7 000 ha to 114 000 ha. However, the SANParks Marine Unit received no additional staff or budget to manage this additional area and at the time of carrying out interviews in 2021, only had seven permanent staff. This results in a considerable gap between authorities being aware of issues, but not being able to respond to them due to limited human and infrastructural resources. Both the NMBM and SANParks also expressed a lack of stakeholder engagement training as well as funds to support engaging estuarine communities. As one SANParks official notes: “...Our staff complement was not increased, you know. So that has put us under pressure” (Interview 2020). This lack of capacity is not unique to the Eastern Cape Province and challenges to integrated coastal management in South Africa have been documented before (Celliers et al. 2013; Sowman and Malan 2018; Hartmann 2021). Some directorates also call upon others to

⁴ *Organisation name removed for anonymity

assist them in fulfilling their mandates due to lack of human resources, which adds further pressure on these directorates.

Linked to the above is poor communication. Local government managers sometimes feel unheard and/or sidelined by provincial or national level government. They describe communication flow from national to local government as often one-directional, with local management only informed on a ‘need-to-know’ basis which results in them being the last to hear about important decisions and national directives that do not always translate well to local level realities in terms of implementation which frustrates manager efforts to fulfil their local mandates effectively. Again, this is supported by current literature (Sowman and Malan 2018).

In terms of limited executive sponsorship, at the time of writing this report, the Environmental Management Directorate at NMBM had no director resulting in a lack of leadership which adds an additional burden of responsibility on already overburdened senior managers. For example, “*essential positions and staff cannot be appointed without the approval of directors which means that staff complements remain small and positions that are unoccupied for several months and years, eventually fall away completely, further weakening the local governance system*” (Interview 2021). These findings are also supported by current literature (Quesada et al. 2018; Hartmann 2021).

Added to these challenges is the experienced lack of support from the judicial system of environmental management units that apprehend transgressors (e.g. abalone poaching syndicates), which often lead to transgressors going un-penalised. This results in the erosion of morale of compliance officers on the ground. A compliance officer details the difficulty of exacting penalties on poachers: “*...And then it comes to a point where it is like for example you will catch guys with overfishing of 150 fish or 200 fish in one vehicle. They came in with a boat, offloaded the fish onto a bakkie or a Land Rover, drive out. We will catch them with the Land Rover, confiscate the Land Rover, book it into the impound. The guy will go to court. The court will give him a R1 000 fine and then give him back his Land Rover...*” (Interview 2020).

The mouth of the Swartkops Estuary, Eastern Cape. © Koos Smith



6.3.6. Limited local stewardship opportunities

There is a lack of realistic opportunities and support from authorities for estuarine users to engage meaningfully in the management process. Users feel sidelined, which erodes confidence in government and management interventions.

Estuarine users and local communities experience limited local stewardship opportunities, which is also supported by the findings of Quesada et al. (2018) and Hartmann (2021). We define stewardship as the actions people take, or sentiments people have, towards responsible use and care for estuaries (developed from Strand et al. 2022a). Several subsistence fishers and bait collectors, as well as other estuarine residents, expressed that they wanted to be more involved in the management of the respective estuaries, and that there were currently little to no opportunities for people to have a say in the development of estuary management plans, general estuary decision-making and implementation. For example, several estuarine users in the Swartkops Estuary emphasised that they had tried to express problems with their lack of access, newly proposed stringent fishing regulations, or becoming involved in litter management, where they were either not heard or considered (Figure 6.5). The continued neglect and lack of consideration of the realities of subsistence fishers in particular, and sometimes recreational fishers, can lead to less buy-in and compliance with current regulations (see Sowman and Sunde 2018), therefore contributing to unsustainable harvesting and resource-use.



Figure 6.5. ‘Factories on the banks of the Swartkops River, near Aloes Community, contribute to industrial waste into the river where resident Francis Nkaki fishes and collects bait’ (Strand et al. 2022a). Several subsistence fishers have expressed wishes to be involved in litter removal and estuarine decision-making. © Mia Strand (from Strand et al. 2022a with permission).

6.3.7. Limited understanding of cultural connections and overlapping benefits of estuaries

The strong cultural connections that users have to estuaries must be acknowledged, understood and viewed holistically with other uses in order to better inform management.

Although some coastal authorities acknowledge that there are cultural uses of estuaries, this understanding is often limited. The arts-based participatory research and participatory community mapping approaches strongly highlight the importance of several different cultural connections to the estuaries, coast and ocean, such as spiritual, religious and ceremonial connections (Strand et al. 2022a; Figure 6.6), that were not adequately acknowledged in current integrated management plans or estuarine management literature.

The Swartkops Integrated Environmental Management Plan's situation assessment (Enviro-Fish Africa 2009), however, recognises the existing socio-cultural importance of specific areas of the estuary:

The north westerly side of Swartkops River, i.e., adjacent to the brick works and 100m from the Swartkops Nature Reserve, is currently used by Zion Christian Church for the baptism of members of its congregation.

The river reach underneath the rail and road bridges on the Old Grahamstown Road is also used for baptisms by another congregation of the Zion Christian Church.

The western side of the Swartkops River near Redhouse is being used by Traditional Healers to perform cleansing ceremonies and to harvest medicinal plants.'

Unfortunately, once this assessment was handed over to the Nelson Mandela Bay Municipality, the project came to a halt and how to best integrate these socio-cultural important areas into the estuary management plan was not explored further. Moreover, the acknowledgement of these socio-culturally important areas does not recognise how some of these uses might overlap with other recreational, livelihood or well-being uses of the estuary.

These cultural connections and the cultural significance of estuarine areas cannot be separated from other estuarine uses and benefits, such as fishing practices, recreational uses and other livelihood practices. For example, in the Sundays Estuary, subsistence fishers often use the same areas for fishing, praying and recreational family time, and in the Swartkops Estuary, subsistence fishers and bait collectors note that their fishery practices are important for spiritual, well-being and cultural reasons alongside livelihood reasons. Estuarine management efforts need to recognise and better understand the ways in which multiple uses of and benefits deriving from estuaries overlap, such as livelihood, spiritual, recreational and cultural. These interconnected uses and connections influence how people relate to the estuary, use the estuary environment and estuary resources, which means that they need to inform how the estuary is managed.



Figure 6.6. Indigenous Khoisan people come to estuaries and the ocean for several different cultural and spiritual purposes, such as praying, spiritual healing, sense of calm, recreational uses and connecting to ancestors. © Mia Strand (from Strand et al. 2022a with permission)

6.3.8. Limited government capacity and knowledge flow structures to incorporate social science in estuarine management and planning

Social science data fails to inform estuarine management processes and policy due to limited capacity and knowledge flow structures to integrate such data.

Social science knowledge and data to support knowledge-based adaptive estuarine fisheries management does exist and is being carried out by research institutes, but it is currently not integrated into estuarine management policy in South Africa. Slowly but surely government departments, agencies and funders are recognising the importance of including social science and governance aspects in coastal management, but the actual uptake of this knowledge is slow: from science to policy to implementation. This finding is supported across interview and workshop data. As one coastal official stated, “...but I think there's one or two social scientists in the Garden Route. But we don't have someone dedicated to Addo, and certainly no one in the marine field. So we rely heavily on people from outside in most parks” (Interview 2021).

Two primary factors seem to contribute towards this: a lack of capacity (funding and knowledge) to be able to assign social scientists to estuarine management development and processes, and lack of systematic knowledge flow structures (knowing where to source this information and then being able

to channel it into policy and then implementation) to allow for this integration. This then results in a lack of social science perspective in estuarine research, management, and training.

Adding to knowing how to engage estuarine users is knowing who to engage. Often estuarine communities and users are a complex, heterogeneous group of people and can be spread across a large area (Hartmann 2021). Individuals with stakeholder engagement skills are needed to be able to identify the easy-to-reach stakeholders but then also the estuarine users who may be overlooked and who are not organised into easily accessible user groups, like subsistence fishers. This need for social science research in estuarine management specifically and integrated coastal management more broadly is recognised in past and current literature and studies (Redman et al. 2004; Hartmann 2021; Strand et al 2022b).

6.3.9. Breakdown in cooperative governance and limited structures for meaningful stakeholder engagement

There are limited governance structures and capacity to engage stakeholders in a meaningful and inclusive way, which can result in increased social tensions rather than shared knowledge, trust and stewardship of estuaries.

Closely linked to the previous lesson learned is limited governance structures and capacity to support meaningful stakeholder engagement in estuarine fisheries management. We understand meaningful stakeholder engagement as “processes that are not merely tokenistic, but stakeholders have access to all relevant information, they understand it fully and have the capacity, agency and power to question, criticise and change processes they are not satisfied with” (Rivers et al. 2023: 11). Social science knowledge is required to understand estuaries as social ecological systems (see section 6.3.8 above), and then the skills and capacity is needed to carry out meaningful stakeholder engagement processes to include estuarine users in management decision-making processes. Following interviews with local coastal managers, the lack of the above requirements seems to be due to viewing stakeholder engagement as quite narrow, once-off information sessions (Williams 2006). There is also lack of investment in the capacity needed to support meaningful stakeholder engagement (e.g. allocated budgets, time, specified expert roles and knowledge).

There are several degrees or levels of stakeholder engagement that are progressively more participatory depending on the legal requirements and resources available. Government stakeholder processes generally operate at the first two levels of informing and consulting stakeholders (Morf et al. 2019). Both levels operate more as tick-box exercises which often result in one-way information flows with little uptake of stakeholder concerns, desires, opinions, needs or knowledge. In order to carry out stakeholder engagement processes at the collaboration, decision-making and process-responsibility levels, skills and expertise are required to know how to guide and facilitate these processes so they do not result in unresolved tensions and disputes but rather in sustainable change, constructive actions and sharing of knowledge and management responsibilities (Benham and Daniell 2016; Strand et al.

2022c). However, there seems to currently be a lack of capacity to support these kinds of engagements because they take time, effort, patience and adequate skills and funding which may not always be readily available if not initially budgeted for by government departments.

6.3.10. Ineffective knowledge flow structures between high level government and resource users

Bureaucracy and ineffective knowledge flow structures means that end users are not always informed, resulting in them being unable to contribute meaningfully to estuarine management processes.

Interactions with estuarine managers and users also highlighted ineffective knowledge flow structures between provincial and local management and resource users leading to a disconnect between local stakeholders and national government. This plays out in several ways, the first being an over-reliance (due to the above-mentioned capacity constraints) by national and provincial government departments on local Non-Governmental Organisations (NGOs) that act as bridges of communication between government and resource users. This means that there is often limited or no direct line of communication between national and provincial governments to find out what estuarine users want or need in terms of estuarine resources and they therefore lose their “finger on the pulse” of what happens at local user level. As one national government official noted, *“I don't have a lot of information on having the community being the ones presenting to us, you know, what they are doing? That would definitely be interesting”* (Interview 2021).

Local municipal ward councillors, traditional leaders (e.g. chiefs and headmen) and NGOs are all responsible for acting as a line of communication between coastal and estuarine users and local government but if they fail to relay important messages from either side then this line of communication becomes ineffective. A Nelson Mandela Bay Municipality official explains this breakdown of communication when he notes: *“Councillors are selected in a position. He's there. He's been elected on behalf of the people. He's the voice of the people I believe. But you go down to his ward and there is sewage, sewer manholes and stuff overflowing, there's litter everywhere. Why doesn't he engage with these people?”* (Interview 2021).

Secondly, bureaucratic structures also lead to ineffective knowledge flows between local level government and coastal and estuarine users which can become exclusionary. Most municipal structures, for example, do not allow for managers to organise stakeholder meetings outside of office hours (08h00 – 16h30) which means that local estuarine users who can only attend meetings outside of working hours are excluded from important meetings that may impact on their use of estuarine resources. As one municipal official explains, *“Now my working hours, not mine, but I'm just saying, as an official, my working hours are eight until half past four. In order for me to have an effective meeting I would have to meet after hours, right? In order to accommodate anyone, everyone. So that would be a problem in itself”* (Interview 2022).

Thirdly, advertisements of local stakeholder meetings can also be exclusionary if limited channels of advertising platforms are used such as only print media (e.g., newspapers) or only virtual platforms (e.g., Facebook or Zoom) as well as only one language (e.g. only English) which may include some stakeholders but exclude others which results in inequitable knowledge flows.

6.4 Lessons Learned

- Estuarine fisheries management is currently informed primarily by scientific knowledge (over other knowledge systems). Estuarine fisheries systems, as complex social-ecological systems, require a consistent integration of different knowledge systems and knowledge holders to manage them effectively, adaptively and sustainably including not only scientific knowledge but practical, Indigenous and local knowledge.
- Resource users' connections with estuarine fisheries are complex, multidimensional and often overlap to the extent that understanding users goes beyond the simplified motivations of subsistence or recreation.
- Socio-economic inequalities and apartheid legacy issues continue to exclude certain users from equitable estuary access and use. Estuary management needs to recognize and understand these complicated dynamics in order to better respond to resource use challenges.
- Structural racism within government institutions and society more broadly, continues to constrain estuarine management measures and sometimes leads to marginalisation and exclusion of certain individuals and communities.
- It is at times challenging for local estuarine managers to fulfil their mandates due to limited capacity, executive sponsorship, leadership and poor communication from superiors.
- There is a lack of realistic opportunities and support from authorities for estuarine users to engage meaningfully in the management process. Users feel side-lined, which erodes confidence in government and management interventions and processes.
- The strong cultural connections that users have to estuaries must be acknowledged, understood and viewed holistically with other uses in order to better inform management.
- Social science data fails to inform estuarine management processes and policy due to limited capacity and knowledge flow structures to integrate such data.
- There are limited governance structures and capacity to engage stakeholders in a meaningful and inclusive way, which can result in increased social tensions rather than shared knowledge, trust and stewardship of estuaries.
- Meaningful and inclusive stakeholder engagement is hampered by bureaucracy and ineffective knowledge flow structures, leading to social tensions, lack of knowledge sharing and the inability of estuarine fisheries users being able to contribute to the management process.

Table 6.2. Summary of findings and examples of evidence from data.

Theme	Description	Examples of evidence from data	Source of data	Research Participant(s)
1. Estuarine fisheries management informed primarily by scientific knowledge (over other knowledge systems)	Estuarine fisheries systems, as complex social-ecological systems, require a consistent integration of different knowledge systems and knowledge holders to manage them effectively, adaptively and sustainably including not only scientific knowledge but practical, Indigenous and local knowledge.	Nonyane, C. L. 2020; Hartmann 2021; Strand et al. 2022a	Nonyane, C. L. 2020; Hartmann 2021; Strand et al. 2022a;	Desktop study
2. Overlapping estuarine resource users and uses	Estuarine resource users and different uses often overlap, and people's connections to the fisheries are more complicated and multidimensional than the simplified understandings of fishers' motivations as either subsistence, livelihood or recreation	Categories of use identified included: Spiritual; Recreation/Fun; Peace/Calm/Escape; Livelihoods; Learning/Knowledge; Future and past uses; Disconnections/lack of access	Participatory community mapping workshops	2 x Cannonville; 1 x Colchester; 2 x South End; 1 x Blue Water Bay/Motherwell; 1 x Amsterdamhoek; Summerstrand; 1 x Kariega; 1 x online;
3. Socio-economic disparities and inequalities result in lack of access to and exclusion from estuary areas	Socio-economic inequalities and apartheid legacy issues continue to exclude certain users from equitable estuary access and use. Estuary management needs to recognise and understand these complicated dynamics in order to better respond to resource use challenges.	<i>God created the ocean and it would be nice if everybody could have access to the ocean. I feel like it is not fair that they ask money at the gate because every human being is supposed to be part of this.</i>	Digital storytelling	Local community member living adjacent to Sundays (2021)
4. Historical and continued structural and societal racism	Structural racism within government institutions and society broadly, continues to constrain estuarine management measures and leads to marginalisation and exclusion of certain individuals and communities.	<i>“And I'm being frank with you now, being a white male, going to a group of, say black harvesters or traditional healers collecting stuff turns upside down into such a massive racial thing and it's certainly not our intention whatsoever”.</i> <i>“Who in the community do you engage with and then they'd say, the ratepayers association and the diving club and this lifesaving club and this hockey club and whatever. And I say those only represent the white community...”</i>	In-depth semi-structured interview; Workshops	Local municipal official # 4 (2021) and NGO/MPA expert # 8 (2021)

		<p><i>“He said to me, that, now all through the last two years, he knows about SAMPAN [the South African Marine Protected Area Network] we were going to set up. He’s been informed and I’ve told him about the project. And this is the project with community working and the MPA [Marine Protected Area]. Yeah, he says to me, ‘As, as long as your white boss deals with my white boss, I will sabotage SAMPAN’”.</i></p> <p><i>“It’s politics... it’s destroying South Africa. It’s separating people, it’s keeping racism alive”.</i></p>		
5. Local management under-capacitated and limited support from high level government	It is challenging for local estuarine managers to fulfil their mandates due to limited capacity, support, leadership and poor communication from superiors	<p><i>“Last year August the MPA was proclaimed, the larger MPA and the, it actually increased 16 times by, from 7 000 hectares around Bird Island to 114 000 hectares but ...Our staff complement was not increased, you know. So that has put us under pressure”</i></p> <p><i>“Because it hasn’t been properly communicated down to the guys, that that’s got a job to do, and are sometimes too afraid to do it because they don’t know what’s going on”.</i></p>	In-depth semi-structured interview	National coastal authority # 10 (2020) and local government official #5 (2021)
6. Limited local stewardship opportunities	There is a lack of realistic opportunities and support from authorities for estuarine users to engage meaningfully in management processes. Users feel sidelined, which erodes confidence in government and management interventions.	<p><i>“Because it’s your livelihood, you have to live for now. Because the bread on the table, you need to pay your vessel, whatever. The focus is now for survival. And the focus is not long term. And unfortunately, with marine conservation, we need to have a long term focus. Fish species live for 20 to 30 years, you have their long term focus. And if you only focus on now and what’s happening tomorrow, I think that long term goal gets lost. And I don’t know if local communities at this point or have the capability or have been shown the way to do it, and to focus on. So if we were to</i></p>	In-depth semi-structured interview	National coastal authority # 1 (2021) and local community member (2021)

		<p><i>explore this [co-management approaches], we would definitely have to have some capacitation of understanding how the system works, how the biology works, and what it means to manage and what the objectives of that are”.</i></p> <p><i>“The problem that we are facing is that the river is being polluted and it is really affecting us in our community in Alocs further up the river. But they don't listen to us that side (...) It's been an ongoing battle (...) They are not even trying to make a plan with the polluted water coming from the Markman side not to enter into the river”</i></p>		
7. Limited understanding of cultural connections and overlapping benefits of estuaries	The strong cultural connections that users have to estuaries must be acknowledged, understood and viewed holistically with other uses in order to better inform management.	<p><i>“This is a beautiful place to come to take out bait. To come and fish, and to sit with your family. By coming here you meditate. It is stress free. It is a safe zone”</i></p> <p><i>“When you're stressed out you just come and sit here. It makes me feel so calm. When you go back you can face the world again. In every Khoisan there is that. If you take them to the ocean they just feel better.”</i></p> <p><i>“This area is where I use to pray all the time when I go through hard times. I pray here because it's very quiet. It's nice.”</i></p> <p><i>“The feeling of being by the ocean is indescribable. It is not the same as how you feel in the community. You feel at peace. You feel really phenomenal. I would like it if more people from my community could have that experience and feeling.”</i></p>	Digital storytelling	Local community member living adjacent to the Swartkops (2021), Indigenous community member (2021), local community member living adjacent to Swartkops (2021), and local community member living adjacent to Sundays (2021).
8. Limited government capacity and knowledge flow structures to incorporate social science	Social science data fails to inform estuarine management processes and policy due to limited capacity and knowledge flow structures to integrate this data.	<i>“...but I think there's one or two social scientists in the Garden Route. But we don't have someone dedicated to Addo, and certainly no one in the</i>	In-depth semi-structured interview	National coastal authority # 1 (2021) and national government official # 6

		<p><i>marine field. So we rely heavily on people from outside in most parks”</i></p> <p><i>“we wouldn't have the capacity to go and collect those things [social science data], by ourselves”</i></p> <p><i>“But it's difficult. When you don't have the backup, you don't have the resources, you want to help members of the public, but then you are seen as an individual George Branford are seen as the person not doing the job”.</i></p>		(2021) and local coastal authority #4
9. Breakdown in cooperative governance and limited structures for meaningful stakeholder engagement	Limited governance structures and capacity to engage stakeholders in a meaningful and inclusive way, which can result in increased social tensions rather than shared knowledge, trust and stewardship of estuaries.	<p>“And then the one guy in the meeting said where was this meeting advertised. They said no it was advertised in the report in the Sunday Times and it was in a local library. So the guy said I fish, I don't have time to go to the library. The library's closed when I come home for fishing, and Sunday Times and I don't even have money for bread. How can I buy Sunday Times? No, it says just little things that sometimes are big little for the communities to get involved, to be inclusive”.</p>	In-depth semi-structured interview	NGO/MPA expert # 8 (2021)
10. Ineffective knowledge flow structures between high level government and resource users	Poor communication, ineffective knowledge flow structures and bureaucracy means that end users are not always informed, resulting in them being unable to contribute meaningfully to estuarine management processes.	<p><i>“I don't have a lot of information on having the community being the ones presenting to us, you know, what they are doing? That would definitely be interesting”</i></p> <p><i>“And it wouldn't be me dealing directly with the fishing communities, or any of them local experts, if you want to call them that”</i></p> <p><i>“We have found that most officials in other departments are constrained to their offices. So they are very well informed administratively. But on grassroots levels practically... They don't understand the challenges”</i></p>	In-depth semi-structured interview	National government official # 3 And local government official # 4 (2021)



7.1 Background

Integrated Estuary Management in South Africa is a concept that has evolved out of necessity. In the not-so-distant past, government departments would for the most part operate in isolation management being somewhat prescriptive. This top-down approach often neglected to include contributions from the end users at a time when the ideals of co-management in South Africa were in their infancy and cooperative governance was a concept referred to in policy and law but rarely practised (Van Niekerk and Taljaard 2003; Taljaard et al. 2019).

The realisation that estuaries are complex systems linked to and affected by catchment and land-use activities, the coastal and marine environment, and human needs and activities, gave rise to the National Estuarine Management Protocol (the Protocol) via the National Environmental Management: Integrated Coastal Management Act. The Protocol prescribes “the need for strategic interventions across multiple sectors to restore estuarine health and protect benefits to people”, and calls for a co-management approach and effective cooperative governance. This integrated approach is facilitated by guidelines and minimum requirements in the Protocol for the development and implementation of estuary management plans.

The effectiveness of any management plan, however, depends on how well it is informed by a range of knowledge systems. Historically, management has mostly been based on scientific knowledge. However, holistic, ecosystem-based management can only be applied once Indigenous, local and practitioners’ knowledge systems are incorporated. A solid knowledge base provides for evidence-based decision-making, and perhaps more importantly allows for flexibility via adaptive management as more knowledge becomes available or situations change. This is key as regime shifts such as climate change together with ever-increasing demands for resources and other anthropogenic impacts require constant re-evaluation of management objectives and their implementation.

Therefore, the perceptions of role players with regards to current strengths and weaknesses of, and solutions to, estuarine management in general and estuarine fisheries in particular, were considered to be of key importance in laying the foundation for developing knowledge-based adaptive management recommendations.

7.2 Materials and methods

During the latter half of 2021, four virtual workshops (25 August, 7 and 27 September, and 10 December) were held via Zoom with 36 stakeholders representing local, provincial and national government, management authorities, non-governmental organisations, management forums, conservancies, consultants and researchers. Two face-to-face meetings (8 October and 6 December) were held with authorities who could not attend the scheduled virtual workshops and the outcomes combined with those from the workshops. Interviews were conducted with two tourism operators on the Kowie Estuary (8 November), nine subsistence fishers from the Kowie and Great Fish estuaries (26 October and 24 and 29 November) and 60 recreational anglers from the Kowie and Great Fish estuaries (11 and 27 December). The aim of these interactions was to obtain knowledge from a wide range of stakeholders with regards the challenges, enablers and solutions to both estuary and estuarine fisheries management. Basic economic data were also collected from the subsistence fishers that were interviewed.

The key question presented to all participants was:

“What are your experiences, insights and challenges in managing South African estuaries in general and estuarine fisheries in particular?”

With the exception of one workshop (see below), all participants were asked to provide insights based on three sub-component questions, namely:

What are the challenges for estuary management and estuarine fisheries management?
 What are the enablers for successful estuary management and estuarine fisheries management?
 What are the potential levers for change to address challenges, which could lead to more successful estuarine management and estuarine fisheries management?

During the first workshop, participants were also asked to provide examples (case studies) of failed and successful estuary management plans and the reasons behind these.

The second workshop, aimed primarily at provincial authorities, was structured slightly differently. The key question remained the same, but the sub-component questions were changed to reflect the original Terms of Reference for this component, namely:

What are the bottlenecks associated with estuary management?
 What are the knowledge gaps in terms of estuary management?
 What are the action gaps in terms of estuary management?
 What are the key research questions that needs to be answered (to improve knowledge for addressing bottlenecks and gaps?)

What management measures are required to secure the future of estuarine fisheries?

In this instance, bottlenecks were regarded as challenges, while action gaps and management measures were regarded as enablers and levers for change respectively.

The levers for change represent the views of role-players from these engagements as well as the opinions of the project team based on the outcomes of the other project components detailed in chapters 5 and 6 and their collective experience in terms of estuarine research and management.

7.3 Findings

The relationship (linkages) between the dominant challenges (Figure 7.1; Table 7.1) demonstrates that estuaries need to be managed as complex socio-ecological systems within an effective cooperative governance framework.

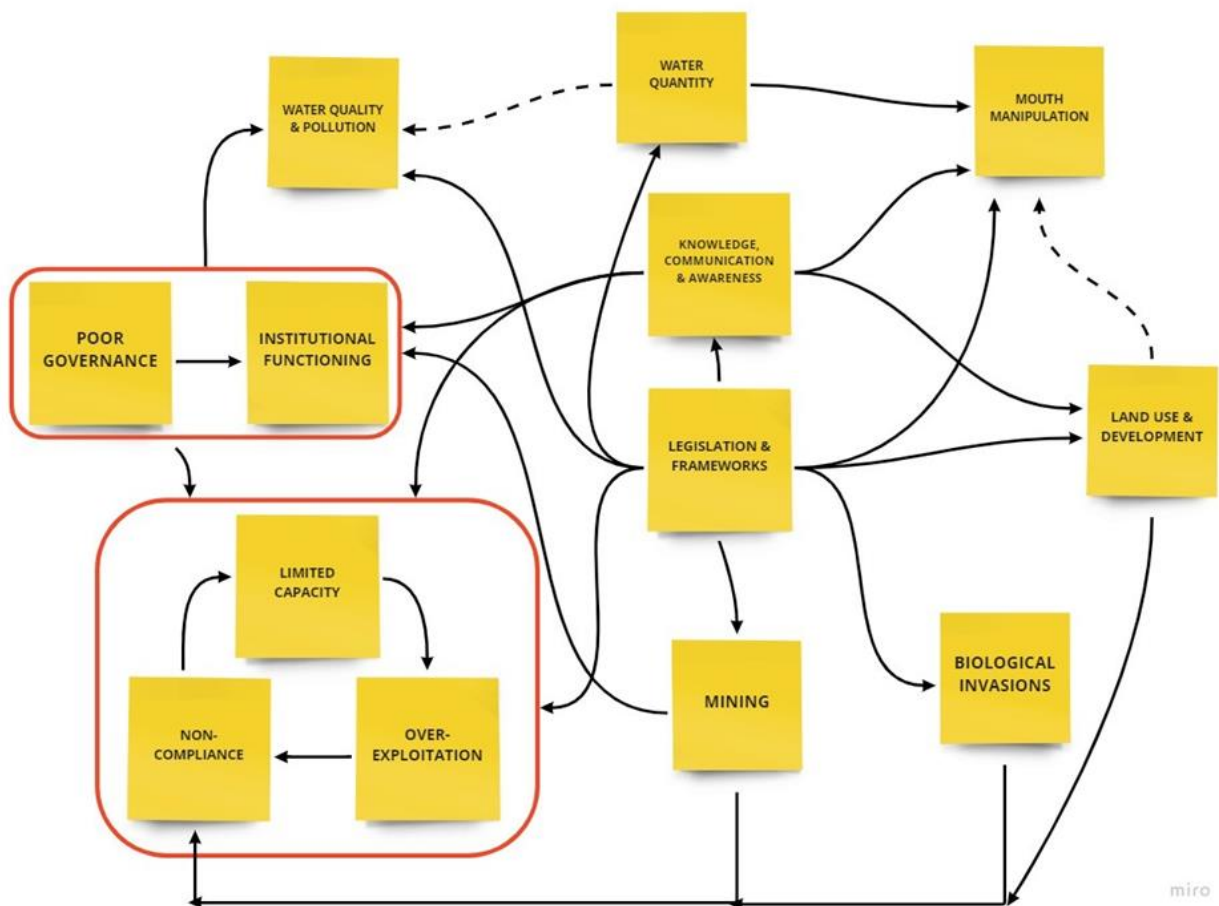


Figure 7.1. Relationships and linkages between the dominant challenges. Challenges that are inexorably linked and have a close causal relationship are grouped together.

The failure to implement mandates by any one government department results in a breakdown of one or more links (Figure 7.1), potentially creating a cascading effect that will have negative consequences in terms of estuarine functioning and ultimately societal well-being that is derived from provisional and cultural estuarine goods and services.

The categorised challenges, enablers and levers for change for all role player engagements combined are provided in Table 7.1. The key challenges, enablers and levers for change identified by participants all include the categories of capacity, enforcement and compliance, effective governance, institutional functioning, knowledge, awareness and communication, legislation/frameworks, and water quality. All of these impact on estuarine fisheries to some degree, however, the main challenge in the context of this project remains the decline of fish and bait stocks due to overexploitation, which includes illicit activities. Common key enablers and levers for change include estuary management plans (simple, clear and concise), but their efficacy relies on them being implementable. In addition, the right people in the right place (champions) and greater levels of protection were also viewed as important. A common challenge and lever for change was the category of water quantity (environmental flows or ecological reserve; Table 7.1).

Table 7.1. Categories for challenges, enablers and levers for change identified by stakeholders for all interactions combined (blue text) indicates dominant or key categories that either elicited the most responses/insights from participants or are highlighted in the National Biodiversity Assessment - Estuarine Realm).

CHALLENGES
Limited capacity; non-compliance; working in silos/lack of effective governance; institutional functioning; knowledge, awareness and communication; mining (habitat destruction, sedimentation & turbidity, noise pollution); legislation/frameworks; water quality/pollution; water quantity; mouth manipulation; biological invasions; declining fish and bait stocks/over-exploitation; habitat loss; societal issues; management approach; climate change; judicial process; disease; ecosystem/habitat connectivity; science-to-policy; access; user-conflict
ENABLERS
Capacity; enforcement; governance; institutional functioning; knowledge, awareness and communication; EMPs; legislation/frameworks; champions; water quality; protection; responsible land-use; societal issues; economic value
LEVERS FOR CHANGE
Capacity; enforcement and compliance; effective governance; institutional functioning; knowledge, awareness and communication; EMPs (includes clustering similar systems; alternative approaches in absence of EMPs); legislation/frameworks; champions; water flow/quantity/quality; protection; societal issues; management approach; determine economic value; judicial process; prioritise funding; reduce user-conflict; alternative livelihoods (reduce pressure on resources); improve public access; regulation/control of biological invasive species; improve/maintain infrastructure

The key pressures (challenges) for estuaries identified in the Estuarine Realm Technical Report of the 2018 National Biodiversity Assessment (NBA; van Niekerk et al. 2019), namely flow modification, pollution, over-exploitation of resources, land-use and development, mouth manipulation and biological invasions (plant and animal) were all raised by participants and are also highlighted in Table 7.1. In addition, mining is identified in the NBA as a rapidly emerging key pressure and was discussed in detail during the workshop with National authorities and the National Estuaries Task Team. Although land-use and development within the Estuarine Functional Zone was not specifically raised as a challenge during the workshops, it is linked to other challenges such as habitat loss, water quality and estuary mouth manipulation.

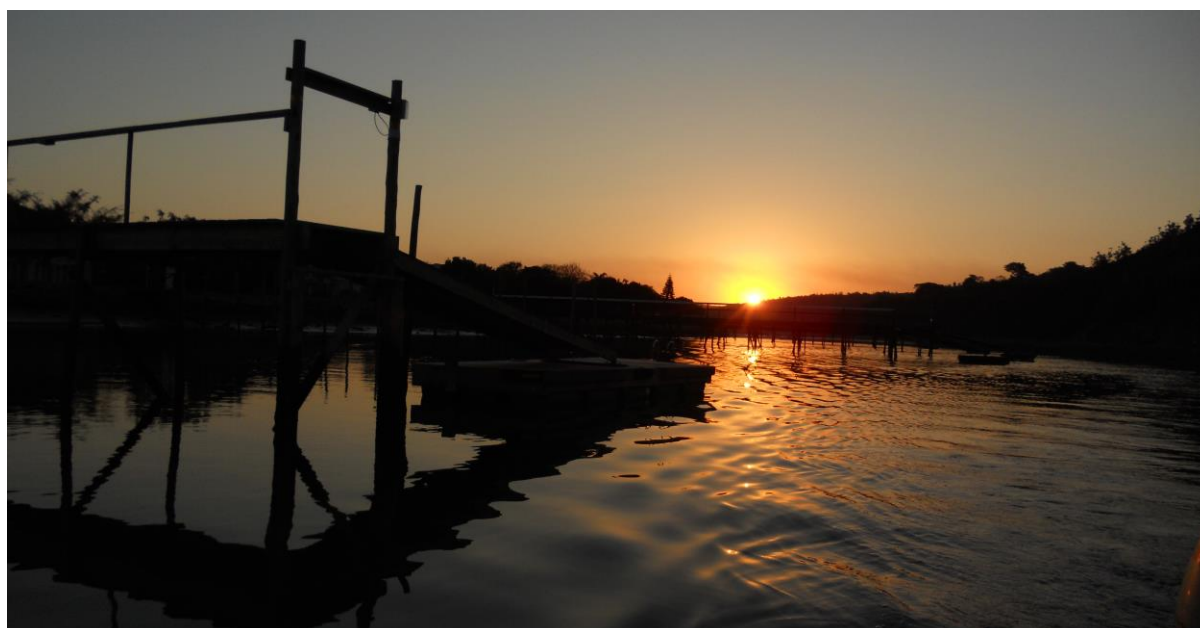
The collated levers for change, presented as management recommendations for either one or more of the dominant challenges are presented in Chapter 9 and Appendix 11.3 of this report.

7.4 Lessons learned

- South Africa has good legislation related to estuary and fisheries management, but a combination of limited capacity (manpower, infrastructure, funding, knowledge) and poor governance (includes poor cooperative governance) mean that mandates and responsibilities are not fulfilled to their full potential.
- Non-compliance or lack of self-regulation across the board erodes management efforts.
- Estuary management plans (EMPs) are an essential enabler and provide a legally binding framework that facilitates cooperative governance to achieve the management of estuaries as complex socio-ecological systems. They should be simple, clear and concise and indicate the What, Who, Where, When and How of estuary issues and management interventions. As a lever for change, EMPs should be developed for priority systems identified in the National Biodiversity Assessment - Estuarine Realm (NBA), and small rural systems with similar characteristics (physical, functional and socio-economic) can be clustered. In the absence of EMPs, protection of the Estuarine Functional Zone (EFZ) via the Environmental Impact Assessment (EIA) process and the use of tools such as the NBA to classify estuaries as Critical Biodiversity Areas or Critically Endangered Ecosystems, will reduce the threat to health and functioning.
- The identification and appointment of key driven people in key positions (champions) is needed to prioritise and implement estuary management efforts.
- Estuaries are complex systems and management interventions and research needs to adopt an integrated socio-ecological systems approach that takes connectivity (catchment to coast), ecological and biological interactions, and socio-cultural-economic values into account.
- Indigenous and local knowledge systems are under-utilised in developing knowledge-based management actions and this leads to the exclusion of communities and end users with the result that trust in government and management authorities is undermined.
- Weak institutional functioning resulting from governance challenges and limited capacity means estuary management is not prioritised, there is a lack of institutional memory, bureaucratic delays hamper management efforts and management bodies such as Estuary Management Forums and Coastal Committees are neither representative nor functioning optimally. Key to resolving this is the appointment of champions in key positions, the recognition of the socio-economic importance of estuaries and representative participation in management.
- Poor understanding of the importance of estuaries to biodiversity and, more importantly, to social well-being, means that management is not prioritised. Raising awareness amongst all role players via two-way communication and the integration of knowledge from all knowledge systems could help focus government efforts to manage estuaries and encourage compliance amongst end users.
- The impact of mining activities needs to be assessed and the environmental authorisation process revisited.

- Impacts from land-use and development, including mining, urban development, infrastructure and agricultural practices can be reduced by formal recognition of the expanded EFZ proposed in the NBA and strict application of the EIA process in the zone.
- Compliance with regulations and standards for improved water quality is essential. The reduction of contaminated agricultural return flows and discharges from waste-water treatment works alone will go a long way in improving the situation.
- The development and implementation of Resource Directed Measures for the NBA-prioritised estuaries should be a priority.
- Estuary mouth manipulation may only be done after authorisation of Mouth Management & Maintenance Plans, or under emergency situations. Making the EFZ a no-go area in terms of land-use and development would preclude the necessity or frequency of artificial breaching.
- Despite the pending kob species and estuary night-fishing ban, more stringent regulations for key line fish species are needed in combination with formal protected areas and no-take zones, established through meaningful stakeholder engagement processes. However, the efficacy of these actions is reliant on enforcement, for which there is limited capacity, and compliance or self-regulation by end users, which is also in short supply.
- The extent of the impact of biological invasions needs to be brought to the attention of authorities so eradication measures can be implemented, and the aquaculture industry and aquarium trade must be better regulated.
- Thirteen management themes that encompass the levers for change to address the dominant challenges were identified, namely increase capacity to govern, improved compliance, effective governance, institutional functioning, enhanced knowledge sharing and communication, reducing impact of mining, amendment and improved implementation of legislation and frameworks, improved water quality and decreased pollution, water quantity, mouth manipulation, sustainable resource use, responsible land-use and development, and control of invasive species.

The sun goes down on the lower reaches of the Kowie Estuary. © Taryn Murray





8

Conclusions

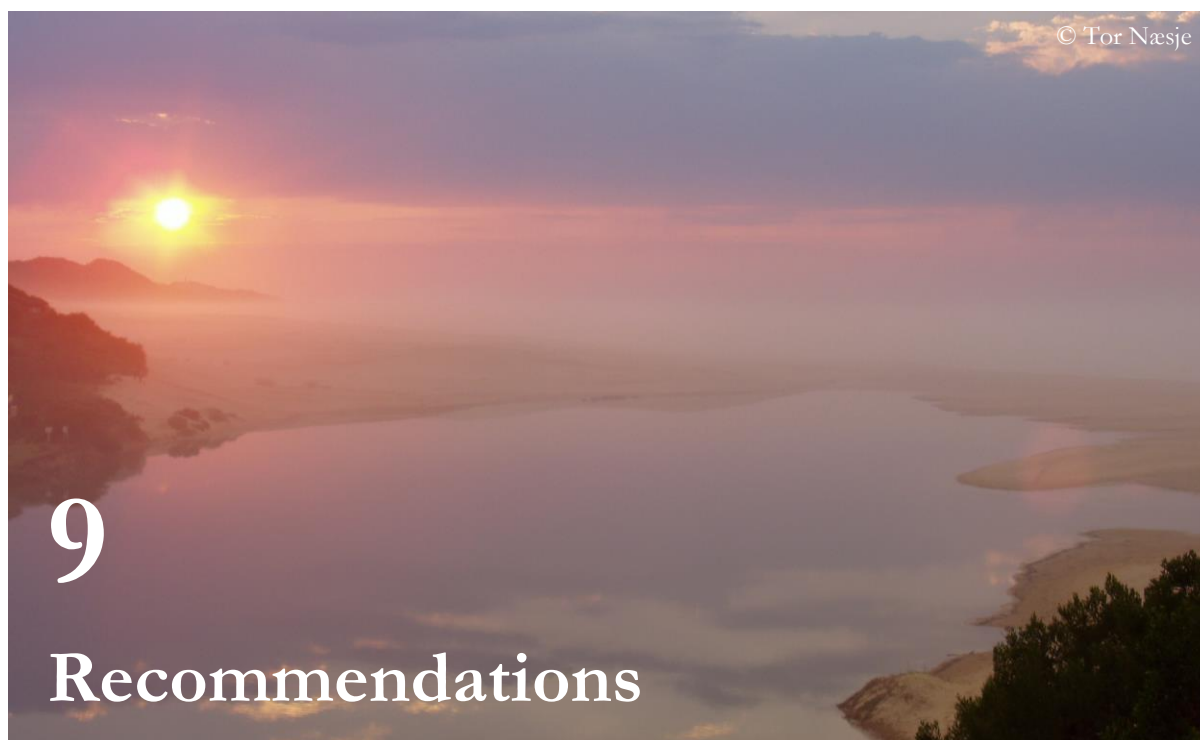
Estuarine fisheries cannot be managed in isolation by only taking the resource and fishers into account.

Estuaries must be co-managed as socio-ecological systems that have critical linkages from their catchment areas to the marine environment. A holistic approach to management, supported by multi-disciplinary research that is inclusive of all knowledge systems, is the only way to improve estuarine functioning and allow for the sustainable provision of goods and services.

To this end, this research has highlighted several key areas that need to be addressed to improve management of estuaries and their resources:

- Consistent integration of scientific, practical, Indigenous and local knowledge systems and knowledge holders for an improved understanding of complex social-ecological estuarine ecosystems.
- Improved management and law enforcement through capacity development, integration of all stakeholder groups, increased financial resources and funding at all levels of governance.
- Strengthen current cooperative governance processes, including policy and legislative coherence to ensure a co-ordinated approach to estuary management.
- All stakeholders need to recognise and understand the complicated dynamics of socio-economic inequalities and apartheid legacy issues that continue to marginalise and exclude certain individuals and communities from equitable access to estuaries and their resources to enable a better response to resource use challenges.
- Stakeholder processes, methodologies and pathways need to be addressed to allow for users to contribute meaningfully to management processes and stewardship of estuaries. This will reduce tensions and conflict and build trust.
- Inclusion and acknowledgement of multiple benefits and services in fisheries management within estuaries is essential. This would include cultural benefits and health.

- Manage and restore vital ecosystem functions through addressing water quality and quantity as a main driver. This could include wastewater treatment management and ecosystem restoration.
- Build capacity for research integration in estuarine management to adequately address and manage estuaries as complex socio-ecological systems.
- Effective implementation of the proposed new fisheries regulations and the establishment of estuary protected areas, in close collaboration with estuarine stakeholders, with linkages to the marine environment is essential for sustainable estuarine fisheries.
- Scenario planning and adaptive management approaches to address emerging serious threats to estuarine functioning posed by mining activities, both legal and illegal, and alien and invasive species.
- Ensure the development and implementation of estuary management plans, which provides a vital tool for facilitating the integrated management of estuaries as socio-ecological systems.
- A significant opportunity to enhance the protection of estuaries and their resources is provided in the proposed expanded Estuarine Functional Zone detailed in the 2018 *National Biodiversity Assessment - Estuarine Realm*.



9.1 Introduction

In terms of the National Development Plan 2030 (National Planning Commission 2012; NDP), policy change, amendments to existing legislation and implementation of mandates to ensure effective and holistic estuary management and sustainable estuarine fisheries will contribute to several of the NDP enabling milestones. This includes increasing employment opportunities, establishing a competitive base of human resources and regulatory frameworks, ensuring household food and nutrition security, realising a developmental, capable and ethical state that treats citizens with dignity, and broadening social cohesion and unity while redressing the inequities of the past. Several of the NDP focus areas will be addressed through policy and legislation that ensures sustainable estuarine fisheries, namely:

- Environmental sustainability and resilience – including environmentally sustainable and climate change resilient development.
- Inclusive rural economy – includes food security.
- Social protection - addresses poverty induced hunger and malnutrition; promotes self-reliant sustainable development amongst individuals, households and communities; and also addresses unemployment.
- Building a capable and developmental state – includes skills development (competent staff – required to implement/enforce policy) and a proactive approach to coordinate activities between tiers of government (cooperative governance with respect to estuary management).
- Nation building and social cohesion – includes improving public spaces (estuaries) and ensuring an equitable society (equal access to estuaries and resources).

9.2 Project recommendations

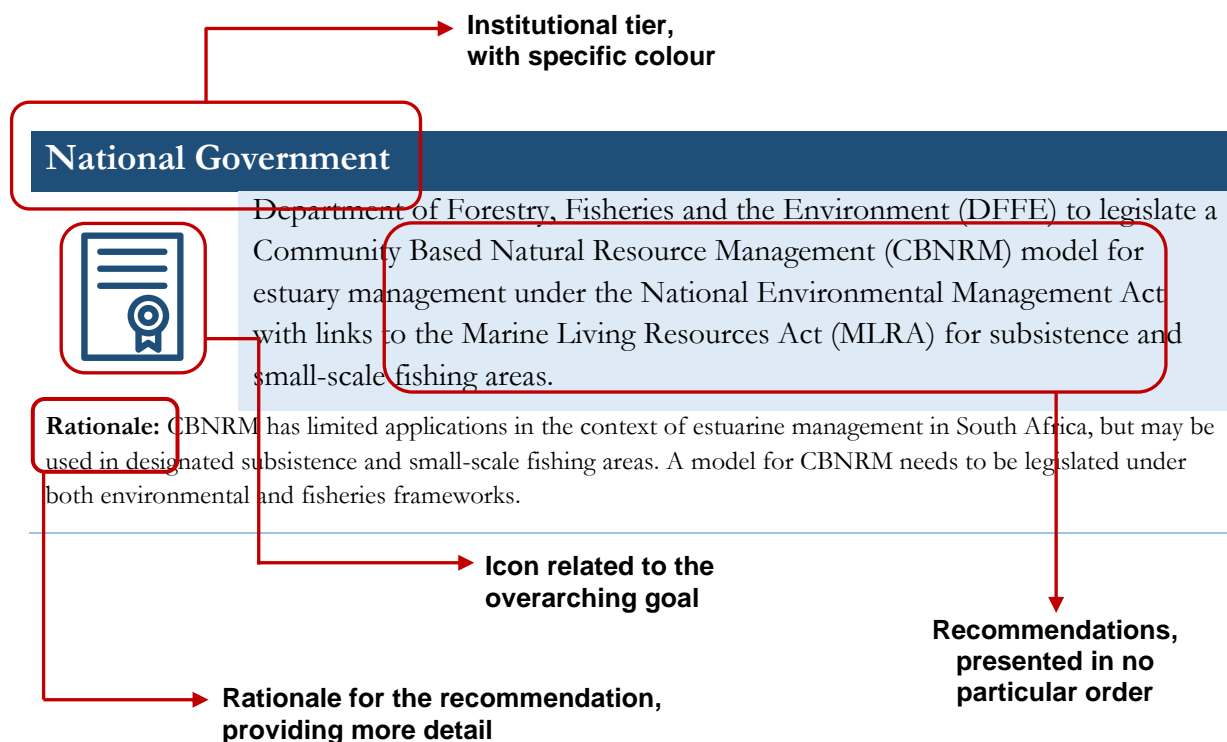
The detailed analysis of all levers for change for the primary challenges identified by this interdisciplinary project and experts' opinions have allowed for the development of the following recommendations. Recommendations have been classified as either **actionable** (i.e., realistically implementable), or unachievable under the current governance regime and requiring **systemic change** before they can be realistically considered, or requiring **behavioural change** by one or more role players. The priority actionable recommendations as identified by the project team are listed below and are separated according to the entities responsible for their implementation. The entities are national, provincial and local government, all tiers of government (co-responsibility), research institutions, civil society and multiple roleplayers (combination of two or more of the previously mentioned entities). The remaining actionable recommendations not considered to be an immediate priority, together with those requiring either systemic or behavioural change, are provided in Appendix 11.3. Each recommendation, both in this chapter and in Appendix 11.3, is accompanied by the applicable themes identified in Chapter 7 and the rationale behind each one.

The sun sets over the Swartvlei Estuary, Western Cape. © Taryn Murray



How to decipher the recommendations

Each recommendation comes with a rationale, which is presented under each recommendation. Each recommendation also aligns with one or more overarching goal(s). The icon presented to the left of each recommendation refers to a specific overarching goal, of which there are 10, presented below. The various institutional tiers (e.g. national, provincial or local government, etc.) are identified by different colours.



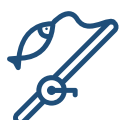
9.2.1 Priority actionable recommendations

National Government (1/3)



Department of Forestry, Fisheries and the Environment (DFFE) to legislate a Community Based Natural Resource Management (CBNRM) model for estuary management under the National Environmental Management Act with links to the Marine Living Resources Act (MLRA) for subsistence and small-scale fishing areas.

Rationale: CBNRM has limited applications in the context of estuarine management in South Africa, but may be used in designated subsistence and small-scale fishing areas. A model for CBNRM needs to be legislated under both environmental and fisheries frameworks.



Revise estuarine fisheries management regulations of an estuary-specific basis, with a focus on the various fisheries and fish resources as a part of estuary management plans.

Rationale: Estuary-specific regulations may be required based on the dynamics of the fishery (multiple user-groups with different motivations and requirements) and the fish resources present; fish behaviour in individual estuaries in terms of estuary use during juvenile and/or adult life-history phases may require tailor-made management approaches, such as closed seasons or closed areas.



Enhance the Environmental Impact Assessment (EIA) process to specify in-depth socio-economic, cultural and environmental evaluation aspects through thorough, timely, vernacular and meaningful stakeholder engagements.

Rationale: The public participation process within the EIA framework needs to take into consideration the diversity of stakeholders and the value of Indigenous and local knowledge so that their involvement can provide a meaningful contribution to the process.



The DFFE to recognise a category for subsistence fishers so they can be individually licenced and compliant.

Rationale: Many indigent fishers do not identify with being called small-scale fishers but instead consider themselves to be subsistence as it reflects their past and present cultural identity. The policy for the small-scale fisheries sector and MLRA needs to be amended to recognise, and therefore decriminalise, a subsistence sector that is not required to be a part of a cooperative, but is instead licenced to operate as an individual to fulfil basic livelihood needs. Although the MLRA no longer recognises the term subsistence, and has substituted it in favour of the term small-scale, the 2022 Draft White Paper on the Conservation and Sustainable Use of South Africa's Biodiversity (the White Paper) specifically refers to both subsistence and small-scale fishing. Whether this a prelude to recognising subsistence fishers and fishing as a valid sector, or a clerical error, is not known. The White Paper further refers to sustainable development that "ensures equitable access to environmental resources, benefits and services to meet basic human needs (...) and special measures must ensure access thereto by categories of persons disadvantaged by unfair discrimination". The recognition of a subsistence fishing sector would qualify this guiding principle.

National Government (2/3)



Functioning and representative Coastal Committees and Estuary Management Forums (EMFs) to facilitate cooperative governance; the DFFE to amend the National Estuarine Management Protocol (the Protocol) to improve and clarify the definition of what equitable representation at local and provincial level should be as well as provide guidelines.

Rationale: Coastal Committees and EMFs provide the institutional framework for cooperative governance. However, effective cooperative governance relies on equitable representation, particularly at the local and provincial level. DFFE needs to amend the Protocol to indicate what is meant by equitable representation and provide guidelines on how this can be achieved.



The DFFE to develop and implement a dynamic socio-cultural-economic value framework for ecosystem goods and services that can be applied to specific contexts as part of a socio-ecological systems (SES) approach to estuary management.

Rationale: An SES approach to estuary management means that the socio-cultural-economic value of goods and services need to be assessed and taken into account. A standardised framework for determining these values needs to be developed and incorporated into the Protocol that guides estuary management plan development.



The DFFE to revisit the Terms of Reference for honorary fisheries control officers (HFCOs) in terms of empowering them to enforce the MLRA, and to provide free training to candidate HFCOs.

Rationale: This addresses the limited capacity within DFFE in terms of enforcing the MLRA fishing regulations and will contribute to increased levels of compliance. The free training will enable members of civil society with limited means to be appointed as HFCOs.



The DFFE, in cooperation with the South African National Biodiversity Institute must use strategic documents such as the National Biodiversity Assessment, National Biodiversity Framework and National Protected Area Expansion Strategy, together with fisheries research, to increase the level of protection, in the form of estuarine and marine protected areas, co-developed in an inclusive manner and declared under the provisions of the National Environmental Management: Protected Areas Act.

Rationale: Current fisheries regulations together with limited capacity to enforce them, high levels of non-compliance and illegal netting have done little to stem the decline of fisheries species. Protected areas afford an opportunity to drastically reduce fishing effort and are easier to manage than open access areas provided management authorities have the capacity and commitment. Links with the marine environment and adjacent marine protected areas will be more beneficial as it will account for multiple life-history stages and movement behaviour of fish. The White Paper recognises that better practises, such as a representative system of protected (and conservation) areas that are effectively and efficiently managed, are needed to rebuild depleted stocks of priority fish species. The White Paper further re-imagines the role of protected areas from one of pure biodiversity protection through exclusion to one that contributes to ecologically sustainable use and inclusive rural socio-economic development. The process for declaring a protected area and developing a management plan must be done with the full participation of all roleplayers and incorporate all knowledge systems, including Indigenous and local knowledge.

National Government (3/3)



Protect the National Biodiversity Assessment (Estuarine Realm; NBA) proposed expanded Estuarine Functional Zone (EFZ) in terms of land-use and activities via the EIA process and spatial planning and development frameworks, and elevate the importance of estuaries in the EIA process.

Rationale: Protection of the proposed expanded EFZ by regulating all activities via the EIA process and using the EFZ to inform Integrated Development Plans (IDPs) and Spatial Development Frameworks (SDFs) will reduce impacts on estuarine functioning and the need for mouth manipulation to protect infrastructure, livelihoods and human life. Gazetting the new EFZ in the Integrated Coastal Management Act (ICMA), National Water Act, National Environmental Management Act, and Spatial Planning and Land Use Management Act is required. The importance of estuaries in the EIA process needs to be elevated, and listed activities triggering an EIA within the EFZ need to be specified in the EIA Regulations. These measures will also afford protection to systems which do not yet have estuary management plans. The White Paper addresses this issue under the Goal of Responsible Sustainable Use, which calls for the integration of biodiversity conservation and ecological integrity into land use and planning and implementation.



Ensure future versions of the NBA recognise, highlight and integrate Indigenous and local knowledge systems (ILKS) and the social importance and cultural significance of estuaries, rivers and coasts to inform management and decision-making.

Rationale: The 2018 NBA states that the next assessment will define and value the benefits society derives from estuaries in more detail. We recommend that the NBA also highlight the social importance and cultural significance of rivers, estuaries and the coast amongst the diverse user groups and the importance of all knowledge systems (including ILKS) in informing integrated holistic management. The White Paper uses the term Traditional or Indigenous Knowledge as defined by the Convention on Biological Diversity as “The knowledge, innovations and practises of indigenous and local communities embodying traditional lifestyles relevant for the conservation and sustainable use of biological diversity.” The White Paper further states that “decisions must take into account the interests, needs and values of all interested and affected parties, and this includes recognising all forms of knowledge, including traditional and ordinary knowledge.” It is assumed that the term “ordinary knowledge” refers to local knowledge and therefore the term ILKS used in this report encompasses all forms of knowledge alluded to in the White Paper.



National government departments involved in estuary management to allocate funding to employ stakeholder engagement practitioners and social scientists.

Rationale: The appointment of people with specialist skills and knowledge will improve government's capacity to carry out meaningful and inclusive stakeholder engagement processes and facilitate a better understanding of sustainability in the context of estuaries as social-ecological systems (need to understand aspects such as the diversity of users and overlapping uses in the context of fisheries management).



The DFFE to ensure equitable access to estuaries and their resources, with a focus on access through private property, by implementing the provisions of the ICMA.

Rationale: According to the ICMA, any natural person has the right to reasonable access to coastal public property. The DFFE needs to implement the relevant sections of ICMA to provide equitable access, with a focus on areas where access is denied across private property.

Provincial Government (1/1)



Develop a strong provincial management authority to drive the estuary management plan (EMP) process and functioning of the Provincial Coastal Committees (PCCs) to ensure authorities are held to account and mandates are fulfilled.

Rationale: The provincial departments of environmental affairs bear the procedural responsibility of developing and implementing the majority of EMPs. Currently these departments are staffed by committed and competent people but the task is overwhelming. The provinces need to motivate the national government for additional capacity by highlighting the importance of estuaries in terms of socio-economic value and biodiversity importance in the context of national priorities and livelihoods. Fully functioning PCCs, effectively the link between municipal coastal committees and the national coastal committee, are key to implementation and accountability.



Ensure effective and representative EMFs with links to Coastal Committees as they are key to facilitating cooperative governance and meaningful participation by local role players.

Rationale: Although the Protocol considers EMFs as informal advisory bodies that facilitate the implementation of an EMP, to most civil society stakeholders they are so much more. They provide the most convenient and realistic opportunity for meaningful participation in terms of EMP implementation. Provincial authorities need to ensure that EMFs are equitably representative, committed and competent and that their value to both municipal and provincial coastal committees is assured.



Reconstitute the KwaZulu-Natal PCC.

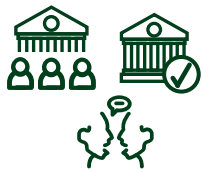
Rationale: Effective governance: The provincial authority in KwaZulu-Natal must reconstitute the PCC as a matter of urgency to facilitate cooperative and inclusive governance of estuaries in the province.

Local Government (1/1)



Estuary-related management issues at local government level to be prioritised in IDPs, SDFs and Coastal Management Programmes (CMPs) for funding allocation and planning.

Rationale: Improved compliance; Amendment and improved implementation of legislation and frameworks: Incorporation and prioritisation of estuary-specific management issues in frameworks such as municipal CMPs, IDPs and SDFs, will facilitate the allocation of resources (funding, manpower, infrastructure) and strategic planning to ensure appropriate land use and protection of the EFZ.



Local government to develop effective partnerships with research institutions, non-governmental organisations and community-based organisations to improve estuarine governance and awareness raising.

Rationale: Partnerships can alleviate capacity issues at local government level by providing knowledge for identifying management issues and solutions, assistance (manpower and funding) in implementing mandates and creating awareness through interaction with civil society.



Local government to encourage and protect 'Environmental Defenders' from local community backlash by providing them with agency and legitimacy, e.g. facilitate appointment as HFCOs.

Rationale: The appointment of members of civil society as HFCOs or honorary municipal environmental officers, facilitated by local authorities, can relieve capacity issues and provide a form of legitimacy amongst local communities and afford a degree of protection against community backlash.

All tiers of government (1/1)



Ensure meaningful input from all stakeholders towards the co-development of EMPs and the DFFE should amend the Protocol to stipulate that ILKS are used to inform the EMPs themselves and not just during the scoping phase.

Rationale: The Protocol mentions the need to engage the private sector and civil society in estuarine management, stipulates that private entities and non-governmental organisations can play a supporting role in developing EMPs, that local knowledge be considered during the scoping phase (situation assessment), and that all relevant stakeholders be actively engaged during EMP development and implementation. The Protocol also refers to the application of scientific evidence or information but is not clear whether this includes ILKS. Authorities responsible for developing EMPs must ensure that stakeholder involvement is meaningful throughout the process and ensure that civil society (and therefore ILKS) is equitably represented on local management forums and coastal committees and part of the decision-making process. The White Paper also speaks to this and recognises that sustainable conservation of biological resources is centred around the participation and involvement of all members of society.



Develop and implement more EMPs that are context-specific (estuaries managed as SES), collaborative, clear, simple and concise with regards objectives, issues and mandates and incorporate into planning or management frameworks.

Rationale: Provincial government is responsible for the development of most EMPs, however, depending on the location, national government or protected area management authorities may also be responsible. Estuaries must be managed as SES. This approach is fast gaining momentum within the research fraternity and is an integral part of the White Paper's Mission to "...maintain and/or restore ecological integrity, connectivity, processes and systems, with resulting ecosystem services providing transformative socio-economic development benefits...". The initial focus on more EMPs should be on all systems within protected areas and those listed as priority systems in the NBA. Once developed, EMPs must be approved and incorporated into CMPs, IDPs and Protected Area Management Plans that can allocate resources for implementation.



Strengthen the implementation of estuarine management within existing governance structures and frameworks.

Rationale: Implementation of estuarine management mandates across all tiers of government can be prioritised and strengthened through existing cooperative governance structures such as coastal committees and strategic planning frameworks such as CMPs and municipal IDPs that allocate resources such as manpower, funds and infrastructure.

Research Institutions (1/1)



Researchers and knowledge brokers to continue to raise awareness amongst the authorities, landowners, aquaculture industry and aquarium trade of the extent of the problem and severity of impacts related to invasive species.

Rationale: Knowledge on invasive species and their impact on estuarine functioning is identified as a critical knowledge gap in the NBA, which states that alien, extralimital or translocated fish are known to occur in 25 % of South Africa's estuaries. Researchers need to conduct a census (as per the NBA recommendation) of invasive species and determine their impact in terms of estuarine functioning and socio-economic benefits.



Institutions to empower researchers on how to get science/research findings included in policy.

Rationale: Management recommendations arising from research are seldom translated into policy or action. Institutions need to empower scientists in terms of procedures that will facilitate knowledge-based policy development or change.



Investigate the feasibility of CBNRM to alleviate capacity issues in government departments – limited application to subsistence and small-scale fishing areas.

Rationale: CBNRM has the potential to alleviate workloads in terms of implementing mandates and improving compliance and sustainable use through self-regulation, but the feasibility in the South African context needs to be investigated. Research needs to identify if local communities have the necessary knowledge, and if not, what would be required to empower them, identify champions or leaders within communities (not restricted to traditional leaders), whether government has the will to devolve power to community organisations while at the same time providing long-term support (funds and advice), and identify opportunities for CBNRM implementation (e.g., subsistence and small-scale fishing areas). The White Paper refers to an Other Effective Area-Based Conservation Measure and defines it according to the Convention on Biological Diversity as “A geographically defined area other than a Protected Area, which is governed or managed in ways that achieve positive and sustained long-term outcomes for the in-situ conservation of biodiversity, with associated ecosystem functions and services and where applicable, cultural, spiritual, socio-economic, and other locally relevant issues.” It does not elaborate on what is meant by “governed or managed in ways”, but this may allude to a CBNRM type approach, which would involve almost complete devolution of powers to the community level.

Multiple role-players

National government & research institutions



Institutions must freely share information from public funded research and monitoring programmes.

Rationale: Publicly funded research and monitoring programmes generate knowledge that can inform management and raise awareness amongst estuary users. Knowledge must be shared, in different languages and in formats catering to decision-makers, managers, fellow researchers and civil society on demand and without conditions (apart from publishing rights); existing platforms such as the National Oceans and Coastal Information Management System and the South African Estuary Information System are neither user friendly nor readily available, and should include an ILKS database as well. The directive and guidelines for this must come from the national government and be implemented by government departments and research institutions that generate the knowledge. The White Paper has highlighted this aspect under the Goal of Increased Capacity, where one of the components is "improving the understanding of biodiversity through conducting research, (...) establishing and maintaining monitoring systems, sharing information and incorporating traditional knowledge." This goal does, however, fall short in that it only refers to traditional knowledge and not ILKS.

National & provincial government



The Protocol must be amended to include spatial mapping of socio-cultural priorities and relations as a requirement for EMPs.

Rationale: National government must amend the Protocol to include spatial mapping of socio-cultural ecosystem services as recognised in the White Paper (but expanded to include religious and spiritual practises) as part of EMPs, and authorities responsible for implementing the Protocol (mostly Provincial authorities) must ensure this is done. This is crucial to the SES approach to management; for many managers, if something is not visual or tangible it doesn't exist and therefore can't be managed.

All tiers of government, research institutions & civil society



Actively include more knowledge co-creation opportunities (e.g. participatory research methods and participatory mapping) that can result in increased stewardship opportunities and sustainable resource use.

Rationale: Enhance knowledge sharing and communication; Sustainable resource use: Funding by government of programmes that involve, and therefore empower civil society with knowledge and a sense of responsibility and stewardship, such as monitoring and research projects, can contribute to sustainable use through increased awareness. Research institutions should be encouraged by the government, in terms of funding opportunities, to embrace citizen science or participatory research as a source of knowledge.

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Appendices

Appendix 11.1

SPECIES-SPECIFIC PUBLICATIONS

Dusky kob *Argyrosomus japonicus*

- Childs A-R. 2013. Estuarine-dependency and multiple habitat use by dusky kob *Argyrosomus japonicus* (Pisces: Sciaenidae). PhD thesis, Rhodes University, South Africa.
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- Næsje TF, Cowley PD, Diserud OH, Childs A-R, Kerwath SE, Thorstad EB. 2012. Riding the tide: estuarine movements of a sciaenid fish, *Argyrosomus japonicus*. *Marine Ecology Progress Series* 460: 221–232. doi: 10.3354/meps09780.

Spotted grunter *Pomadasys commersonnii*

- Childs A-R. 2005. Movement patterns of spotted grunter, *Pomadasys commersonnii* (Haemulidae), in a highly turbid South African estuary. MSc thesis, Rhodes University, South Africa.
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Leervis *Lichia amia*

- Murray TS. 2016. Estuary-dependency and multiple habitat connectivity of juvenile leervis *Lichia amia* (Pisces: Carangidae) and the factors influencing their movements. PhD thesis, Rhodes University, South Africa.

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White steenbras *Lithognathus lithognathus*

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Appendix 11.2

TRAVEL COST METHOD OF MEASURING ECONOMICS VALUE OF ESTUARIES

From regression analysis, we obtain a coefficient of travel costs providing the effect of daily travel costs on the number of trips one does per year.

From economic theory, a negative relationship is expected between costs per trip and the number of trips made by an estuary user. The smaller the effect of daily trip costs on the number of trips, the larger the Consumer Surplus (CS). Intuitively, CS is a measure of the economic benefit that consumers gain from consuming goods or services at current costs, yet they were happy to pay even more. People purchase goods at market price because they believe they have a higher value than their market price. This implies a higher CS presents room for additional charges like entrance fees, levies, and licences without significantly reducing use of estuary, or it shows that the consumer is prepared to incur additional costs to get the service- current costs to not deter. We compute CS as follows:

$$CS = - \frac{1}{\beta \cdot Daily_TripCost}$$

Where $\beta \cdot Daily_TripCost$ is the coefficient estimate of the effect of daily trip costs on the number of trips made.

The analysis aims to compare the identified parameters between the two estuaries; and at the end we also compare the estimates with those reported in similar studies (with monetary values updated to present).

Appendix 11.3

The tables below provide the actionable recommendations not regarded as being of immediate priority (i.e. those not listed in Chapter 9) and all the recommendations requiring either systemic or behavioural change. Recommendations are separated according to the entities responsible for their implementation as detailed in Chapter 9. Each recommendation is accompanied by the applicable themes (in bold text) identified in Chapter 7 and the rationale behind each one.

NON-PRIORITY ACTIONABLE RECOMMENDATIONS

National Government
The Department of Forestry, Fisheries and the Environment (DFFE) to empower authorities and managers such as fisheries control officers (FCOs) through training, skills development and knowledge via service providers such as the FishForce Academy.
Increase capacity to govern; Improved compliance; Enhance knowledge sharing and communication: The 2022 Draft White Paper on the Conservation and Sustainable Use of South Africa's Biodiversity (the White Paper) calls for the "strengthening of existing management capacity through appropriate training." The capacity of authorities and FCOs in terms of knowledge and skills, and their application towards more effective enforcement (correct procedures and application of the law) and interaction with resource users (working tactfully with people and imparting knowledge), can be improved through training by accredited institutions such as the FishForce Academy at Nelson Mandela University. Raising awareness amongst users by authorities and managers empowers users with knowledge as opposed to criminalising them.
The DFFE must establish a functional National Coastal Committee (NCC).
Effective governance: The DFFE needs to constitute the NCC, whose functions are currently being fulfilled by Working Group 7 and the National Estuaries Task Team.
National government to ensure estuarine and fisheries management is placed into context with regards the National Development Plan's triple threat of poverty alleviation, unemployment and inequality, together with food security.
Effective governance: If the government were to recognise the value of estuaries and estuarine fisheries in terms of addressing national priorities, it could prioritise estuary management at all levels, stimulate effective governance and inform decision-making processes. The White Paper appears to address this and recognises the need to invest in the management and conservation of biodiversity in the context of its important contribution to livelihoods, the economy and job creation. This has direct applications to addressing national priorities such as poverty alleviation, unemployment, inequality and food security.
The DFFE to amend the National Estuarine Management Protocol (the Protocol) to be more specific about the clustering of estuaries for the purpose of developing one estuary management plan (EMP).
Increase capacity to govern; Amendment and improved implementation of legislation and frameworks: The resources required to develop and implement an EMP place a burden on limited finances and manpower, particularly at the provincial and local government level. Clustering systems will alleviate this burden, but DFFE needs to amend the Protocol to be more specific on the guidelines as to when this would be appropriate. It will most likely only be appropriate for small rural systems located in close proximity with similar physical, functional and socio-economic characteristics.
Department of Water and Sanitation to prioritise resources to focus on Resource Directed Measures determination for the remaining priority estuaries listed in the 2018 National Biodiversity Assessment - Estuarine Realm (NBA).
Increase capacity to govern: The NBA-listed priority estuaries are those that are considered most important in terms of goods and services provision, which relies significantly on sufficient freshwater inflows (ecological reserve). Prioritising limited financial resources towards this end will ultimately benefit estuarine functioning in the nation's key systems.

<p>Department of Water and Sanitation (DWS) to action the establishment of the Anti-pollution Task Team and prioritise resources for water quality monitoring (in estuaries and of return flows and discharges); DWS to provide support (free training and equipment) to users who are able to help with monitoring (e.g., resource users, honorary fisheries control officers, estuary management forums, non-governmental organisations).</p>
<p>Increase capacity to govern; Improved water quality and decreased pollution: Good water quality is essential for estuarine functioning. Prioritising DWS resources (budgets and manpower), establishing the Anti-pollution Task Team, and enlisting the help of trained and equipped members of civil society will not only alleviate the challenge of limited manpower but will enable more effective and widespread monitoring.</p>
<p>Punitive measures (eg. fines, confiscation of gear) should be considered as a last resort for fishers offending for the first time, but should be the preferred action for poachers, industry, agriculture and civil society whose non-compliance affects estuarine functioning.</p>
<p>Improved compliance; Enhance knowledge sharing and communication: Fishers should be afforded the opportunity of being educated/informed by fisheries control officers (carrot) before facing punitive action (stick); non-compliance from other user groups, whose activities pose a serious risk to estuarine functioning, should face severe punitive action.</p>
<p>Increased uptake, by all government departments, of research and knowledge on social, cultural, economic, political and historical aspects of illegal activities to understand it better for more effective or appropriate punitive action.</p>
<p>Improved compliance; Enhance knowledge sharing and communication: Understanding the socio-cultural-economic drivers behind non-compliance can provide context for appropriate enforcement activities and penalties, e.g., the political context of not recognising, and therefore criminalising, individual subsistence fishers trying to meet the most basic of needs.</p>
<p>Increase the frequency of joint enforcement operations under Operation Phakisa banner (South African Police Service, DFFE, DWS) and ensure successful and fair prosecution and stringent penalties; focus on illegal gill netting and prosecute poachers as members of organised crime syndicates (same as abalone).</p>
<p>Improved compliance; Sustainable resource use: Joint operations that combine limited resources from multiple institutions can be an effective compliance tool. As long as procedures are correctly followed, successful prosecutions and harsh penalties can provide a deterrent to would-be law breakers. Poaching, in the form of illegal gill netting which accounts for over 60% of fish catches in estuaries, should be considered as part of syndicate-run operations and prosecuted as organised crime.</p>
<p>The DFFE to amend the Protocol to stipulate timeframes for the EMP approval process.</p>
<p>Effective governance; Amendment and improved implementation of legislation and frameworks: At present the Protocol provides for EMP approval by either a provincial Member of the Executive Council for the environment or the national minister for environmental affairs, but no timeframe is provided. In the interests of good governance, the Protocol should be amended to address this as it did in the 2013 version, i.e., 21 days to acknowledge receipt of the EMP from the management authority, and 90 days to approve EMP after acknowledgement of receipt.</p>
<p>Training for management authorities on the value and importance of Indigenous and local knowledge systems (ILKS) as part of the Protocol training workshops.</p>
<p>Increase capacity to govern; Enhance knowledge sharing and communication: Management authorities need to be made aware of the value of ILKS in terms of informing estuarine management and the procedures for engaging with diverse user groups. Training workshops that empower authorities in terms of the Protocol need to include these aspects.</p>

National government departments to appoint knowledge brokers/communication experts to communicate knowledge to inform roleplayers, including officials, involved in estuarine management.
Increase capacity to govern; Enhance knowledge sharing and communication: Transfer or communication of knowledge is a specialised field. National government needs to appoint qualified and competent practitioners to disseminate knowledge on estuarine-related issues to all roleplayers to facilitate informed participation and decision-making. This imperative is encapsulated in the guiding principles of the White Paper that state "all people must have the opportunity to develop the understanding, skills and capacity necessary for achieving equitable and effective participation", and "community well-being and empowerment must be promoted through environmental education, the raising of environmental awareness, the sharing of knowledge and experience and other appropriate means."
National government to provide mandatory diversity training at provincial and local level to sensitise managers and authorities to acknowledge and respond appropriately to diversity.
Effective governance; Enhance knowledge sharing and communication: Estuarine end users are diverse with myriad reasons and motivations for their activities. Managers and authorities need to know and understand who they are engaging with and how to adopt sensitised attitudes or approaches depending on each interaction and circumstance.
The DFFE to initiate and fund estuarine focused research to provide the Department of Mineral Resources and Energy (DMRE) with Geographic Information System layers of the Estuarine Functional Zone (EFZ), ecological and socio-cultural sensitive areas and buffers.
Reducing impact of mining; Amendment and improved implementation of legislation and frameworks: National DFFE to fund research that provides the DMRE with visual representation of sensitive estuarine areas and no-go areas such as the EFZ. Research should also be used to inform guidelines for listed activities and Social and Environmental Impact Assessment requirements for the control of mining impacts.
The DFFE and DMRE to initiate and fund a mining Strategic Environmental Assessment (SEA) for estuaries as per the NBA recommendation in order to determine the extent of mining impacts.
Reducing impact of mining; Amendment and improved implementation of legislation and frameworks: The NBA has identified mining as a rapidly emerging threat to estuarine health and functioning. National government (DFFE and DMRE) urgently need to fund a mining SEA to determine the extent of this threat and provide recommendations for its mitigation.
The DMRE to revisit and strengthen regulations pertaining to, and increase monitoring of, small mining operations (<200 employees) whose cumulative impact is ever-increasing.
Reducing impact of mining; Amendment and improved implementation of legislation and frameworks: Small mining operations are neither well regulated nor monitored sufficiently, and their cumulative impact (e.g., west coast in Northern Cape province) poses a significant threat to estuarine functioning.
Action the establishment of the Mining and Biodiversity Task Team in a consolidated effort to address mining issues at the highest level and hold the DMRE accountable; until then, ministerial intervention from the DFFE or Department of Cooperative Governance and Traditional Affairs (COGTA) is needed to force attendance by DMRE representatives at Working Group 7 (WG7) meetings.
Effective governance; Reducing impact of mining: Representatives from the DMRE do not attend WG7 meetings and only ministerial intervention from DFFE, and perhaps COGTA can resolve this. The establishment of the focused Mining and Biodiversity Task Team under WG7 would leave the DMRE no alternative but to attend meetings and cooperate with their counterparts in other departments.
Reduce light pollution by controlling activities and development in the EFZ via amendments to and application of the EIA Regulations by the DFFE.
Amendment and improved implementation of legislation and frameworks; Improved water quality and decreased pollution: Light pollution impacts on animal behaviour such as predator/prey interactions and therefore estuary functioning. The EIA Regulations and listing notices need to be amended to include aspects related to light pollution and the EIA process used to restrict development and activities close to estuaries to mitigate against this.

As per the NBA, the DWS needs to amend the National Water Act to include the river-influenced nearshore marine environments as a water resource that is factored into the determination of Resource Directed Measures such as the ecological reserve.

Amendment and improved implementation of legislation and frameworks; Ensuring water quantity: The NBA has proposed that the river-influenced nearshore marine environments be included in the expanded EFZ. Freshwater flows into this estuarine-connected habitat are vital in terms of nutrients and sediment supply, providing cues for fish spawning and migration and facilitating optimal conditions for nursery areas. Current determination of the ecological reserve does not take this into account and this needs to be remedied.

National government to investigate the feasibility of providing seed funding that is required for supplementary livelihoods or small-business ventures for communities that are dependent on estuaries for basic needs.

Effective governance; Sustainable resource use: In line with national priorities, the government should allocate funding (or source from the business sector) to provide additional livelihood opportunities for the subsistence and small-scale fisheries sectors (e.g., the Department of Agriculture's National Rural Youth Service Corps Programme). This will not only address the national priorities of unemployment and poverty but could also reduce fishing effort if other avenues of income are available to individuals currently relying on fish to meet basic needs. In addition, the needs of the present generation in terms of food security that is reliant on an already severely depleted resource, means that the needs of future generations cannot be met (sustainability must be intergenerational) unless the government creates opportunities for employment that would reduce current levels of effort and reliance on the resource.

The DWS's Working for Water programme to increase efforts to remove invasive aquatic and riparian vegetation in catchments and the EFZ.

Increase capacity to govern; Control of invasive species: According to the NBA, a third of estuaries have invasive terrestrial plants occurring within the EFZ whilst aquatic invasive species heavily infest 8% of estuaries. Increased efforts to eradicate invasive plants will improve the health of riverine and estuarine systems by restoring habitats and increasing freshwater availability. The programme also has the potential to increase capacity through job creation, training and skills development.

Local Government

Investigate alternatives to municipal wastewater treatment works, such as bio-remediation.

Improved water quality and decreased pollution: Bioremediation involves the use of organisms such as bacteria, microalgae and macrophytes to degrade pollutants, and can be a viable, sustainable and cost-effective alternative to traditional treatment of wastewater. This is particularly applicable in developing countries where a combination of insufficient infrastructure and poor maintenance cannot cope adequately with exponentially increasing waste volumes. Bioremediation can also be used to treat contaminated agricultural return flows, and is already being applied in the industrial, agriculture, mining and aquaculture industries in South Africa.

Correct application and enforcement of municipal by-laws as a tool to implement wake-free zones to reduce noise pollution.

Improved compliance; Improved water quality and decreased pollution: Noise pollution scares away birds, affecting feeding, mating and roosting behaviour, and impacts soniferous fish such as estuarine round-herring, spotted grunter and dusky kob that use sound to communicate. Research has shown that kob call louder and longer to overcome the masking effects of anthropogenic sound, leading to longer recovery times, suggesting distress and a greater energetic cost which could inhibit growth. Noise produced by outboard engines can be reduced by using municipal by-laws to implement and enforce wake-free zones in large parts of estuaries.

All tiers of government

Increase stewardship opportunities for estuarine users, ensuring that interested individuals and groups can act on their initiative towards responsible use and care for the environment.

Improved compliance; Enhance knowledge sharing and communication; Improved water quality and decreased pollution: Stewardship empowers estuary users to become involved in activities such as clean-up operations, monitoring and engaging with fellow members of civil society to change worldviews, attitudes and perceptions towards the environment to improve estuarine functioning. This is linked to the government providing agency and legitimacy to civil society in terms of environmental protection and awareness raising. The notion of stewardship is contained in the Duty of Care guiding principle of the White Paper, which states that "all persons (...) have a duty of care to conserve and avoid loss of biodiversity", and is specifically addressed under the Goal of Enhanced Capacity, where one of the components is "increasing public education, awareness and stewardship of the value and importance of biodiversity, and public involvement in its conservation and sustainable use."

Develop and adhere to Mouth Management Plans and subsequent Mouth Maintenance Management Plans and raise awareness amongst role players of the consequences of illegal and/or badly managed breaching via a user-friendly guide or booklet accessible to and understood by all.

Improved compliance; Effective governance; Enhance knowledge sharing and communication; Management of mouth manipulation: National and provincial governments need to develop a standardised framework for the development and implementation of mouth management and maintenance plans. The Western Cape has a solid foundation for this and should be used as a blueprint for national standards. Correct mouth management and maintenance will lead to optimal mouth breaching practices that will reduce the risk to human safety, livelihoods and infrastructure while ensuring estuarine functioning. These plans can be put into effect within an estuary management plan framework or gazetted as stand-alone documents; Provincial authorities in cooperation with local government need to develop a user-friendly guideline document that raises awareness amongst all role-players (authorities and civil society) as to the consequences of badly managed and/or illegal mouth manipulation activities. This would form part of the local government's key role in implementing the policy based on the White Paper, namely to "institute and participate in public education, awareness and training programmes."

Development (by government) and uptake and use (by authorities and civil society) of a central reporting and response application (App) for incident reporting, logging and tracking of progress/response, and to facilitate interdepartmental coordination in terms of actions and responsibilities.

Improved compliance; Effective governance: Reporting of incidents by authorities and civil society via an App that allows for issues to be logged and the response to be tracked; this contributes towards compliance, good governance, enables civil society to hold authorities accountable in terms of fulfilling their mandates, and can also assist in the functioning of EMFs and Coastal Committees.

Multiple role-players

National & Provincial Government

The South African National Biodiversity Institute, DFFE and Provincial authorities to engage with the aquaculture industry and aquarium trade to co-develop legislation and regulations applicable to alien fish species and improve compliance.

Increase capacity to govern; Improved compliance; Effective governance; Amendment and improved implementation of legislation and frameworks; Control of invasive species: The majority of invasive fish species can be attributed to the aquaculture industry and aquarium trade (although some are translocated by anglers) and both national and provincial authorities need to co-develop implementable legislation with all roleplayers and improve capacity to monitor and enforce compliance.

Buffer zone for the EFZ to be determined on an estuary-specific basis depending on aspects such as topography, types of activity and level of risk.

Amendment and improved implementation of legislation and frameworks; Responsible land-use and development: National government must amend the Protocol to require the determination of a buffer zone surrounding the EFZ on an estuary-specific basis. Authorities responsible for driving the estuary management plan process must ensure that this is implemented.

All tiers of government, research institutions & civil society

Actively include more knowledge co-creation opportunities (e.g. participatory research methods and participatory mapping) that can result in increased stewardship opportunities and sustainable resource use.

Enhance knowledge sharing and communication; Sustainable resource use: Funding by government of programmes that involve, and therefore empower civil society with knowledge and a sense of responsibility and stewardship, such as monitoring and research projects, can contribute to sustainable use through increased awareness. Research institutions should be encouraged by the government, in terms of funding opportunities, to embrace citizen science or participatory research as a source of knowledge.

RECOMMENDATIONS REQUIRING SYSTEMIC CHANGE

National Government

The DFFE to source funding from fees generated from fishing licences to employ and train additional compliance personnel and provide them with the required operational infrastructure; management recommendations, such as those proposed for kob species and the estuary night-fishing ban, will be ineffective if there is no capacity to enforce.

Increase capacity to govern; Improved compliance: The ability of DFFE to carry out their mandate in terms of enforcing compliance with fisheries regulations is hampered by lack of capacity (manpower, funding and infrastructure). A substantial increase in the number of FCOs need to be employed, trained and provided with the means necessary to perform, e.g. vehicles, boats, fuel and firearms.

The DFFE needs to enter into Memoranda of Agreement with and funding of organisations to implement mandates on their behalf.

Increase capacity to govern; Improved compliance; Effective governance: Although there is potential for this to work and hence alleviate capacity issues, honouring agreements in the past has proven to be problematic due to lack of funds (e.g. Breede Estuary).

Increase education and awareness from a stewardship point of view through formal education structures.

Improved compliance; Enhance knowledge sharing and communication: This would involve a change in the school curriculum with a focus on instilling a stewardship ethic from a young age. Developing an environmentally aware and responsible young generation will facilitate compliance and encourage stewardship, but would require major change in the education system.

Oversight across all tiers of government by the Department of Cooperative Governance and Traditional Affairs with disciplinary action and punitive consequences for non-functioning or non-compliant individuals or departments.

Improved compliance; Effective governance; Amendment and improved implementation of legislation and frameworks: Good governance demands that government departments or individuals who are non-compliant with regards fulfilling mandates need to be held accountable. When one institution fails it can place undue burden on others.

National government should consider the application of Community Based Natural Resource Management in selected estuaries for specific situations, e.g. subsistence or small-scale fishing areas.
Improved compliance; Effective governance; Sustainable resource use: A mindset and policy change is required by the national government to provide initial training and skills development, and to ultimately devolve powers to the community level and provide long-term support with minimal operational interference.
The DFFE must make recreational fishing licences available in multiple formats (paper, electronic), from multiple outlets and online.
Improved compliance; Effective governance: The availability of recreational fishing licences from a single outlet (post office) and in a single format (hard copy) is untenable. Weak governance means that resource users are forced to be non-compliant when licences are either not available at the point of sale or the post office is closed (over weekends when demand is high or when points of sale are closed due to non-payment of rent).
Improve cooperation between the DFFE and DWS.
Effective governance; Improved institutional functioning; Ensuring water quality: Many of the mandates with regards estuarine and fisheries management are the responsibility of DFFE and DWS, e.g. developing and enforcing fishing regulations, and estimating freshwater requirements (DFFE), and developing Resource Directed Measures and Resource Quality Objectives (DWS). However, lack of cooperative governance leads to inaction over closely linked or overlapping mandates, which is further complicated by limited capacity in both institutions. Structures such as the National Estuaries Task Team and Coastal Committees need to strengthen cooperation and ensure that these institutions hold one another accountable. The Vision of the White Paper is based on a set of principles, one of which is to acknowledge the role of good governance, inter-governmental coordination and strong institutions in managing conservation and sustainable use of biodiversity. It is telling that the White Paper identifies global change, habitat loss and degradation, invasive alien species, overharvesting and illegal harvesting as threats to biodiversity, but also acknowledges that the lack of government capacity and cooperative governance is also a major threat.
Amend the Mineral and Petroleum Resources Development Act (MPRDA) and EIA Regulations so that environmental applications and authorisations relating to all aspects of mining are administered by the DFFE and not the DMRE.
Effective governance; Reducing impact of mining; Amendment and improved implementation of legislation and frameworks: Environmental authorisations and the EIA process should be the sole mandate of DFFE. The situation at present, with DMRE processing applications, assessments and management plans, is untenable. It is revealing that the White Paper does not list the MPRDA as being either applicable to, or having implications for, biodiversity conservation and sustainable use, although it does state that DMRE will have a vital role to play in the implementation of the policy. The White Paper also highlights the need for 'Regulatory Independence', stating that "some organs of state that are responsible for promoting activities that are likely to have negative impacts on biodiversity are also charged with the regulation of those activities, which results in a potential conflict of interest." This statement is particularly relevant to the activities of the DMRE.

Despite pending new regulations for kob species, and the proposed night ban on estuarine fishing, more stringent measures such as moratoriums or reduced bag limits need to be considered by the DFFE.

Increase capacity to govern; Amendment and improved implementation of legislation and frameworks; Sustainable resource use: The definition of sustainable use refers to the responsible use of the components of biodiversity that, amongst others, does not contribute to its long-term decline in the wild; does not disrupt the ecological integrity of the ecosystem in which it occurs; and ensures continued benefits to people that are equitable and meet the needs and aspirations of present and future generations. Based on this definition from the White Paper, it is clear that estuarine resources (most notably fish) are not, and never have been, used sustainably. Current regulations are ineffective and the proposed new kob species and estuary night fishing ban regulations will do little to protect fish species given the low levels of enforcement and high levels of non-compliance. If a state of emergency truly exists for certain linefish species then nothing short of a moratorium should be considered for at least white steenbras throughout its distribution (<6 % of pristine levels) and dusky kob (<2 % of pristine levels) caught from the shore and in estuaries east of Cape Agulhas. Due to the overlap in distribution of kob species and the difficulty in identifying separate species, a nation-wide moratorium on dusky kob will be impossible to implement, however, kob caught from the shore and in estuaries east of Cape Agulhas will predominantly comprise dusky kob and could therefore be managed by a moratorium in this area. Other restrictions to be considered are reducing leervis to 1 pp/day and spotted grunter to 2 pp/day. However, until the government can address the capacity issue with regards enforcement, even these drastic measures will likely be ineffective.

Reconceptualise EIAs to become Social and Environmental Impact Assessments.

Amendment and improved implementation of legislation and frameworks; Enhance knowledge sharing and communication: Until such time as the national government invests in knowledge brokers and social scientists, they will not be able to fully understand the social and cultural significance the environment holds for the diversity of people who make up our nation. The importance of social dynamics within EIAs is underrated and misunderstood, but this appears to be a low priority as evidenced by the government's inability to conduct meaningful engagements with stakeholders, particularly amongst rural communities.

Government institutions such as the DFFE and the Sector Education and Training Authority (SETA) should apply lessons learnt from the failed Swartkops Estuary subsistence bait fishery in order to formalise bait fisheries on selected estuaries with strict monitoring and waste reduction strategies and provision of long-term support.

Effective governance; Sustainable resource use: The organised Swartkops Estuary subsistence bait fishery ultimately failed due to lack of government support and monitoring. Infrastructure failure, lack of compliance monitoring and lack of basic business skills training all contributed to the failed venture. The fishers were, however, not blameless, and flouted regulations in terms of bag limits (unsold excess was wasted), collecting methods that damaged habitats and participation by unlicensed operators. The SETA could lead the development of bait fisheries, with support from DFFE, by ensuring skills development and long-term infrastructure support such as selling points with power and water, fridges and storage tanks to keep bait fresh for longer. However, lack of long-term government commitment to community upliftment programmes can lead to failure, and without the capacity to monitor compliance, ventures like this are unlikely to receive support. The White Paper aims to address transformation through meaningful access to nature-based development activities and benefits to marginalised communities, and the Goal of Biodiversity Economy Transformed highlights the need to "promote and develop inclusive economic opportunities that are compatible with and which compliment the conservation and sustainable use of biodiversity." These should be used as a motivation for the government to develop small-scale commercial bait fisheries within existing frameworks such as the National Biodiversity Economy Strategy.

National government needs to build capacity at municipal and provincial level to monitor activities and enforce environmental authorisations linked to the EFZ.

Increase capacity to govern; Improved compliance; Responsible land-use and development: Provincial and local authorities lack the capacity to fulfil their obligations and a massive increase motivated and funded by the national government is needed. Given the numbers of additional people, resources and infrastructure required, it is unlikely that this will be feasible.

Ensure greater recognition and acknowledgement of historical land use and cultural heritage practices in and around estuaries in the development and implementation of EMPs.

Effective governance; Enhance knowledge sharing and communication; Responsible land-use and development: The zoning of estuaries within EMPs seldom takes into account historical land-use by local communities and cultural heritage practices. This knowledge gap means that all roleplayers are not fully understood, access is denied, and estuaries cannot be effectively managed as socio-ecological systems. Social science needs to be more inclusive in the estuary management process and up till now, evidence suggests that the national government is not ensuring this is recognised or implemented. The White Paper, however, recognises that South Africa's natural heritage "...offers natural spaces and a valued sense of place for recreational, cultural, and traditional practices and activities." In addition, one of the guiding principles of the White Paper is "People First", which states that biodiversity must be protected in a way that "...promotes and enhances human health and well-being, and their physical, psychological, spiritual, developmental, cultural and social interests." The White Paper, however, still needs to be adopted as policy and used to inform new, or amend existing, legislation that will then need to be effectively implemented before the situation can be addressed.

Provincial Government

Address capacity at provincial level to facilitate the development of more EMPs within specific timeframes.

Increase capacity to govern; Effective governance; Improved institutional functioning: The Protocol, for the most part, places the responsibility for driving the process of developing and implementing EMPs with the provincial authorities. Capacity (manpower and funding) at the provincial level needs to be ramped up so that more EMPs can be developed, approved within stipulated timeframes and implemented. Systems in rural areas that are far removed from major centres risk being overlooked due to limited capacity. It is unlikely that the funds required for this are available.

Local Government

Better solid waste control and disposal, and management of landfill sites, by municipalities.

Effective governance; Improved water quality and decreased pollution: Poor management of solid-waste collection and non-compliant municipal solid-waste disposal sites leads to pollution of estuaries by wind dispersed rubbish. Until such time as municipalities are held accountable and forced to comply with standards and regulations, there will be no solution to this problem.

Municipalities need to ensure responsible and appropriate land-use planning and infrastructure development around estuaries to improve estuarine functioning in the long run.

Increase capacity to govern; Effective governance; Amendment and improved implementation of legislation and frameworks; Responsible land-use and development: Capacity at local government level, in terms of knowledge and awareness of the importance of estuaries, skills in terms of infrastructure development and maintenance, and prioritising estuaries in municipal integrated development plans, is lacking. Corruption also contributes to the approval of inappropriate activities and land-use that impacts negatively on estuarine functioning. Until such time as this is remedied it is unlikely there will be any change.

All tiers of government

Identify and nurture champions within all government departments and across all tiers of government over the long-term.

Increase capacity to govern; Effective governance: Appointing qualified and competent people, and nurturing them within their respective institutions (institutional memory and longevity), is good governance. Appointing unqualified people in key positions of authority does not empower good governance or engender confidence by civil society.

Authorities must want to leave a legacy of creating a better life for all and being a servant of the people.

Effective governance: Actions speak louder than words. Motivated and qualified people in key authority and management positions do exist, but the perception amongst many roleplayers engaged during this project is that more like-minded individuals are needed to improve on mandate delivery and good governance.

Build trust with civil society through transparency and competence.

Effective governance; Improved institutional functioning: A lack of transparency when dealing with civil society, and the appointment of unqualified people to key positions together with poor training and skills development, has led to a lack of trust in government by civil society. Better communication with and an understanding of civil society's needs, employing and nurturing champions, and effective spending of public money (generated from sources such as fishing licence and boat launching fees) towards improving estuarine condition and infrastructure, is required.

Eradicate corruption across all levels of government.

Effective governance; Improved institutional functioning: Corruption erodes government's ability to govern for the good of the people. Efforts to confront and decisively deal with this challenge need to be increased.

Multiple role-players

National & Provincial Government

The DFFE needs to establish and empower a dedicated enforcement unit (like the Green Scorpions), delegated to province, to specifically respond to illegal mining activities that are impacting on estuarine functioning.

Increase capacity to govern; Improved compliance; Effective governance; Reducing impact of mining: The national government needs to delegate powers to provincial authorities to clamp down on illegal mining, however, it is unlikely they have the capacity to do so. In addition, syndicates controlling illegal activities such as sand mining in the Eastern Cape and minerals in the Northern Cape, are well-connected and armed and would present a significant threat to any attempts at stopping them.

National & Local Government

National government needs to invest in increased water quality monitoring and the effective maintenance of waste-water treatment works (WWTW) and point sources for contaminated urban runoff by trained personnel.

Increase capacity to govern; Improved compliance; Effective governance; Improved water quality and decreased pollution: Poor maintenance and failure of WWTW is a major source of pollution in estuaries. A major effort is required by the national government to invest in appointing champions and employing and training personnel at the local level to maintain infrastructure and monitor water quality.

RECOMMENDATIONS REQUIRING BEHAVIOURAL CHANGE

Local Government

Municipalities to raise awareness about the threat and consequences of solid waste amongst estuary users.

Enhance knowledge sharing and communication; Improved water quality and decreased pollution: There is a culture of littering in South Africa. Solid waste, in particular plastics, pose a threat to estuarine fauna and functioning. Local management authorities can erect public notices, and conduct public meetings and on-site awareness raising while performing compliance patrols, to demonstrate the severity of the solid waste problem.

All tiers of government

Learn from institutions that have had success with enabling or implementing estuary management plans and the estuary management process.

Effective governance; Enhance knowledge sharing and communication: Institutions that are struggling to fulfil mandates in terms of estuary management need to learn from their mistakes and from the successes of functioning institutions (e.g., CapeNature and Western Cape Department of Environmental Affairs and Development Planning).

Authorities to support and participate in efforts by civil society, e.g. non-governmental organisations (NGOs) and community-based organisations (CBOs) to raise awareness through education initiatives (e.g. sending representatives and providing a venue).

Effective governance; Enhance knowledge sharing and communication: CBOs, NGOs and conservancies often conduct awareness raising initiatives with estuary users. Support from the government in terms of sending representatives and providing venues would not only enhance the legitimacy of such activities, but engender confidence in government.

Multiple role-players

Local Government & Civil Society

Angling clubs, tourism operators and civil society organisations to organise clean-up activities with support from local government.

Improved water quality and decreased pollution: Many organisations already take on the responsibility of conducting clean-up operations and should encourage others to do so via social media and word-of-mouth. Local governments could be involved by supplying bags or containers to collect waste and for their transfer to solid waste disposal sites.

Research Institutions

Scientists/researchers need to be transparent about data collection and analysis when it is used to inform management.

Enhance knowledge sharing and communication: For all roleplayers to be fully empowered in terms of a knowledge-based decision-making process, researchers must be transparent about all aspects of their research, namely data collection, analysis and potential conflicts of interest such as possible hidden agendas linked to funders.

Civil society

Self-regulation of, and increased awareness by the recreational angling sector promoted via social-media driven peer pressure.

Improved compliance; Enhance knowledge sharing and communication: Recent research showed that the level of non-compliance in the South African recreational shore-based marine fishery was as high as 52% (Bova et al. 2022); social-media posts, particularly by well-known anglers or brand ambassadors, with a strong environmental conservation message have the potential to alter behaviour and increase compliance through self-regulation in the recreational fishing sector. Naming and shaming those who flaunt regulations can also alter behaviour via peer-pressure.

Organised angling structures should sanction offenders via expulsion of individuals or exclusion of a club from the national controlling body.

Improved compliance: Organised angling in South Africa is governed by the South African Sports Angling and Casting Confederation which prescribes a code of conduct to be followed by its component organisations and individual members. Individuals or organisations that do not adhere to the code should be sanctioned and excluded from official structures. This sanction would exclude members from official competitions and representation at provincial and national level and would create incentive to be compliant.

Civil society should be encouraged to hold the government accountable at all levels.

Effective governance: Civil society champions need to encourage and teach others, via outreach programmes, chat groups and social media platforms, to become activists instead of bystanders and hold the government accountable.

Estuary users should be encouraged by their peers to disseminate information with an environmental-based message via social media platforms.

Enhance knowledge sharing and communication: Estuary users with a high profile social media presence can promote stewardship amongst civil society through the dissemination of knowledge and encourage their followers to do the same.

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