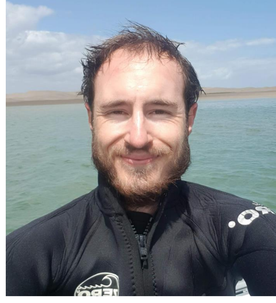
Scoping an Integrated Ecosystem Assessment for the southern Benguela: fisheries still biggest risk



Eugin Bornman[1], Lisa Skein[2,3], Lynne Shannon[1], Astrid Jarre[1]

[1]Department of Biological Sciences and Marine and Antarctic center for Innovation and Sustainability (MARIS), University of Cape Town, South Africa. E-mail: euginbornman@gmail.com

[2]Marine Programme, South African National Biodiversity Institute, Cape Town, South Africa

[3]Institute for Coastal and Marine Research, Ocean Sciences Campus, Nelson Mandela University, Gqeberha, South Africa

Background:

The southern Benguela ecosystem, located off the coast of South Africa (**Fig. 1**), is a distinct and dynamic marine ecosystem that supports diverse and economically important fisheries. Over the years, many of South Africa's marine resources in the southern Benguela have been exploited, spatio-temporal changes in key species have been observed, with severe impacts on its social-ecological systems (Blamey et al., 2015). Understanding the impacts of human activities on this ecosystem is crucial for sustainable management and conservation efforts. Integrated ecosystem assessments (IEAs) provide a holistic approach to evaluate the status and trends of the ecosystem and quantify the risks associated with different human activities on ecosystem components (Levin et al., 2009). This study builds on a South African-wide marine IEA scoping exercise to closely examine dependent sectors in the southern Benguela using the ODEMM (Objectives and Design of Ecosystem-based Marine Management) approach (Robinson et al., 2014), which identifies sectors and pressures needing urgent management action through linkage chains and impact risk scores calculated based on the exposure and severity of impacts faced by ecological components. Impact risk scores were generated and compared for three ecologically meaningful time periods (1961-1981, 1982-2002, and 2003-present) in the southern Benguela ecosystem.

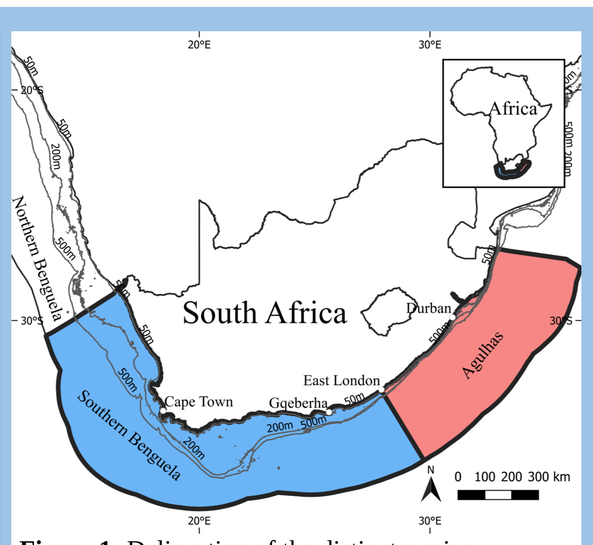


Figure 1: Delineation of the distinct marine ecosystem of the southern Benguela and the South African EEZ

The risk assessment results of the southern Benguela ecosystem show how each sector contributes to different pressures that pose a risk to various ecosystem components (**Fig. 2**). Fishing is identified as the sector with the highest overall risk of impact, primarily through the pressures of species extraction, bycatch, incidental loss, and abrasion, which pose risks to a significant number of assessed ecosystem components (**Fig. 2**). Out of 348 impact chains, 183 were attributed to the fishing sector, accounting for 52.6% of the Impact Risk scores of the southern Benguela, highlighting areas for management action with a high risk-reduction return. Furthermore, the system-wide impact of contaminants is higher than previously thought (Jarre et al. 2015). Species extraction, bycatch, incidental loss, and abrasion emerged as key pressures that remain high despite decreasing in the past two decades due to the successful implementation of mitigation measures (Cockcroft & Dudley, 2020) (**Fig. 3**).

Figure 2: All sectors and their current pressures on the ecological components of the Southern Benguela, South Africa.

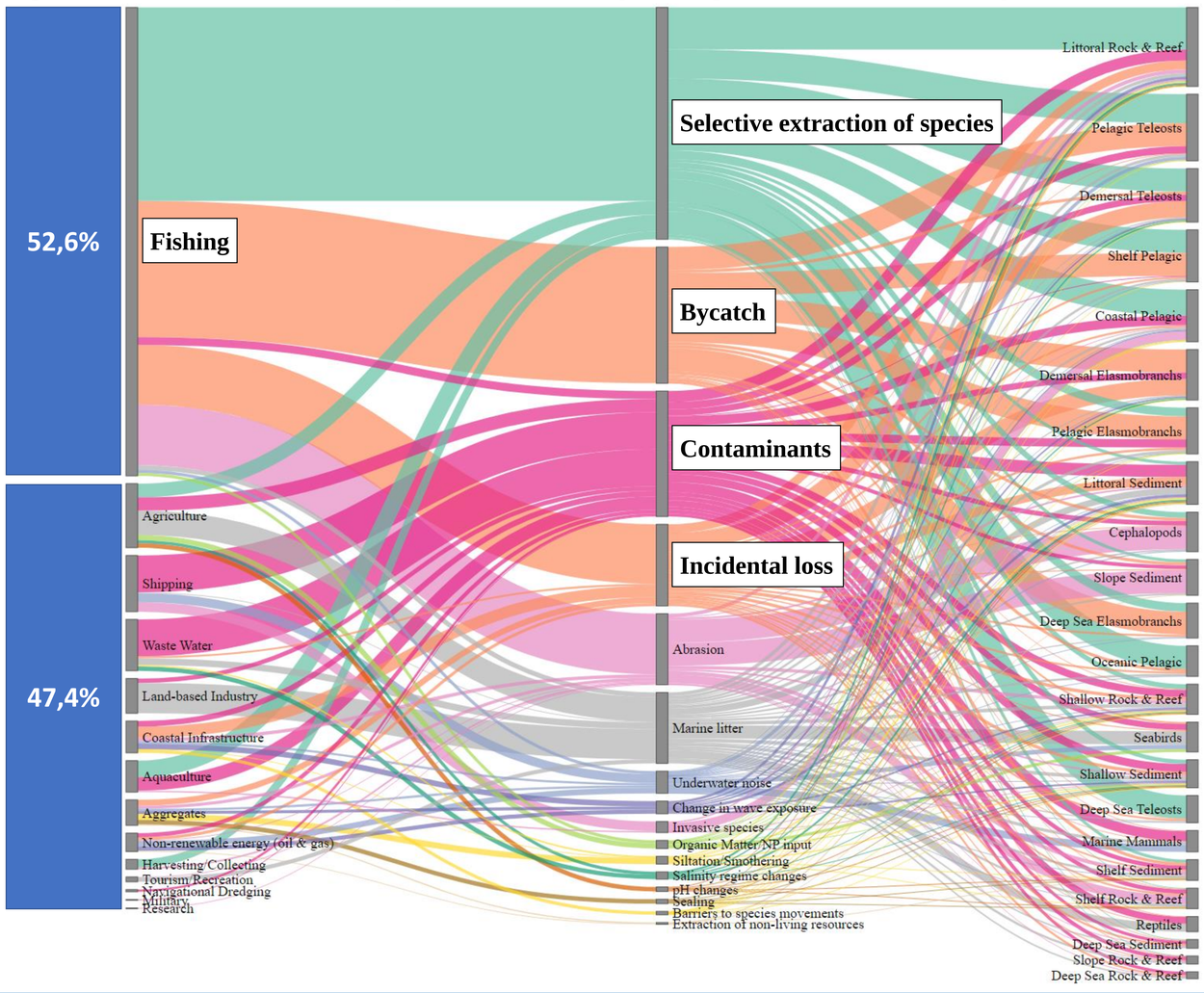


Figure 3: Spatial and temporal change of pressure impact risk scores by the disaggregated fisheries sector

The IEA with disaggregated fishing sectors indicated that the offshore demersal trawl sector had the highest impact risk in the southern Benguela currently (**Fig. 4**). This is due to the pressure exerted on slow growing benthic habitats which are slow to recover . The mixed species inshore trawl sector targets a wide variety of species and thus impacts a range of ecological components resulting in high impact risk scores (**Fig. 5**). Both trawling sectors are historically known for high bycatch which peaked in 1980-2000 before the implementation of mitigation measures (Cockcroft & Dudley, 2020) (**Fig. 4**). The highly mobile linefish and recreational fishery had the highest connectance and also targets high-priced fish species which are prone to being overfished. However, these sectors operate on a relatively small scale and therefore had lower impact risk scores than the highly capitalised demersal and inshore mixed species trawling sectors (**Fig. 4**).

The trophic links of upwelling ecosystems are relatively simple (Jarre et al., 2015) and have extensively been modelled (Shannon et al., 2020), however this study found that the impacts of the fishing sectors in the southern Benguela has the potential to be more complex than previously thought.

The southern Benguela is a highly dynamic ecosystem and has shown decadal-scale changes (Jarre et al., 2015) as well as a nonsignificant increasing trend in upwelling (Varela et al., 2015; Tomety 2022). Nearshore cooling due to increased upwelling has caused the south-eastward movement of species such as the West Coast rock lobster (Blamey et al., 2015). Despite these physical changes, recent improved fishing management measures, such as bycatch mitigation, has caused the biggest reduction of impact risk over time (**Fig. 4**).

Figure 4: Spatial and temporal change of ODEMM impact risk scores of disaggregated fisheries sectors.

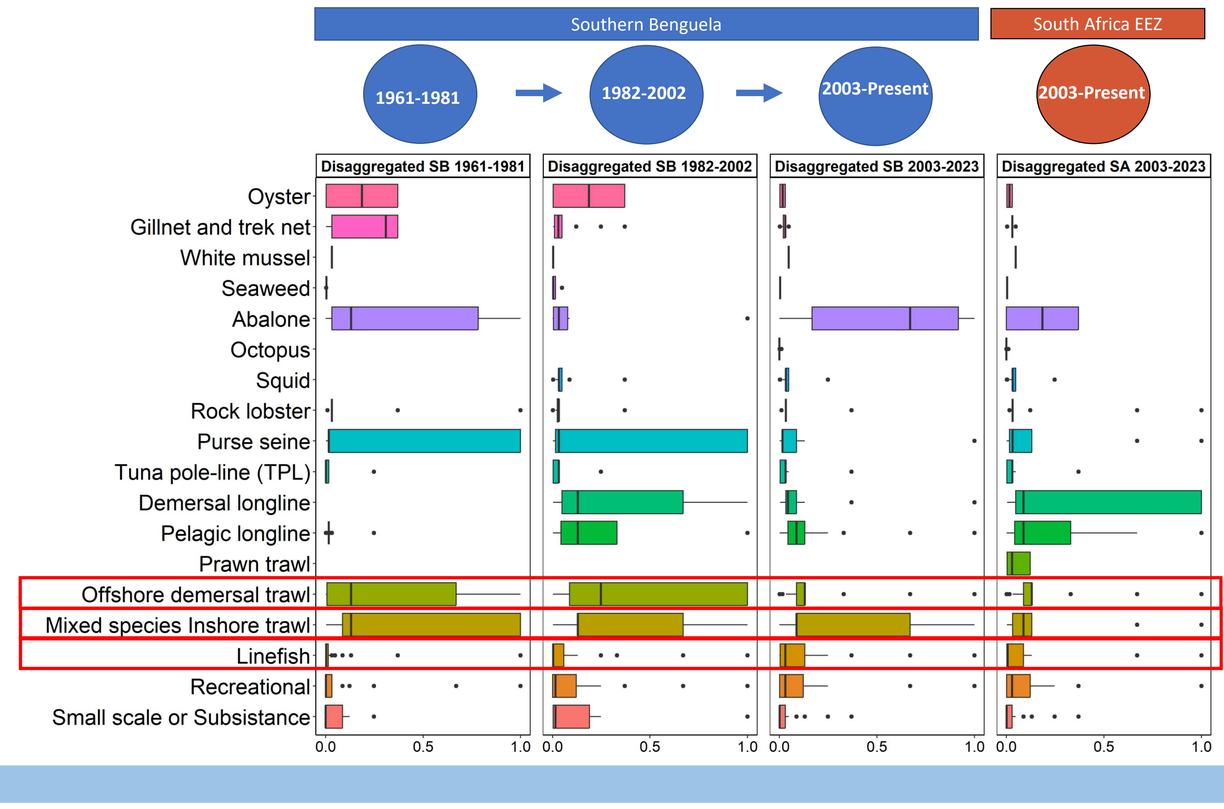
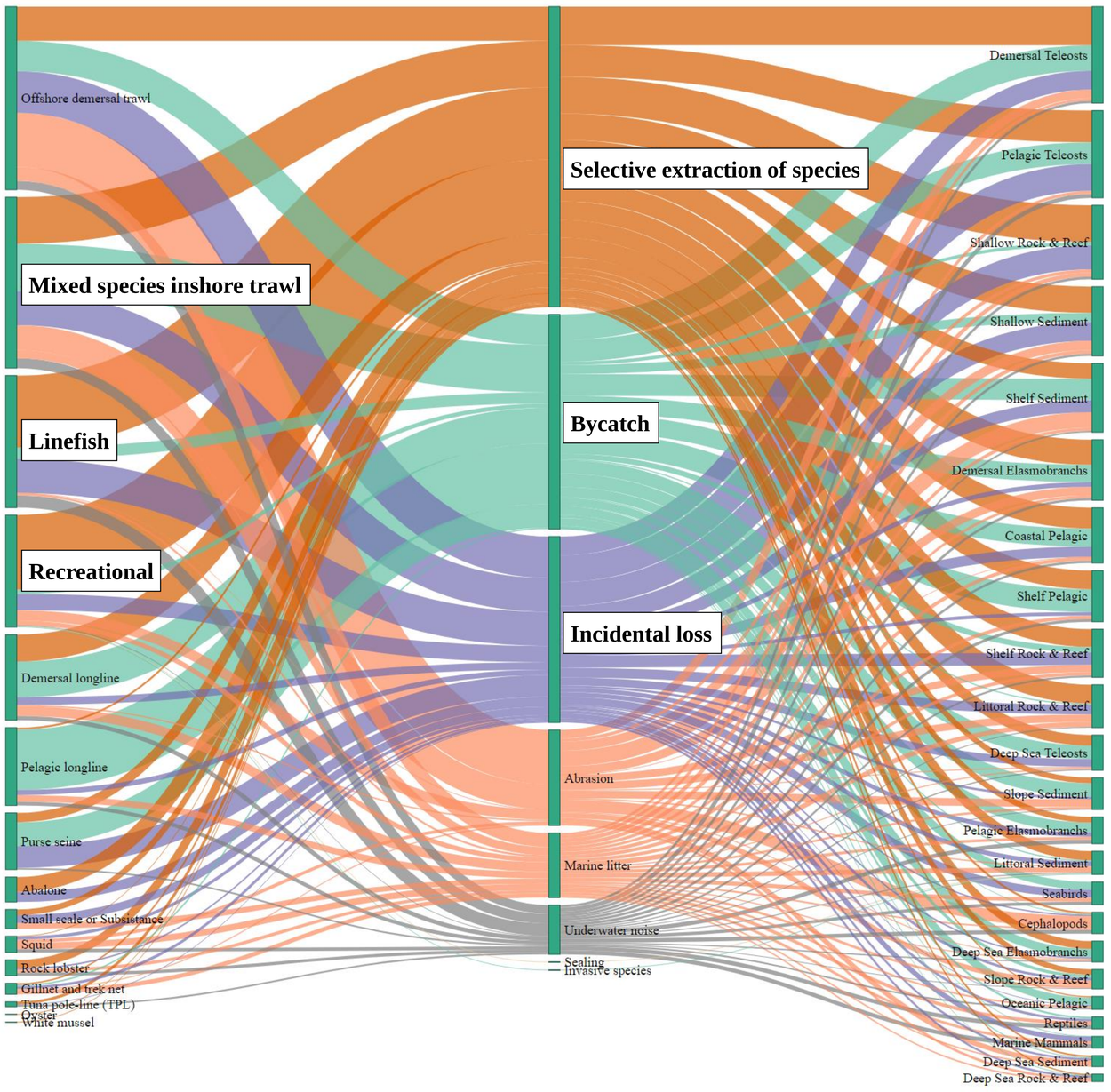


Figure 5: Disaggregated fishing sectors and their current pressures on the ecological components of the Southern Benguela.



Conclusion

Findings emphasize the need to lower the impacts of the fisheries sector in the southern Benguela by reducing the identified pressures (selective extraction of species, bycatch and incidental loss) in order to improve its health and maintain its ecosystem services. Furthermore, IEAs are underpinned by knowledge on specific habitats, species and ecosystem services and need to be considered in the context of climate impacts. Therefore, to improve confidence in future ecosystem service assessments, research must consider spatio-temporal changes between its two subsystems, the west coast upwelling and the south coast/Agulhas Bank warm-temperate shelf. Research into key knowledge gaps, such as the impact of underwater noise and recreational fisheries in the southern Benguela is also encouraged.

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