

Short communication

Alarming incidence of porcupinefish bycatch in the Lamu seascape beach seine fishery: Could this be a sign of an ecosystem imbalance?

Gladys M. Okemwa^{*}, Almubarak A. Abubakar¹, George W. Maina², Melckzedek Osore¹

¹Kenya Marine and Fisheries Research Institute, P.O. Box 81651-80100, Mombasa, Kenya

²The Nature Conservancy, Africa Regional Office, P.O. Box 19738-00100, Nairobi, Kenya

*Corresponding author: gokemwa@kmfri.go.ke, (+254) 20 8021561

Abstract

Overfishing and destructive fishing practices are strongly associated with loss of biodiversity and habitat degradation resulting in the proliferation of non-target and resilient species. In the long-term, this may also lead to an ecosystem imbalance. This short communication documents a worrying trend of high catch ratios of porcupinefish in the Lamu seascape beach seine fishery observed during catch assessment surveys conducted in 2021 – 2023. The increasing incidence high puffer bycatch is alarming fishers due to concerns over economic loss. Unfortunately, there is very limited data and information on the status of the puffer populations and ecosystem impacts within the seascape. A comprehensive study is recommended to better understand patterns of seasonal abundance as well as ecological and socioeconomic impacts. Research on alternative commercial uses of the harvested puffers can also be explored. However, such exploitation must be undertaken with caution considering the potential risk of incentivizing direct targeting which may secondarily encourage increased beach seine fishing effort. As part of a multi-institutional collaboration to restore the critical marine ecosystems of the Lamu seascape, it is hoped that a gear exchange programme will encourage beach seine fishers to exit the fishery and adopt other more environment friendly fishing practices.

Keywords: Overfishing, impacts, climate change, management

Introduction

Porcupinefish form a large proportion of the discarded bycatch in Kenya's artisanal fishery. Porcupinefish belong to the order Tetraodontiformes, which contains nine other families: Tetraodontidae (pufferfish), Balistidae (triggerfishes), Molidae (molas), Monacanthidae (filefishes), Ostraciidae (boxfishes), Triacanthidae (triplespines), Triacanthodidae (spikefishes), Tridontidae (threetooth puffers), and Aracaniidae (deepwater boxfishes) (Panão *et al.*, 2016). Worldwide, at least 19 different species of porcu-

pinefish have been discovered (Leis, 2006; Matsuura, 2014). Although they can reach lengths of up to 100 cm, they usually measure 20 – 50 cm. *Diodon liturosus*, *Diodon holocanthus*, and *Diodon hystrix* are three species that are regularly found along the Kenyan coast and are locally referred to as *Bunju* in the South Coast and *Matoetoe* in the North Coast up to Lamu (Froese and Pauly, 2023). They are typically solitary and inhabit a wide range of habitats such as inner reef flats and lagoons, where they can be found in seagrass beds, sandy and muddy bottoms,



Figure 1. A typical beach seine catch dominated by parrotfish, *Leptoscarus vaigiensis* (left) and bycatch dominated by porcupinefish, *Diodon holocanthus* (right) (Source: Almubarak A.).

estuaries, coral reefs, rocky substrates, seagrass beds, mangroves, artificial structures, pelagic open water, tide-pools, as well as deep-water habitats (Froese and Pauly, 2023). Their diet is diverse, consisting primarily of algae, molluscs (like clams), and crustaceans (like crabs and lobsters). Although population trends are unknown, the World Conservation Union (IUCN) has classified all three porcupine species as least concern (LC).

Incidence of porcupinefish bycatch

In contrast to the rest of the Kenyan coast, the Lamu seascape is regarded as a global biodiversity hotspot sustaining highly productive marine ecosystems and fisheries (Kairo *et al.*, 2021). In some areas of the seascape, fishermen have reported an increase in the frequency of large porcupinefish capture ratios in beach seine catches over the past three years (Fig. 1). Alarm has been raised by the new trend due to worries about a possible underlying environmental imbalance. The high bycatch ratios have an unknown underlying explanation, but there is a nagging doubt as to whether this could be connected to a population boom. Porcupinefish population surges have been documented all across the world, including in India, where the overfishing of predators was blamed for the phenomenon (Padate *et al.*, 2022). Sharks, lizardfish, sea snakes, catfish, cobia, skipjack tuna, and octopus are some of the

few natural predators of porcupinefish (Stump *et al.*, 2018; Ulman *et al.*, 2021). As a result of previous overfishing, which altered food webs (trophic cascades), most apex predators, including sharks, have unfortunately suffered (Azzurro *et al.*, 2019). Overfishing of sea urchin predators, particularly triggerfish, was blamed for the early 1990s population explosion of sea urchins at numerous locations along the Kenyan coast (McClanahan and Shafir, 1990).

Management interventions

Interventions to control overfishing and habitat degradation include promoting use of more selective and environment friendly fishing methods in addition to mitigating use of harmful fishing practices. Due to their high catch efficiency and close interaction with seagrass and reef environments, beach seines are among the most harmful fishing methods (McClanahan and Mangi, 2004; Samoilys *et al.*, 2011; 2017). Effective enforcement of the 2001-enacted national beach seining prohibition is necessary to limit the usage of beach seines. When they are dragged down the sea floor, they not only destroy vital fish spawning and feeding grounds, but they also increase juvenile fish catch rates and hence contribute towards overfishing. A typical beach seine net is up to 300 m long and is lined with buoys or floats at the top to keep the upper part afloat and lead sinkers at the

bottom to keep the net submerged in the water. In order to catch fish that are herded into the net through the water, the net may additionally feature a cod end. Beach seining is a labour-intensive activity that requires a sizable workforce (8-40 people), hired by the owners of the equipment.

It is also possible to conduct research on alternative applications for harvested porcupinefish bycatch. For the treatment of cancer, it has been discovered that the extracted toxin possesses anti-tumour characteristics (Fouda, 2005; Lago *et al.*, 2015; Bucciarelli *et al.*, 2021). Any commercial exploitation, however, needs to be done cautiously and with due regard for the potential risk of rewarding direct targeting, which might subsequently stimulate more beach seine fishing effort.

On porcupinefish populations and catches around the Kenyan coast, there are, regrettably, very few data and details available. To better comprehend the causes, as well as the ecological and socioeconomic effects of excessive porcupinefish bycatch, a thorough study is recommended. There is an urgent need to map the incidents, estimate the overall catch and bycatch rates, and evaluate the seasonality of occurrence in beach seine catches. The exercise may encompass a scaled-up version of any ongoing partnerships with relevant stakeholders, including the fishing communities. The purpose of this partnership would be to lessen the use of destructive fishing methods such as beach seines in Lamu. A beach seine gear exchange initiative undertaken by KMFRI, The Nature Conservancy (TNC), Kenya Wildlife Service, County Government of Lamu and the Northern Range Trust (NRT) is also ongoing as part of this multi-institutional collaboration to entice beach seine fishermen to transition to utilizing other more environmentally friendly fishing gears like handlines and traps. The program makes use of important takeaways from earlier gear exchange initiatives and directly incorporates

local fishing communities and Beach Management Units in decision-making. Fisherfolk collaborate closely with KMFRI and other partners in co-production and knowledge sharing to identify best practices and provide information for adaptive management. These initiatives and the suggested management strategies are anticipated to make a significant contribution to the restoration of vital marine ecosystems that constitute the Lamu seascape, while minimizing any potential ecosystem imbalance.

References

- Azzurro E, Sbragaglia, V, Cerri J, Bariche M, Bolognini L, Ben Souissi J, Moschella P (2019) Climate change, Biological Invasions and the shifting distribution of Mediterranean fishes: a large-scale survey based on local ecological knowledge. *Global Change Biology*, 25: 2779–279 [https://doi.org/10.1111/gcb.14670]
- Bucciarelli GM, Lechner M, Fontes A, Kats LB, Eisthen HL, and Shaffer HB, (2021) From poison to promise: The evolution of tetrodotoxin and its potential as a therapeutic. *Toxins*, 13(8): 517 [https://doi.org/10.3390/toxins13080517]
- Fouda FM, (2005) Anti-tumor activity of tetrodotoxin extracted from the Masked Pufferfish *Arothron diadematus*. *Egyptian Journal of Biology*, 7: 1-13
- Froese R Pauly D (eds) 2023. FishBase. World Wide Web electronic publication. Retrieved from www.fishbase.org, version (02/2023)
- Kairo J, Mbatha A, Murithi MM, Mungai F (2021) Total ecosystem carbon stocks of mangroves in Lamu, Kenya; and their potential contributions to the climate change agenda in the country. *Frontiers in Forests and Global Change*, 4. Retrieved from https://www.frontiersin.org/articles/10.3389/ffgc.2021.709227

- Lago J, Rodríguez LP, Blanco L, Vieites JM, Cabado AG (2015) Tetrodotoxin, an extremely potent marine neurotoxin: Distribution, toxicity, origin and therapeutical uses. *Marine Drugs*, 13(10): 6384–6406 [<https://doi.org/10.3390/md13106384>]
- Leis JM, (2006) Nomenclature and distribution of the species of the porcupinefish family Diodontidae (Pisces, Teleostei). *Memoirs of Museum Victoria*, 63(1): 77–90
- Matsuura K, (2014) Taxonomy and systematics of tetraodontiform fishes: a review focusing primarily on progress in the period from 1980 to 2014. *Ichthyological Research*, 62: 72–113 [<https://doi.org/10.1007/s10228-014-0444-5>]
- McClanahan TR, Shafir SH (1990) Causes and consequences of sea urchin abundance and diversity in Kenyan coral reef lagoons. *Oecologia*, 83: 362–370 [<https://doi.org/10.1007/BF00317561>]
- McClanahan TR, Mangi S (2004) Gear-based management of a tropical artisanal fishery based on species selectivity and capture size. *Fisheries Management and Ecology*, 11: 52–60 [<https://doi.org/10.1111/j.1365-2400.2004.00358.x>]
- Okemwa GM, Kaunda-Arara B, Kimani EN, Ogotu B (2016) Catch composition and sustainability of the marine aquarium fishery in Kenya. *Fisheries Research*, 183: 19–31 [<https://doi.org/10.1016/j.fishres.2016.04.020>]
- Padate VP, Can A, Rivonker CU (2022) Puffer proliferation in tropical coastal waters: influence of indiscriminate trawling. *Indian Journal of Geo-Marine Sciences*, 51(02): 161–169 [doi: 10.56042/ijms.v51i02.56343]
- Panão I, Carrascosa C, Jaber, JR Raposo, A (2016) Pufferfish and its consumption: To eat or not to eat? *Food Reviews International*, 32(3): 305–322 [<https://doi.org/10.1080/087559129.2015.1075213>]
- Samoilys MA, Maina GW, Osuka K, (2011) Artisanal fishing gears of the Kenyan coast. CORDIO/USAID, Mombasa. 36 pp
- Samoilys MA, Osuka K, Maina GW, Obura DO (2017) Artisanal fisheries on Kenya's coral reefs: Decadal trends reveal management needs. *Fisheries Research*, 186: 177–191 [<https://doi.org/10.1016/j.fishres.2016.07.025>]
- Stump E, Ralph GM, Comeros-Raynal MT, Matsuura K, Carpenter KE, (2018) Global conservation status of marine pufferfishes (Tetraodontiformes: Tetraodontidae). *Global Ecology and Conservation*, 14: e00388 [<https://doi.org/10.1016/j.gecco.2018.e00388>]
- Ulman A, Harris HE, Doumpas N, Deniz Akbora H, Mabruk A, Azzurro E, Bariche M, Çiçek, BA, Deidun A, Demirel N, Fogg AQ (2021) Low pufferfish and lionfish predation in their native and invaded ranges suggests human control mechanisms may be necessary to control their Mediterranean abundances *Frontiers in Marine Science*, 8: 670413 [<https://doi.org/10.3389/fmars.2021.670413>]