By-Catch Assessment and Mitigation in the Western Indian Ocean (BYCAM)

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Background:

- Marine Small Scale Fisheries (SFF) employ >0.5 million fishers and contribute >70% of SWIO marine fishery catch.

- SSF are generally data poor and impact marine ecosystems - reflect the global challenge of balancing conservation goals with community dependence on marine resources.

- Marine megafauna (elasmobranchs, marine mammals and sea turtles) are vulnerable to fisheries, and play important roles in marine ecosystems. Yet, little is known of the interactions between SWIO SSF and these species.

Aims:

- to provide for future sustainable fisheries by creating a baseline estimate of current marine megafauna exploitation,
- to develop and test methods for mitigation of vulnerable megafauna catches, and
- to provide recommendations for future governance and management.

Focussed on three fisheries with known bycatch problems:

Semi-industrial **prawn trawls**, and small-scale coastal **gillnets** and **longlines**

BYCAM - Objectives

1. Quantify SSF catch and composition of vulnerable megafauna and assess vulnerability through Productivity Susceptibility Assessment.
2. Explore life-history and relative extinction risk for selected species
3. Assess fishers' dependence on elasmobranchs.
4. Develop and test low-cost mitigation methods to reduce megafauna in gillnets (dolphins) and longlines (turtles) and assess impact on target species catch.
5. Assess and trial turtle excluder devices (TEDs) in prawn trawls.
6. Investigate limitations in existing policy, resource user perceptions of management and management efficacy.

BYCAM - Methods

1. Gillnet, longline and handline megafauna landings observed over 12 months (2016-17) at 21 sites in Kenya, Zanzibar and northern Madagascar.
2. Assessment of life-history, fishing and natural mortalities, and comparison with estimates of population increase for selected species.
3. Questionnaire surveys collating data on SFF socio-economy and dependence on marine megafauna catch.
4. Plastic bottle acoustic reflectors and glass bottle alarms trialled in driftnet fisheries in Kenya and Zanzibar. Circle hooks compared to J-hooks in longlines in Kenya.
5. Trials with TEDs on prawn trawls in Kenya to reduce turtle catch.
6. National governance workshops conducted in Kenya, Madagascar and Zanzibar with participation by relevant stakeholders.

1. Baseline catch, composition and threat in small-scale fisheries

- Currently, broadly poor documentation of small-scale fisheries and their catch limit assessment and use in evidence-based management.
- Volume and composition data is of poor resolution and heavily biased.

Marine megafauna interactions with small-scale fisheries in the southwestern Indian Ocean: a review of status and challenges for research and management

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- Monitored 21 landing sites for 147 days over a 12-month period.
- Monitoring days were randomly selected after stratifying for lunar cycle.
- Monitoring was simultaneous across all sites.

Marine megafauna catch in southwestern Indian Ocean small-scale fisheries from landings data

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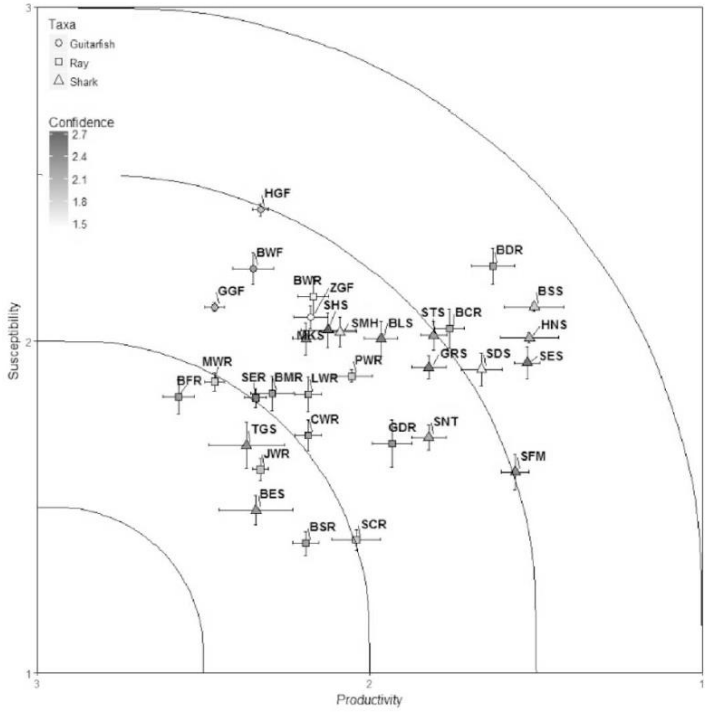
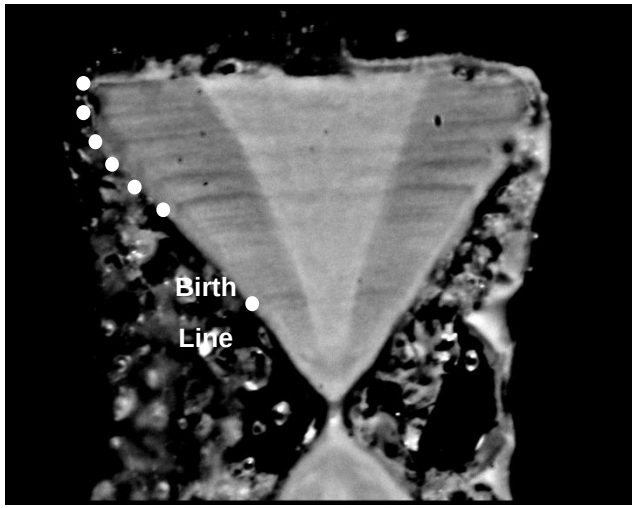
1. Results:

- 59+ species in landings (including 3 turtle + 2 dolphin species, + a dugong).
- Catch dominated by small/moderately-sized coastal requiem sharks and whiprays (generally overlooked in landings data).
- These species likely threatened more than some “poster” species but virtually ignored despite importance to fishers.
- Total annual catch estimates 72-130% higher than official reports.
- Diversity of species catch demonstrates potential impacts of SSF across multiple ecosystems – and also how external impacts to these ecosystems threaten SSF livelihoods



2. Life-History Assessment and Extinction Risk

- Many of the species overlooked in previous assessments (small/moderately-sized requiem sharks, whiprays) have limited life-history data, limiting sustainability assessments.
- e.g. recently described (2016) Baraka's whipray dominates catches in Kenya and Zanzibar.
- Combine life-history assessment (aging, growth curves, maturity, maximum size, lifespan) with metrics of resilience (intrinsic population growth rate, r_{max}) and exploitation (total *Z*, fisheries *F* and natural *M* mortality, and exploitation ratio *E*).
- Similar analysis for Spurdogs (*Squalus* sp.) and smooth hounds (*Mustelus* sp.) ongoing.

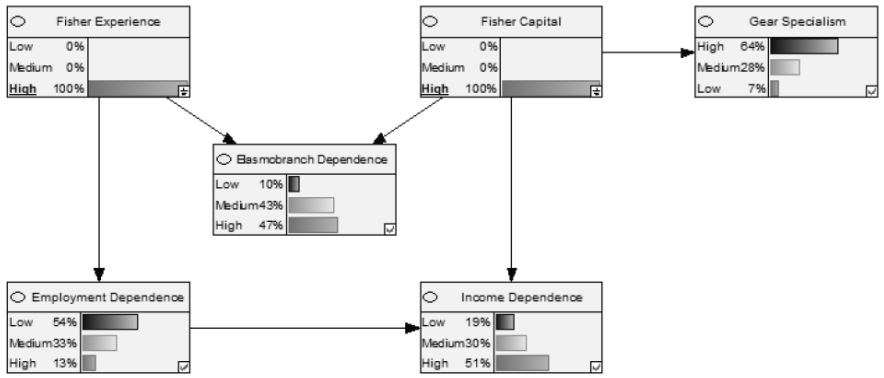


3. Small-scale fishers' dependence on elasmobranch resources

- Examined convergence of inherent vulnerabilities of fishers and their households, elasmobranch resources and coastal ecosystems.
- Understanding dependence can help to target fishers and households most at risk and in greatest need of livelihood diversification.
- 521 resource-user interviews across 23 sites in three countries.
- Exploratory Factor Analysis was used to identify latent factors described by collected variables.
- Bayesian Belief Networks with structure-learning algorithms and bootstrapping used to examine linkages between resource dependence and demographics.

3. Results:

- Elasmobranch dependency is linked to financial capital and fishing experience, further linked to household engagement in income generation and dependence on fisheries for income. Capital linked to gear specialisation.
- Findings suggest that elasmobranch-dependent households tend towards specialist livelihood strategies (relative to the rest of the fishery) and may be less resilient to social, environmental or economic shocks.
- Targeted livelihood diversification for elasmobranch-dependent households, either for fishers or non-fishing household members (especially women) may increase household resilience in the face of future shocks (e.g. stock collapse or changes in demand).



4. Low-cost mitigation methods to reduce dolphin catch in drift gillnets

- Two main conditions for fishers to use mitigation:
    1. Not reduce catch of target species
    2. Have no or very low cost
- Dolphins use sound (echolocation) to navigate and detect objects.
- Gillnet density similar to water – limits dolphin detection, leads to bycatch.
- Electronic acoustic alarms (pingers) can reduce dolphin bycatch, but costly (US$30-100 per 100m net)
- We developed low-cost (US$0.25 per 100m net) solutions from recycled plastic and glass bottles.
- Air bubble in water = prefect (passive) sound reflector
- Glass bottles with metal bolts = cheap pingers

Recycled bottles offer potential low-cost solution to marine mammal bycatch

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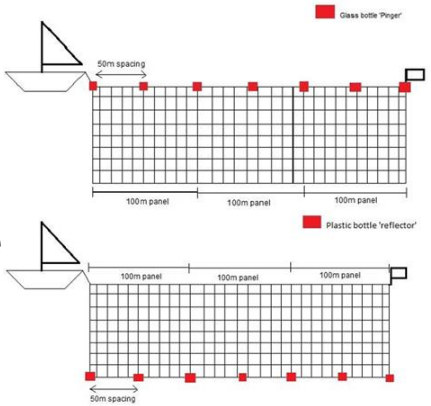
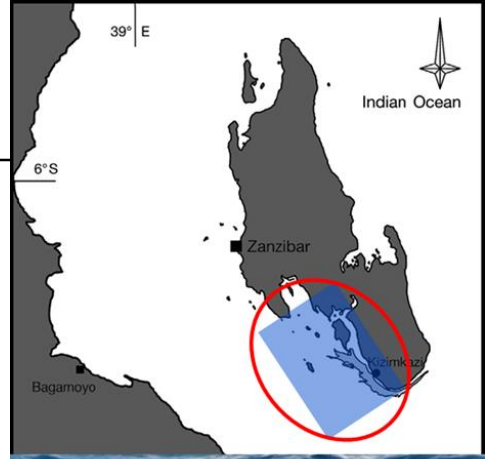
In Review: ***Scientific Reports***

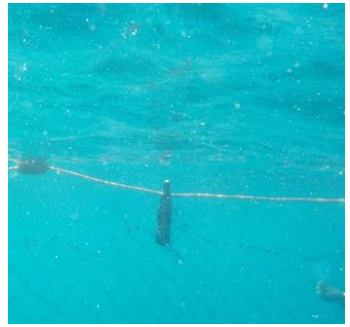
4a. Low-cost mitigation methods to reduce dolphin catch in drift gillnets

- Trial objective: Test if glass bottle alarms and/or plastic bottle acoustic reflectors reduce dolphin bycatch in driftnets.
- Zanzibar: 36 boats, 2 villages, January-March 2017.
- 1/3 of boats randomly assigned treatment:

    1. Control
    2. Glass bottle alarms every 50m on headrope
    3. Plastic bottle reflectors every 50m on footrope







- Each vessel randomly assigned onboard observer to record effort and catch. Treatment and observers re-assigned monthly.

4. Results:

	Control	Glass	Plastic	Total
No. observed hauls	401	394	312	1107
Dolphin bycatch Observed:	0	0	0	0
Dolphin bycatch Expected:	8 (401x0.02)	?	?	
Fish catch CPUE:				Sign. higher catch with plastic bottles
Mean fish catch/km x hr	0.8	1	1.8	
Mean tuna catch/km x hr	0.6	0.7	1.4	

- No dolphin bycatch recorded during the trial although expected catch in control nets was 8 dolphins (based on previous observer programmes).
- Dolphins were present in the area (reported by fishermen and acoustic monitoring).
- Target fish catch higher in nets with plastic bottles; glass bottles had no effect.

4b. Circle hooks as a low-cost mitigation methods to reduce megafauna bycatch in artisanal longline fisheries

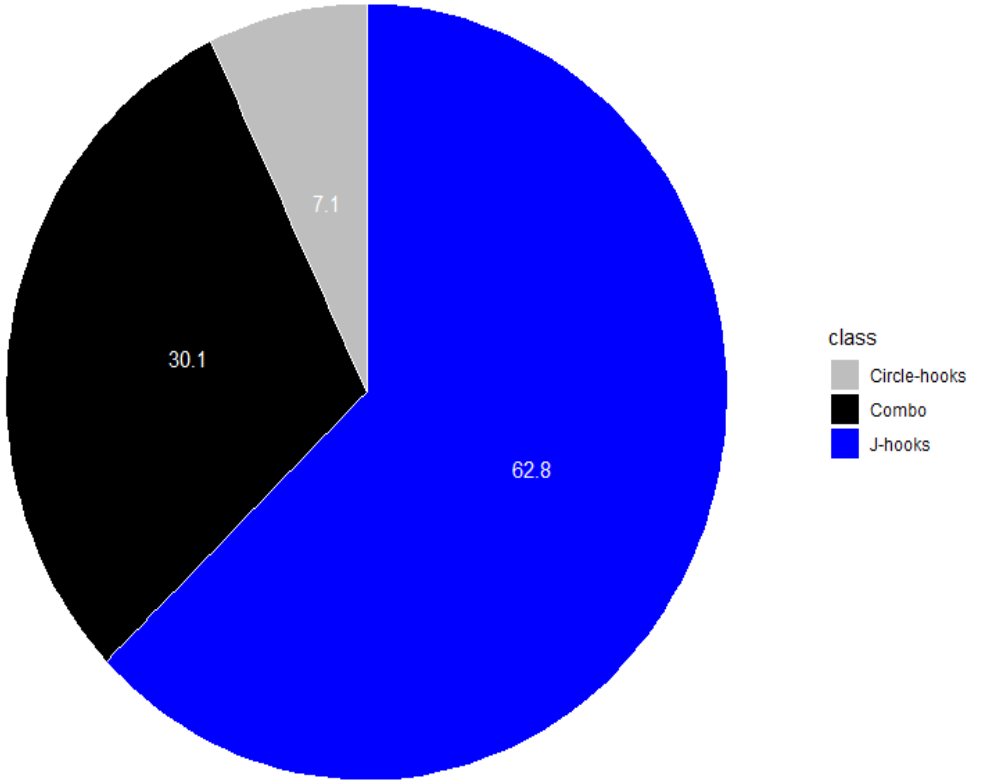
- Trial objective: assess the performance of J hooks and circle hooks in mitigating artisanal longline fisheries megafauna bycatch.
- Three sizes of circle hooks (8/0, 9/0, and 10/0) and two sizes of J-hooks (5/0 and 6/0) were tested respectively
- Fishers deployed each type of hook separately (either J or Circle hooks), or combination of both.
- Landed catch identified and measured; fishing outing details recorded.

J- hooks

Circle hooks

4. Results:

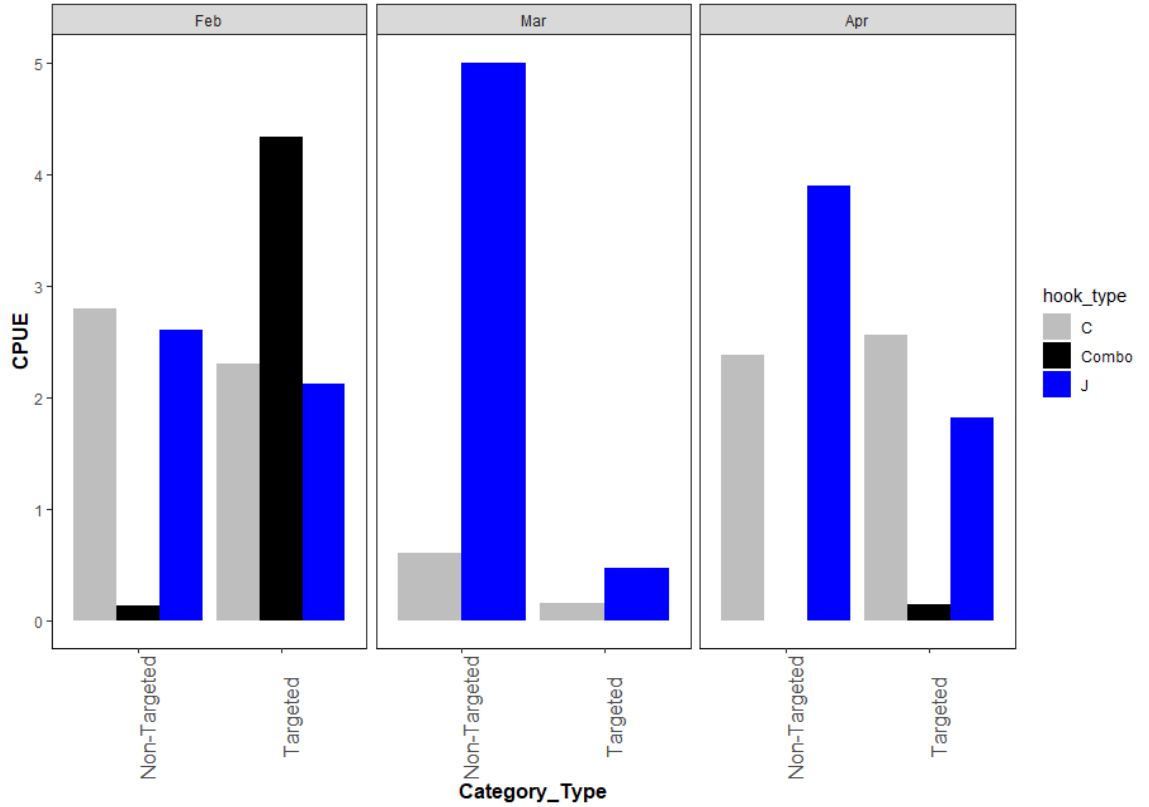
- 14 boats participated, Feb-Apr 2019; fishers considered circle hooks expensive + would reduce catch rates;
- J hooks had highest catch + CPUE for both target and non-target catch, followed by circle hooks and ‘Combo’.



Contribution to landings by J, Circle and Combo

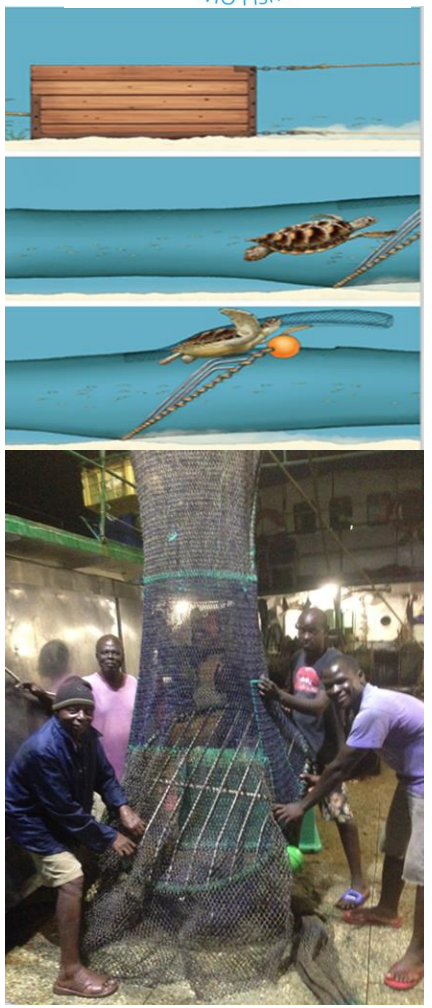
4. Results:

- A total of 5 032 fishes, 42 families were recorded. J- hooks (3159), circle hooks (1514), ‘Combo’ (359)
- CPUE of targeted species > non-targeted species with ‘Combo’ hooks in Feb; CPUE for J and C hooks similar
- CPUE of non-target species with J hooks > C hooks; and
- Circle hooks were more selective of non-target and target species compared to J-hooks.



5. Assess and trial turtle excluder devices (TEDs) in prawn trawls

- Several WIO countries require TED use in prawn trawls. But doubt exists about TED effectiveness in decreasing bycatch while maintaining prawn catches - based on BYCAM analysis of TED use in SWIOFP trawl surveys in Kenya and Tanzania in 2011.
- BYCAM aimed to trial and press for TED implementation in Mozambique; but lack of co-operation meant trials were moved to Kenya.
- Insufficient local TED knowledge → gear expert → successful trials (50 tows) → no loss of target catch, slight reduction in bycatch; increased local TED capacity, and scope for further roll-out.



6. Small-scale fisheries governance in the SWIO

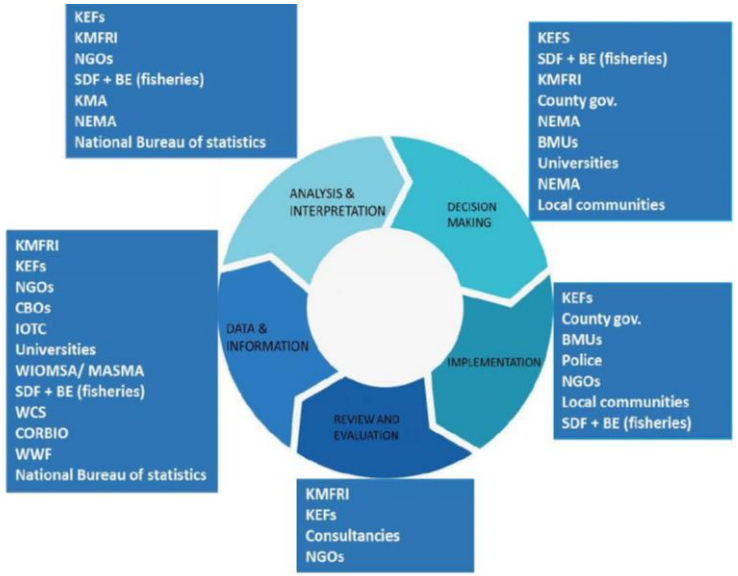
- Few studies in the SWIO have examined the relationship between efficient governance and fisheries management efficacy.
- BYCAM has extended earlier socio-economic research, by running national policy development workshops to address strengths and weaknesses in governance systems.
- Workshops engaged a wide range of stakeholders engaged with fisheries governance at national levels.
- We highlight here two overarching issues identified across countries:
  - Attitudes towards and facilitation of fisheries management
  - Management resource allocation

6. Results: Attitudes towards and facilitation of fisheries management

- Stakeholders were positive about attempts to improve fisheries management and regulation, with the goal of sustainability.
- However, a lack of transitional arrangements and assistance, particularly to those least capable of adaptation e.g. elderly or specialist fishers, was identified as a common roadblock for effective change.
- Further, limited consideration or resources were given to mitigating/responding to unforeseen consequences to fisher households.
- Understanding fishers adaptive capability (and vulnerability) to change was a consistent theme in the human component of BYCAM. Identification of least adaptive fishers and households may be a priority in facilitating future change and improving resilience.

6. Results: Management resource allocation

- Management resources (monetary and physical) were primarily directed towards collecting data.
- Relatively few resources are put towards enforcement of regulations, so the potential impacts of regulations are limited and evaluation of the efficacy of regulation changes is undermined.
- Relatively few resources were put towards reviewing and evaluation of data, legislation outcomes and management practices.
- Resource allocation to support sustainable management of fisheries is not optimised and undermines the efficacy of the policy cycle.
- Thus SWIO nations' capability to achieve effective and adaptive management is hindered.



BYCAM - Conclusions

- BYCAM assessments of SFF show FAO elasmobranch catch is very under-reported.
- Diversity of species in catch demonstrates impacts of SSF across multiple ecosystems.
- Vulnerable species are likely overexploited by SFF, and livelihoods relying on this catch are under threat.
- Low-cost mitigation methods for dolphins in gillnets - promising – no effect on target catch. Local TED capacity increased, scope for further roll-out in SWIO prawn trawls.
- Studies on bycatch selectivity between J and C hooks shows need for extended studies to measure the efficacy of C hooks in SSF.
- Targeted livelihood diversification for elasmobranch-dependent households offers scope for their increased resilience in the face of future fisheries shocks (e.g. stock collapse).
- The project has taken the first steps towards building governance frameworks to promote sustainable fisheries management within the WIO.

BYCAM- Acknowledgements

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