Fisheries management: fishing gear and effort

Over-exploitation of fisheries and the use of non-selective and destructive gears can reduce the abundance and diversity of coral reef fish populations. This can: a) have cascading effects that impact on the diversity of key functional species, like herbivores; b) reduce the availability of target fisheries; and c) be detrimental to reef habitats.

Current strategies: include effort reduction (e.g., licensing, closures), gear restrictions (e.g., prohibited gear or minimum mesh size), and gear modifications (e.g., escape gaps in nets / traps). Temporary and permanent marine protected areas are also used as a fisheries management tool and these are assessed in report cards 10 and 12.

Assumption for resilience: Strategies assume that: a) reducing effort to the extent that specified threshold levels of fish biomass are protected can avoid tipping points in coral reef ecosystems; b) gear restrictions and modifications can protect juveniles and enhance selectivity, thereby protecting key functional species or avoiding over-exploitation of particularly vulnerable species; and c) effort and gear management can improve fisheries sustainability thereby enhancing fishers' livelihoods and income.

Ecological impacts

Positive

Documented examples have shown:

- Gear restrictions (e.g. bans on seine nets and spearguns) result in higher fish biomass and diversity compared to areas with no gear restrictions, and can result in an increase in fish body size.
- Increased fish size and reduced catch of key herbivores and by-catch (butterflyfish and other low value species) in modified traps.

Negative

Documented examples have shown:

- Gear restrictions are preserving biomass above key threshold levels for sustainable fisheries but are not achieving conservation targets.
- Even with gear restrictions the preferred target species are still fully exploited.

Implications for ecological resilience

- Improved fish biomass was associated with larger fish and more functionally important species.

Social impacts

Positive

Documented examples have shown:

- Current gear restrictions protect a significant proportion of catch up to maturity thus catch rates and incomes can rise. Optimisation of yield requires an increase in mesh size restrictions.
- Evidence for income benefits is mixed. Some empirical studies suggest no significant impacts on income from modified traps (in less exploited fisheries or those near MPAs), others find a 25% increase in the economic value of the catch from gated compared to control traps due to a strong size–price relationship in the fishery.
- Gear restrictions are more socially acceptable to communities than closures.

Negative

Documented examples have shown:

- Mesh size restrictions in traps have mixed impacts, with some studies showing substantial catch losses.
- Modelling studies predict:
- One year of financial loss in profits from gated traps in heavily exploited fisheries, followed by substantial profits once undersized fish have grown large enough. The extent of losses depends on the mesh size of the escape gate.

It has been suggested that:

- Effort management techniques are rarely successful in tropical fisheries.

Implications for social resilience

- Potential for reduced social resilience in the short-term but improved resilience in the medium- to long-term, if resilience is linked to income.

Spatial scale: Local to regional

Temporal scale: Negative impacts are felt in the short-term. Benefits tend to accrue in the medium- to long-term, but for some species (e.g. octopus) can occur in the short-term.

Case study: Modified African basket traps

Basket traps are a traditional fishing gear commonly used globally and along the African coast. They are used to target reef fish such as groupers and snappers in coral reef lagoons. As they are largely unselective, most fish that enter the traps are retained, resulting in the catch of many juvenile fish and non-target species. Harvesting this by-catch can reduce fisheries biomass and productivity as well as impact the ecology of coral reefs. Reducing by-catch is therefore a key concern for improving fisheries sustainability and ecosystem-based management. In response to this, scientists from the Wildlife Conservation Society and the Kenyan Marine and Fisheries Research Institute have retrofitted traditional African basket traps with 4 cm × 30 cm escape gaps that allow smaller fish to exit the traps. Between October 2010 and October 2011, they tested the effectiveness of the modified traps compared to unmodified ones.

Has it been successful? The overall number of fish caught per trap was not significantly different, but modified traps caught fewer by-catch species, especially ornamental butterfly fish. There were also significant differences in terms of length, weight and value of fish between trap types. Fish caught in the modified traps were 31 % longer and 55 % heavier and there was a 25 % increase in the economic value of the fish caught as larger fish attract higher prices.

Challenges facing the project: While modified traps help reduce the by-catch of narrow bodied species, they do not reduce the by-catch of wider bodied species. Trap modifications therefore need to be implemented together with other gear restrictions. Upscaling also remains a challenge. Relatively few fishers took part in initial trials and uptake of the modified traps was reported in 2013 to be slow.
No subsequent data on uptake was identified.

Future application: As existing basket traps can be retrofitted with escape gaps, this is a low tech and low cost solution that can be easily exported to other coastal fisheries. Adoption requires no change in fishing method and is therefore perceived as more socially acceptable than other fisheries management methods, such as area closures. More research is needed, however, on the impact of modified traps on fish populations and wider reef ecology and whether improvements in fish populations could also benefit spear, handline and net fisheries by making large fish available to them.

Further reading

Blue Ventures. Accessed 2017. *Locally led marine conservation*. https://blueventures.org/conservation/community-conservation/

Condy, M., Cinner, J.E., McClanahan, T. and Bellwood, D.R. 2015. Projections of the impacts of gear-modification on the recovery of fish catches and ecosystem function in an impoverished fishery. *Aquatic Conservation: Marine and Freshwater Ecosystems* 25: 396–410

Hicks, C.C. and McClanahan, T.R. 2012. Assessing gear modifications needed to optimise yields in a heavily exploited, multi-species, seagrass and coral reef fishery. *PLoS ONE* 7(5): e36022.

Kawaka, J., Samoilys, M.A., Church, J., Murunga, M., Abunge, C. and Maina, G.W. 2015. Locally Managed Marine Areas (LMMAs) in Kenya: a detailed history of their development and establishment. CORDIO East Africa. 24pp. http://cordioea.net/wp-content/uploads/2015/07/LMMA-Review-Kawaka-et-al.-2015-Final-10Jul.pdf

Kawaka, J.A., Samoilys, M.A., Murunga, M., Church, J., Abunge, C. and Maina, G.W. 2017. Developing locally managed marine areas: Lessons learnt from Kenya. *Ocean & Coastal Management* 135: 1–10.

Mbaru, E.K. and McClanahan, T.R. 2013. Escape gaps in African basket traps reduce bycatch while increasing body sizes and incomes in a heavily fished reef lagoon. *Fisheries Research* 148: 90–99.

McClanahan, T.R., Graham, N.A.J., MacNeil, M.A. and Cinner, J.E. 2015. Biomass-based targets and the management of multispecies coral reef fisheries. *Conservation Biology* 29(2): 409–417.

McClanahan, T.R. and Abunge, C.A. 2014. Catch rates and income are associated with fisheries management restrictions and not an environmental disturbance, in a heavily exploited tropical fishery. *Marine Ecology Progress Series* 513: 201–210.

Images courtesy of Andrea Moroni (front) and Mwambao Coastal Community Network (back).