

RAPID ASSESSMENT OF MARINE MEGAFUNA CAPTURE, FISHING EFFORT, AND SOCIOECONOMIC AND CULTURAL DRIVERS OF ARTISANAL FISHERIES IN NORTHERN MADAGASCAR

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Introduction

Bycatch, or accidental capture, in artisanal fisheries poses a significant threat to marine megafauna (sharks, sea turtles, and marine mammals) populations globally (e.g., Peckham et al. 2007, Jaramillo-Legorreta et al. 2007, Moore et al. 2010). Because a high number of threatened and vulnerable species overlap with these relatively little-studied fisheries, bycatch in developing nations is a significant problem for marine megafauna conservation. Understanding the magnitude of marine megafauna bycatch is critical to the conservation of these species and their marine environments, as they are important consumers in their ecosystems. Africa, including the southwest Indian Ocean region (SWIO), has been noted as one of the most data-deficient regions with regards to bycatch in artisanal fisheries (Read 2008). Few studies have explored the extent of bycatch in artisanal fisheries of the SWIO (Kiszka et al. 2008).

Understanding the context of marine megafauna bycatch

Though addressing marine megafauna bycatch in artisanal fisheries is a rather specific goal, it must be pursued in light of a wider ecosystem perspective. Because these fisheries are a vital livelihood for coastal communities, it is neither sufficient nor ethical to focus only on “saving the dolphins”. Rather, marine megafauna conservation must address the needs of local human populations in the context of ecosystem-based management (EBM), an emerging paradigm in marine conservation that stresses holistic, interdisciplinary understanding of ecosystems, including human socioeconomic and cultural systems. Addressing the threat of bycatch of marine megafauna as part of a larger EBM effort is necessary because:

- It is likely that these artisanal fisheries are also having a negative impact on the larger ecosystem, and are currently not sustainable sources of livelihood.
- Both marine megafauna and artisanal fisheries are likely impacted by other human activities, which must be examined and addressed.

- Local cooperation – recognized as vital to conservation success in developing countries – is contingent on perceived benefits to local communities.

Collecting bycatch data through interviews

Due to the decentralized nature of artisanal fisheries, limited infrastructure for research and monitoring in developing countries, and logistical obstacles to establishing observer programs, collecting data on bycatch through interviews is recognized as a practical method for estimating the magnitude of bycatch in artisanal fisheries (Moore et al. 2010). Such surveys can provide an overview of the extent of bycatch, fishing effort, socioeconomic drivers of local fisheries, condition of the ecosystem as manifested in the size and quality of fishing yields, local ecological knowledge (LEK), local perceptions about conservation, and cultural ties to the marine environment.

Several studies on artisanal fisheries impacts on marine megafauna have used interviews to collect data from local communities and benefit from LEK (e.g., Dolar 1994, Krieb and Budiono 2005, Yeo et al. 2007, Hines et al. 2009). Duke University's Project GloBAL (Global Bycatch Assessment of Long-lived species) expanded this approach, using standardized questionnaires in various areas of the world and developing regional and country reviews of marine megafauna bycatch and artisanal fishing effort (Moore et al. 2010).

Limitations of interview data include biased responses and memory decay (Bernard 1988); the issue of bias is particularly relevant for the study of bycatch, as fishers may be fearful of punitive action or may view potential conservation efforts as a threat to their livelihood (Moore et al. 2010). However, given the time- and cost-effectiveness of interviews, they are valuable for providing at least a minimum estimate of bycatch at sites, in addition to background information on the health of associated marine ecosystems and the socioeconomic and cultural context of artisanal fishing communities.

Rapid Bycatch and Socioeconomic Assessment Methods

We conducted rapid bycatch assessment interviews in artisanal fishing villages in northern Madagascar to assess (1) the extent to which cetaceans, sea turtles, and sharks are captured, and (2) socioeconomic and cultural aspects of these fisheries and their relationship to marine megafauna. We asked about frequency of bycatch and deliberate capture; marine megafauna market values; cultural perceptions of marine megafauna (including local taboos, or *fadys*); fishing effort; fisheries trends; and concerns about fisheries management.

573 interviews were conducted in 13 sites (encompassing a total of 35 landing sites), from July 2009 through June 2010. Interviews were conducted by local research assistants and volunteers trained as interviewers, using structured questionnaires translated into Sakalava (a dialect of Malagasy). Respondents were found as interview teams canvassed the villages. No formal sampling method was used; as such, these results should not be assumed to be adequately rigorous for quantitative analysis or to be representative of the fishing communities. However, they offer a snapshot of the fishing practices and environmental impact of these communities.

Results & Discussion

Shark Bycatch & Targeted Capture

Shark capture, both accidental and targeted, was widespread. Bycatch of sharks was reported by 164 fishers and targeted catch was reported by 129. Sharks were most often captured in large-mesh (>20cm) nets known as *jarifa*, though they were also captured by longlines, other nets, and harpoons. Fins brought in the highest price, with the buyers mainly being Chinese, in addition to Comorian, African, and Malagasy buyers; meat was mainly consumed locally, but also bought by Comorian, African, and Malagasy buyers. Shark teeth, jaws, and oil were also reported as sold, with the teeth and jaws being mainly for purchase by tourists.

Roughly the same number of fishers reported an increase (106) and a decrease (113) in the number of sharks; often, fishers from the same landing site would report conflicting trends. Reasons given for an increase in the number of sharks include: few people catch them; they reproduce quickly; *jarifa* nets have been banned in some locations; natural seasonal fluctuation; and decrease in illegal fishing boats. Fishers reporting a decreasing number of sharks cited overexploitation, use of *jarifa* nets, foreign industrial fishing boats, and an increase in demand as explanations.

Fadys about sharks mainly related to restrictions on consumption of sharks by people possessed by *tromba*, or the spirits of dead kings. Some respondents also reported that it was *fady* to eat sharks because sharks had once saved their ancestors from drowning, or because sharks had once eaten their ancestors and thus possessed the spirit of their ancestors. General community feelings about sharks were largely negative, and fishers were happy when they caught sharks because (1) they dislike sharks and see them as enemies, and (2) shark parts, especially fins, could be sold for a high price.

Sea Turtle Bycatch

Sea turtle bycatch was frequent, with 133 respondents reporting accidental capture (and 18 reporting targeted capture). Most capture occurred in nets, including *jarifa*, and longlines, though some fishers reported catching them by hand while they were nesting. Most fishers would release accidentally caught sea turtles. 57 respondents said that they eat sea turtles that they capture, and 14 reported selling sea turtles. 25 reported collecting sea turtle eggs at some point in their lives, though many stated that they no longer do so due to regulations protecting the eggs. Respondents reported selling sea turtle meat, shells, and eggs.

203 respondents reported an increase in sea turtle numbers, citing regulations, reproductive capacity, and avoidance of fishers by sea turtles as explanations. 74 respondents reported a

decrease, due to extensive catch, *jarifa* nets, habitat degradation, people breaking laws, natural predators, and migration.

Fadys related to sea turtles included prohibitions against capturing them and eating them, and traditional methods for killing and butchering them (some respondents stated that a trained person needed to butcher the sea turtle in a ceremony). Many respondents seemed to translate current regulations against capturing sea turtles into *fadys*.

Cetacean Bycatch

37 respondents at 9 landing sites reported cetacean bycatch. 17 of these respondents were from three landing sites on the island of Nosy Faly. All reported bycatch occurred in nets, with mesh sizes ranging from 2cm to over 20 cm (*jarifa* nets); 11 fishers reported bycatch of cetaceans in *jarifa* nets. Reports of cetacean bycatch did not correspond with the extent to which *jarifa* nets were used in the fishing villages, suggesting that there may be across-site differences in dolphin distribution, methods of using *jarifa* nets, or willingness to report bycatch.

Bycaught cetaceans were reported as being released or killed if found alive, and discarded, eaten, sold, or distributed for consumption if found dead or killed. Consumption and sale of cetacean meat and oil was reported at 12 landing sites, and three landing sites where we did not find reports of bycatch reported prices for cetacean meat, suggesting that consumption of cetaceans occurs at least occasionally at those sites.

Several fishers reported that the capture and consumption of cetaceans was considered *fady*, or taboo, with a commonly-cited *fady* stating that cetaceans were viewed as saviors of drowning fishers. *Fadys* against harming cetaceans appeared to be stronger in the more northern fishing villages. This may have influenced the willingness of respondents to report bycatch.

Fishing Effort

Most fishers reported increasing fishing effort at their landing site, with 377 respondents reporting that the number of fishers had increased at their fishing grounds (37 reported a decrease, while 99 reported no change). Most respondents cited poverty and a lack of alternative livelihoods as an explanation for the increase in fishers (see Table 1).

Most respondents (324) noted a decrease in the total weight of their catch; 148 noted a decrease in the size of individual fish caught, though most respondents (333) noted no change. Decreases in catch size were mainly attributed to an increase in the number of fishers and overfishing, though a variety of explanations were given for trends in catch size (Table 2).

Table 1. Reported explanations for trends in the number of fishers.

Explanations for increase in No. of fishers	Explanations for decrease in No. of fishers
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Poverty Unemployment No other options No education (lack of interestor money) Immigration Population growth Farmers turned to fishing due to bad weather conditions for crops More people have access to boats, gear now Demand and price for marine products has increased Seen as a lucrative occupation Want to be their own bosses	Less/no fish here now Fishing conditions have worsened (e.g., due to sedimentation) Fishers broke <i>fadys</i> , now fishing is hard People left for other jobs (e.g., farming; jobs in the cities such as restaurants, tourism)
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Table 2. Reported explanations for trends in total catch size.

Explanations for decrease in catch size	Explanations for increase in catch size
Increase in number of fishers Overfishing Fewer fish now Fish have moved elsewhere Habitat destruction Climate change Illegal fishing Industrial fishing Disrespect of <i>fady</i> Disrespect of local fishing regulations Fish have learned to avoid fishing gear Earnings from selling fish decreased	Fewer fishers now More fish Seasonal fishing closures Change in fishing location Change in gear used

Fishers from the same site often had differing perceptions about fishing trends; though we have not yet looked closely at these conflicting responses, this may be due to differences in fishing grounds that fishers based at the same landing site used, differences in the length of time that a respondent had lived and fished in the area, or differences in the decisions and behavior of the people in a respondent's social circle.

Fadys about fishing included those dictating behavior while fishing (e.g., cannot be loud, whistle, point, speak the official Malagasy dialect), what cannot be brought on fishing trips (e.g., money, coconuts, ginger, manioc), and inappropriate times to go fishing (e.g., certain days of the week).

At one site, a recently-established *fady* prohibited people from fishing at night; this had evolved from a *dina*, or local regulation, to conserve stocks of a fish species. Other fishing regulations included time-area closures and gear restrictions, mainly aimed at fine-mesh nets but also including fishing with SCUBA tanks, dynamite, poison, and, in some sites, *jarifa* nets.

Conclusion

Many fishers were concerned about conserving marine resources, the impact of industrial fisheries, and opportunities to escape poverty. Some sites had active fishing associations and local governments that established local fishing regulations, which appeared to have a wide base of support in the communities and which at least some respondents credited with restoring depleted fish stocks. There was awareness about regulations protecting marine mammals and sea turtles from exploitation; the extent to which this may have influenced reports of bycatch is unknown. It appears that impacts of these fisheries on cetaceans are relatively low, though more in-depth work in the Nosy Faly area is warranted; reported exploitation and bycatch of sharks and sea turtles is cause for concern. Addressing the impacts of these fisheries on marine megafauna will require examination of the potential for alternative livelihoods and locally enforced regulations. These results demonstrate the deep human roots of fisheries interactions with marine megafauna that must be understood for effective management and conservation.

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