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An Overview of Destructive Fishing in the Philippines

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ABSTRACT

The Philippines, being positioned in the center of the coral triangle, is among the major-fish producing countries globally. However, in many parts of the country, illegal fishing is rampant, particularly destructive fishing practices (DFPs). Fisheries involving DFPs cause direct ecological damage to the corals. These fishing activities threaten both natural habitats and aquatic resources. In this review paper, we reviewed available scientific literature reporting the DFPs in the Philippines from 1979 to 2022. Results revealed that most DFPs, such as dynamite fishing, cyanide fishing, and muro-ami fishing, were prevalent and remained a lingering problem in the Philippines from the 1930s up to this date. The weak enforcement of the existing laws and regulations fuels these activities, compromising the productive coral reef areas in the Philippines. Thus, it is urgently necessary to cease these DFPs as well as protect the integrity of vital and fragile ecosystems. It is therefore recommended that strict implementation of the laws and regulations at local and national levels is likely to stop or if not least, reduce the pressing issues of destructive fishing techniques.

INTRODUCTION

As an archipelagic country in Southeast Asia, the Philippines has 7,641 islands with 2,200,000 km^2 of total territorial water, including an exclusive economic zone (EEZ) and a 27,000 km^2 coral reef area (BFAR, 2019; Tahiluddin & Terzi, 2021). The Philippine archipelago lies at the center of the Coral Triangle, the area that is home to the most marine species in the world (Veron, 1995; Allen & Werner, 2002; Carpenter & Springer, 2005; Muallil et al., 2014; Tahiluddin & Terzi, 2021; Mohamad et al., 2022). There are 3,645 fish species in the Philippines, and 3,213 species are marine (Froese & Pauly, 2022). The Philippines is known as one of the major fish producers in world fisheries. In 2020, the Philippines ranked 13th globally, contributing nearly 1.76 million metric tons in terms of marine capture production (FAO, 2022). Philippine capture fisheries are divided into commercial and municipal sectors. The municipal capture fisheries sector contributed 1.10 million metric tons to the total production in 2020, whereas the commercial capture fisheries sector contributed 0.98 million metric tons (PSA, 2021).

Fishing is one of the oldest forms of subsistence, relying on the abundance of aquatic resources for survival. Millions of people still rely on marine fisheries for livelihood and food even up to this date. However, due to the high demand, many fishers used illegal methods in order to catch fish faster and more profitably. Various forms of illegal fishing contribute to the depletion of fish stocks (Alvarico et al., 2021). Globally, nearly 80 percent of fish stocks have been depleted or overexploited. Ocean scientists claim that overfishing threatens not only aquatic ecosystems but also food webs and the aquatic food supply (Purcell et al., 2013; Arias & Pressey, 2016; Pala et al., 2018). The Philippines remains one of the most threatened countries with regard to marine ecosystems due to illegal fishing (Quiazon et al., 2013). Over the last years, fishing rates of the Philippine municipal fisheries have been decreasing (PSA, 2021); this may be attributed to the use of illegal fishing practices. Illegal and destructive fishing is one of the challenges facing marine fisheries (Tahiluddin & Terzi, 2021).

An illegal fishing practice that damages either the fished habitat or the primary habitats providing sustenance to the fished habitat is a destructive fishing practice (Pet-Soede & Erdmann, 1998a). The term destructive fishing refers to fishing gears or methods that cause ecosystem components to be destroyed or cease to function normally. In addition, a limited number of fishing gears or catches are inherently destructive methods, usually explosives and synthetic toxins (Willer et al., 2022). Due to increasing population growth and economic pressures, coral reef areas in the Philippines have been prone to destructive fishing since 1985, triggered by the coastal villagers (McManus et al., 1997). Destructive fishing has been one of the main causes of fishery decline in small-scale fisheries in the country for the last decades (Muallil et al., 2014).

The practice of destructive fishing is associated with poverty, as this is the faster way of capturing fish (Lauraya et al., 2010). A study by Alvarico et al. (2021) explored Filipino fishers' stories about why they used illegal fishing and the socio-economic and cultural factors that influenced the use of destructive fishing practices in coastal areas of northern Mindanao, Philippines, particularly Misamis Oriental. According to their findings, illegal fishing assisted the fishers in doing more and providing for their families with their essential needs since it doubled their catch, earned them more, and paid for medication for their sick family members. Since they used to fish together, they acquired their illegal fishing technique from their families, friends, and peers, which, according to them, was much more convenient and profitable than conventional fishing methods. The enforcement of laws is essential to restoring damaged marine habitats by curbing destructive and illegal fishing practices (Dalabajan, 2005). However, there are still persisting practices of destructive fishing in the Philippines, despite existing laws and regulations prohibiting them. In this paper, we reviewed and compiled the dispersed peer-reviewed scientific articles and books detailing destructive fishing practices, which were only confined to dynamite, cyanide, and muro-ami fishing practices in the Philippines from 1979 to 2022.

DYNAMITE (BLAST) FISHING

Dynamite fishing, also called bomb fishing or blast fishing, is one of the destructive fishing practices that uses explosives to stun or kill schools of fish (Katikiro & Mahenge, 2016). In the Philippines, the first dynamite is commonly prepared in a powder form consisting of 75% potassium chlorate, 15% charcoal, and 10% sulfur or cornstarch (Naughton, 1985). The commonly used blast fishing in the country is the use of dynamite or ammonium nitrate (Rubec, 1988). Anecdotal evidence shows that in the Philippines, an alternative to dynamite such as the use of locally available resources, like fertilizers (ammonium nitrate or sodium nitrate), prepared and mixed with kerosene or gasoline, and the explosive mixture is poured into an empty glass bottle. A makeshift fuse is created, stuck in the bottle, and sealed with rubber part of a flip-flop sandal around the fuse. As part of its operation, the explosive bottle is tied to a steel rod or similar heavy material to sink quickly. In the local fishing ground, explosive bottle with sinker is thrown at schools of fish or in coral reef areas. A few minutes after the explosion, the fishers dive and start collecting dead and stunned fish with the aid of a scoop net and compressor. The groupers (*Cephalopholus* spp., *Plectropomus* spp., and *Epinephelus* spp.), rabbitfish

(*Siganus* spp.), snappers (*Lutjanus* spp.), as well as reef associates such as fuseliers (*Pterocaesio* spp. and *Caesio* spp.) are the primary targets of dynamite fishers because of the increase in exports and the expansion of hotels and restaurants in the region (Pet-Soede & Erdmann, 1998b).

Apart from injuring and killing fish, dynamite fishing also destroys coral reefs, decimates reef habitats, breaks natural barriers that protect the coastline against storm surges and erosion, and threatens the reputation of the Philippines as an internationally renowned marine tourism destination (Chevallier, 2017). Marine organisms and coral habitats are damaged by dynamite fishing, which is a destructive and wasteful method (Alcala & Gomez, 1979; Yap & Gomez, 1985; Alcala, 2000; Raymundo et al., 2007). It is fairly straightforward to determine what the influences of dynamite fishing practices would be on the structure of reefs and productivity (Riegl & Luke, 1999; Alcala, 2000; Fox et al., 2003), and an increasing body of research is indicating that the removal of coral habitats likely to cause a decline in fish species (Lewis, 1997; Halford et al., 2004).

Dynamite fishing is a common issue worldwide, such as in Southeast Asia (Yap & Gomez, 1985; Pet-Soede & Erdmann, 1998a; Erdmann et al., 2000; Chou, 2000; Raymundo et al., 2007; Pacini et al., 2016; Hampton-Smith et al., 2021), Africa (Bigot et al., 2000; Wells, 2009; Pacini et al., 2016), and Oceania (Sulu et al., 2002; Brewer, 2013). In the Philippines, a number of different islands have practiced dynamite fishing since the 1930s, including the islands of Babuyan, Mactan, Bohol, Palawan, eastern Mindanao, Ozamis, Basilan, Misamis Occidental, Zamboanga Peninsula, and part of the Sulu Archipelago such as Turtle Island (Thomas, 1985; Magdaong et al., 2014), as fishers seek to improve production in the easier fashion (Pastoral & Ramiscal, 1997). Thus, dynamite fishing continues today, but it occurs at a local level, indicating that it still exists (Magdaong et al., 2014), and anecdotal evidence supports this study that even up to this date, dynamite fishing still continues to persist.

The use of dynamite fishing has also likely impaired innocent marine mammals. Veloria et al. (2021) stressed that marine mammals' ability to communicate, locate food, and navigate underwater was severely impacted by underwater noise including dynamite fishing. Dynamite and related impulsive sound exposure are associated with the hearing loss of marine life (Pacini et al., 2016). An experimental study assessed the effects of blast fishing on marine mammals, especially cetaceans, in San Fernando, La Union; the results indicated that marine mammals with more than 100 m from the explosion would suffer debilitating injuries (disorientation, acoustic trauma) even from a single pulse of the blast (Veloria et al., 2021). Over the past few years, a number of marine mammals have been stranded in the Philippines due to underwater explosions caused by blast fishing (Pacini et al., 2016). In addition, fishers accidentally wounded a British volunteer in 1991 with blast fishing while surveying coral reefs in the Samar Sea (Saeger, 1993).

CYANIDE FISHING

Cyanide fishing is widely used in the marine live reef fish food trade and marine aquarium fish trade, using sodium cyanide, a toxic chemical utilized to stupefy hard-to-catch species (Magdaong et al., 2014). Cyanide fishing in the Philippines has been practiced since 1962 in Central Visayas and Batangas, targeting tropical marine fish, especially agile and inaccessible reef fishes, and contributes an important role to the devastation of coral reefs and food and the dwindling of aquarium fish (Rubec, 1986; Cudia & Romero, 2022). Since the beginning of its use, over a million kg of toxic sodium cyanide have been spurted onto the Philippines' coral reefs to stupefy and collect ornamental aquarium fish species fated for the aquariums and pet shops in Western countries like North America and Europe (Barber & Pratt, 1997). Along with other illegal fishing practices, cyanide fishing is still a common problem in municipal waters (Baticados, 2004). In the late 2000s, it was estimated that over 260 000 cyanide fishers and fishing trips were recorded in the Calamianes Group of Islands alone (Dalabajan, 2005).

The preparation and operation of cyanide are clearly described by Rubec & Soundararajan (1990). Firstly, the cyanide tablets, about the size of hockey pucks, are broken down and placed into bottles of plastic detergent. The dissolved hydrocyanic acid (HCN) is used by the collectors to stupefy aquarium fishes and kill food fish; as the collector swims toward the target area, the fish hide in the coral. The collectors ensure all the exits are sealed off by spurting clouds of milky hydrocyanic acid solution on the coral head. During the dive, the concentration of hydrocyanic acid in the bottle is successively diluted. Nearly 50% of the exposed fish die of acute doses (5-50 mg L^{-1}) of being unable to control the concentration from the bottle. At the same time, the other remaining fish become bewildered and run away. Some stunned fish are retrieved from the bottom, while others are driven into gill nets. Roughly 10% of the exposed fish are being selected by the fish collectors choosing only the colorful species of interest to aquarists. Most fish can get recovered once placed in clean seawater (Rubec & Soundararajan, 1990).

A number of colorful species, including the clownfish *Amphiprion ocellaris* and large-sized wrasses and groupers, are targeted by illegal cyanide fishing in the Indo-Pacific region, including the Philippines (Madeira et al., 2020). However, the use of sodium cyanide is deleterious to non-target aquatic organisms, like corals and other invertebrates (White & Wells, 1982; Rubec, 1988; Barber & Pratt, 1997), especially larvae forms (Werorilangi et al., 2019), including phytoplankton such as marine diatom (Pablo et al., 1997), as a consequence of uncontrollable exposure doses of cyanide by the fish collectors during dive operation (Rubec & Soundararajan, 1990). Coral reefs of the Philippines have been threatened by cyanide fishers for the past years. White & Wells (1982) estimated that in every 100 fish collectors that use cyanide, about 11 million coral heads are being squirted by cyanide. The authors also mentioned coral heads exposed to cyanide are typically dead but intact, unlike dynamited corals which are fragmented. In addition, cyanide is highly dangerous to humans once inhaled, absorbed across the skin, or ingested (White & Wells, 1982; Graham & Traylor, 2022).

MURO-AMI FISHING

Muro-ami is destructive fishing that originated in Japan around the 1930s, where Okinawan migrant fishers came to the central Philippines to fish (Anonymous, 1985; Olofson, 2014). It consists of a big stationary bag net (37 m long × 10 m deep), held open with the aid of a current (Dalzell & Ganaden, 1987; Gomez et al., 1994). There are two detachable wings with a size of 100 m × 10 m, which serve as a guide for the fish towards the net (Anonymous, 1985). It is usually set over the coral reefs with a depth ranging from 13-30 m, with flagpole buoys serving as markers (Anonymous, 1985). Scarelines, made of ropes with plastic strips which are tied at intervals and 3-5 kg of stone weights on edge, are held by the swimmers aiming to drive fish into the nets and to jig them up and down on the corals as they proceed (Anonymous, 1985; Magdaong et al., 2014). Commercial muro-ami uses 200-300 swimmers, which are typically young boys, to frighten the fish (Anonymous, 1985; Dalzell & Ganaden, 1987). The majority of fish caught by muro-ami fishing in the Philippines are shoaling herbivores and planktivores of the Acanthuridae (surgeon fishes, *bagis* and *labahita*) and Caesionidae (fusiliers or *dalagang-bukid*) families (Anonymous, 1985).

A modified form of muro-ami, which is *kayakas*, used bamboo instead of rocks to scare the fish driving into the net (White & Wells, 1982; Magdaong et al., 2014). Banging the bottom by the swimmers with rocks or bamboo, the habitats are being disturbed, and pronounced effects are the corals which are pounded and broken as a result of this mode of operations (White & Wells, 1982). The reduction of coral reef cover has been attributed to these operations inducing overfishing as a result of slow recovery and replenishment of disturbed fish stocks (Magdaong et al., 2014). With the frequent use of muro-ami, it is no longer providing a livelihood for coastal villagers but rather further creating poverty among rural Filipinos (Olofson & Tiukinhoy, 1992). Moreover, due to its extensive damage to coral reef habitats brought about by muro-ami, which can cause depletion of the fish stock population, increasing protests from different sectors raised awareness of this destructive gear (Miclat et al., 1991). Additionally, socio-economic issues like child labor, inequitable profit-sharing system practiced among fishing cooperation, and lack of health and shipboard sanitary conditions (Miclat et al., 1991). These have prompted demands to ban this fishing method in the country, and in 1986, commercial muro-ami was banned (Dalzell & Ganaden, 1987; Miclat et al., 1991). Considering an alternative

Table 1. Philippines' regulations and penalties for dynamite fishing, cyanide fishing, and muro-ami fishing

Regulation Categories	Specific Regulations	Penalties
Republic Act 10654, section 92 (Prohibition on the use of fishing through toxic or poisonous substances and explosives)	Actual use of toxic or poisonous substances, explosive including those not caught illegally if they co-exist with those caught illegally	• Taking the gears and catch and inflicting an administrative fine equivalent to five times the catch's value • A fine of 3,000,000 pesos is imposed for large-scale commercial fishing • A fine of 1,500,000 pesos is imposed for medium-scale commercial fishing • A fine of 300,000 pesos is imposed for small-scale commercial fishing • A fine of 30,000 pesos is imposed for municipal fishing • 5 to 10 years in prison
	Explicit criminal cases are filed when explosives, toxic or poisonous substances are actually used and result in physical harm or death	• Taking the gears and catch and inflicting an administrative fine equivalent to twice the catch's value • A fine of 1,000,000 pesos is imposed for large-scale commercial fishing • A fine of 500,000 pesos is imposed for medium-scale commercial fishing • A fine of 300,000 pesos is imposed for small-scale commercial fishing • A fine of 10,000 pesos is imposed for municipal fishing • 6 months to 2 years in prison
Republic Act 10654, section 97 (Prohibition on Muro-ami drive fishing)	Actual use of muro-ami fishing	• Taking the gears and catch and inflicting an administrative fine equivalent to five times the catch's value • A fine of 2,000,000 pesos • In the case of failure to pay the fine, fishworkers who serve as pounders will be penalized with 20,000 pesos or community service • A fine equivalent to twice the administrative fine and imprisonment of 2 - 10 years
Act No. 2255	An act prohibiting the manufacture, possession, and sale of dynamite and other explosives without a special permit, providing a penalty, therefore, and for other purposes.	• Fine not to exceed 2,000 pesos but not to be less than 600 pesos, and by imprisonment for not less than 3 months nor more than 3 years, in the discretion of the court.
Presential Decree No. 534 August 8, 1974	Imposing stiffer penalties for illegal fishing	• If explosives are used, 10-12 years in prison • In the case of a physical injury caused by the explosion, the punishment may range from 12-20 years in prison, and if human life is lost, then the penalty is life in prison or death • If toxic or poisonous substances are used, 8-10 years in prison • In the case of a physical injury caused by such substances, the punishment may range from 10-12 years in prison, and if human life is lost, then the penalty is up to 20 years or life in prison or death
Republic Act 6969	The Act provides penalties for violations of the sale, purchase, and possession of toxic and hazardous substances, including sodium cyanide.	• The penalty ranges between 6 years and 1 day to 12 years in prison, and a fine of at least 250,000 pesos
FAO 163	Governing Philippine waters by prohibiting the operation of *kayakas* and muro-ami	• The Court may impose a fine of 500 pesos to 5,000 pesos, or imprisonment of 6 months to 4 years, or both

non-destructive method, the Bureau of Fisheries and Aquatic Resources of the Philippines proposed a "Pa-aling," a new modified gear as a substitute to muro-ami. The new technique involves the use of bubbles, powered by surface-supplied air via plastic hoses, to frighten and drive towards a set-net (Miclat et al., 1991).

REGULATION OF DESTRUCTIVE FISHING

Law enforcement is an efficient way of controlling the widespread use of destructive fishing in the Philippines as a promising solution to regenerate deteriorated marine habitats (Dalabajan, 2005). The Philippines has various existing laws and regulations against destructive fishing and penalties for committing these unlawful practices (Table 1). However, over the last decades, weak law enforcement is still one of the main reasons for the prevalence use of destructive fishing (Barber & Pratt, 1998). Areas that are far from law enforcement are among the most users of destructive fishing, such as dynamite fishing (Dalzell & Ganaden, 1987). Scientists and researchers are even developing or improving some way of detecting fish caught by destructive fishing. For instance, the use of potentiometry for cyanide detection has recently been improved by Cudia & Romero (2022); this method can be used to monitor any cyanide-caught fish for better regulation.

Aside from national laws and regulations, municipal ordinances throughout the country also exist. However, in most municipalities, these ordinances are not being implemented or are weakly enforced (Lauraya et al., 2010). For example, in Barangay Atulayan, Sangay municipality, Camarines Sur province, due to the indolent grind of the wheels of justice, the barangay captain lost hope in implementing the law. There were many instances when the barangay captain had apprehended many violators caught with dynamite possessions, reported and turned them over to the Philippine National Police (PNP) officers. However, after the investigation, the PNP argued that the confiscated dynamites were sodium nitrate or fertilizers. The lack of further investigation by the higher authority ignited the barangay captain's loss of faith in implementing the ordinance (Lauraya et al., 2010).

CONCLUSION

It is evident that destructive fishing practices, such as dynamite fishing, cyanide fishing, and muro-ami fishing, are still prevalent methods of capturing marine resources in the Philippines. These practices threaten marine habitats, particularly the coral reefs - crucial habitats of most reef fishes, and jeopardize the sustainability of local fishing livelihood. Despite existing law enforcement governing these illegal, destructive fishing practices, the lack of effective regulation still fuels the lingering of these practices. It is therefore recommended that strict implementation of the laws and regulations at the local and national levels is likely to stop or if not least, reduce the pressing issues of destructive fishing techniques. Sustainable fishing practices, such as spear fishing and line fishing, are still the friendly way to capture fishing sustainably while maintaining a sound and healthy environment.

Compliance with Ethical Standards

Authors' Contributions

Both authors have contributed equally to this paper.

Conflict of Interest

The authors declare that there is no conflict of interest.

Ethical Approval

For this type of study, formal consent is not required.

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