The negative impacts of gillnet fishing on marine ecosystems: a scientific review

Julio Benavides, MSc, PhD

Research Professor, Universidad Andres Bello, Chile

Affiliated Researcher, University of Glasgow, UK

Turneffe Atoll Trust

Contents

Introduction

If Belize's goal is to obtain long-term benefits from its fishing sector and preserve its highly diverse marine ecosystems for its tourism industry, sustainable fishing practices are essential. Indiscriminate fishing gear, such as gillnets, results in both declining fishing stocks and threats the survival of marine species that attract tourists to Belize from all over the world. Limiting these harmful and unsustainable fishing practices should be a priority and this is broadly supported by scientific evidence demonstrating the negative impacts of gillnet fishing.

There is substantial scientific evidence that gillnets have resulted in fish population declines worldwide, taking several fish species to near extinction (Syrja and Valkeaja, 2010). Additionally, the negative impacts of gillnets extend to many other marine species (Regular *et al.*, 2013). Gillnets have low selectivity and high mortality rates associated with their bycatch and this represent a major threat to coastal ecosystems (Dunn *et al.*, 2010). Gillnet bycatch negatively affects a wide range of species including turtles, marine mammals, sharks and seabirds. For some of these species like turtles, gillnets are considered the main threat to their survival. Lost gillnets can also be highly detrimental. Although less studied, lost gillnets also manifest negative effects by damaging corals and polluting water with plastic. Detrimental effects on corals and plastic pollution produces cascading effects for other species dependent on corals. In this report, we detail scientific-based arguments for the negative impacts of gillnet fishing on several species in Belize.

I- Negative impacts of by-catch

1- Turtles

Bycatch from gillnets, even on a small-scale, is one of the major drivers of sea turtles decline (Lewison and Crowder, 2007; Gilman *et al.*, 2010). For example, up to 3000 adult female leatherbacks are estimated to be caught by gillnets in Trinidad annually, accounting for 35% of the mortality risk of turtles (Lum, 2006). Compared to other techniques such as longlines, gillnets have a very high mortality related to bycatch, even if the intent is to release the turtles. In Mexico, bycatch from small-scale gillnet fishing is considered among the biggest current threats to turtles, with estimates of up to 1000 loggerhead turtles dying in gillnets annually, and a 73% mortality for turtles caught as bycatch (Peckham *et al.*, 2007). Gillnet fishing is considered a major threat to the recovery of several turtles species present in Belize including hawksbill, green, loggerheads and leatherback turtles (NOAA, 2018). Overall, gillnets represent a major threat to the sea turtle populations of Belize - species that are already affected by coastal development and climate change.

Foley, Mark T., 1943-. *Green sea turtle killed in gill net.* State Archives of Florida, Florida Memory. <https://www.floridamemory.com/items/show/134441>, accessed 2 April 2019

2- Marine mammals (dolphins and manatees)

Indiscriminate bycatch by gillnets also affects large marine mammals such as cetaceans and manatees. Increasing evidence shows a high mortality rate associated with bycatch of marine mammals (Northridge *et al.*, 2017). For example, at least 15 species of cetaceans are caught in gillnets of Central America and the wider Caribbean (Vidal, Waerebeek and Findley, 1994). Worldwide, bycatch related to fishing techniques such as gillnets has a significant negative effect on the demographics of many marine mammals (Read, Drinker and Northridge, 2006). For example, gillnets have taken the endemic cetacean vaquita porpoise to near extinction in Mexico and a gillnet ban has been recommended as a last resort to avoid the vaquita's extinction (Agrosa, Lennert-cody and Vidal, 2000; Taylor *et al.*, 2017). Gillnets also cause mortality of manatees (Northridge *et al.*, 2017). Although further research on specific impacts is needed, gillnets are a clearly a major threat to marine mammals of Belize.

3- Sharks

Gillnets are very detrimental to sharks and are considered one of the main reasons for the broad-scale absence of sharks on reefs in the greater Caribbean (Ward-paige *et al.*, 2010). Gillnets are intentionally used to catch sharks, but sharks can also be victims of gillnet by-catch. In fact, it is estimated that bycatch of sharks causes almost 100% mortality (FAO). In addition to direct mortality, gillnets also cause physiological changes in sharks associated with the stress of the catch and the consequences of this for their survival is unknown (Frick, Reina and Walker, 2009). Therefore, gillnets are a major threat for the shark populations of Belize.

NOAA Central Library Historical Fisheries Collection

4- Fish

Artisanal fisheries throughout the wider Caribbean utilize gillnets and their ecological consequences on many fish species can be profound, although these consequences remain poorly understood (Dunn *et al.*, 2010). Although economically beneficial to some small-scale artisanal fisherman, gillnets have detrimental effects if they are used unsustainably. Given that most gillnet fishing is indiscriminate, it has resulted in the sharp decline of many fish stocks. For example, artisanal gillnets have caused the near extinction of several fish species worldwide, as well as the local extinction of Nassau grouper in the southern Mexican Caribbean coast (Aguilar-perera, 2006; Syrja and Valkeaja, 2010). Similarly, gillnets have contributed to the critically endangered status of sawfishes that are easily captured as bycatch by gillnets (Guttridge *et al.*, 2015; Dulvy *et al.*, 2016). Available scientific evidence, therefore, recommends that sustainable fishing in Belize use other fishing techniques and avoid the use of gillnets.

5- Sea birds

"Gillnets have been the cause of some of the highest recorded mortalities of seabirds worldwide. The status of seabird populations is deteriorating faster than other bird groups and bycatch in fisheries is identified as one of the principle causes of declines." (Žydelis *et al.*, 2009; Žydelis, Small and French, 2013). Few diving seabird species live in the Caribbean, and there is no available data from the Caribbean reporting seabird bycatch by gillnets (Žydelis, Small and French, 2013). However, given the overall negative impact of gillnets on seabird species (Regular *et al.*, 2013; Žydelis, Small and French, 2013), we expect similar negative effects in Caribbean species that are yet to be quantified. Overall, the example of seabirds

illustrates that unexpected and non-reported negative impacts of gillnets on species such as birds are probably under-reported despite their high impact to the marine ecosystem.

II- The unnoticed but high impacts of lost gillnet gear: the consequences of ghost fishing

It is well known that a large proportion of lost gillnets drift on currents and continue to bycatch animals for several years, or otherwise sink to the sea bottom and pollute ecosystems such as corals with non-biodegradable plastics (Valderrama Ballesteros, Matthews and Hoeksema, 2018). 'Ghost fishing occurs when lost fishing gear continues to catch and kill animals' (Breen, 1990) and it can have dramatic consequences on marine animals for several years (Matsuoka, Nakashima and Nagasawa, 2005). Furthermore, gillnets show up on coral reefs or beaches months after they are lost (Valderrama Ballesteros, Matthews and Hoeksema, 2018).

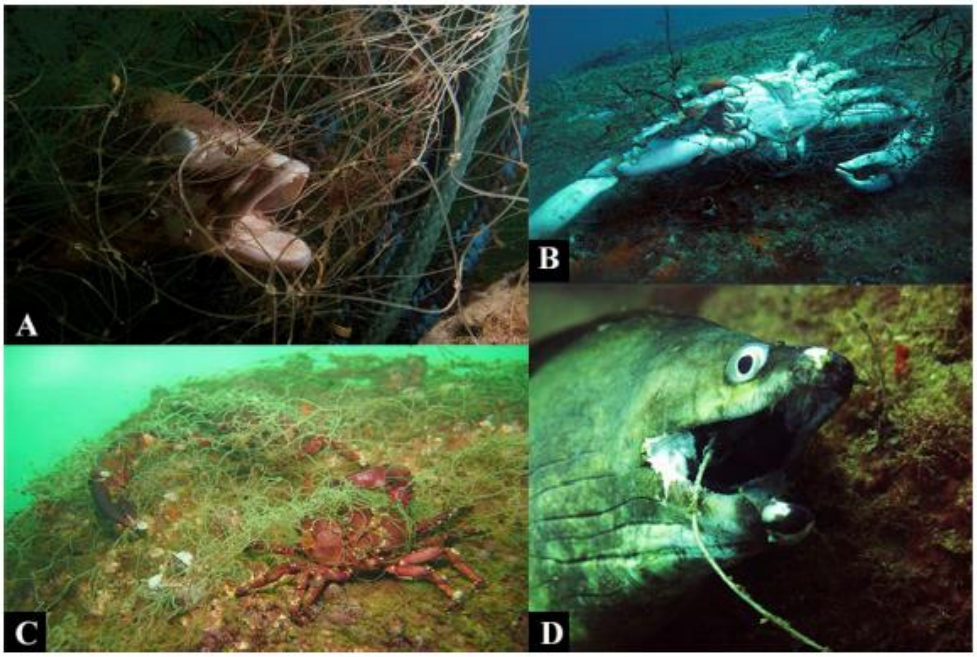

Fig. 2. Examples of entanglements and ingestion of ALDFG. (A) Fish tangled in a ghost net, Arvoredo Island, Brazil (Photo: Daniel Pohl). (B) Dead crab in ghost net (Photo: Jéssica Link). (C) Crab tangled in ghost net, Arvoredo Marine Biological Reserve, Brazil (Photo: Edson F. Junior). (D) Dead moray due to ingestion of fishing gear, Arvoredo Island, Brazil (Photo: Jessica Link).

Figure 2. from Link et al. 2019: 'Abandoned, lost or otherwise discarded fishing gear in Brazil: A review'. Perspectives in Ecology and Conservation.

A major concern for Belize's marine ecosystems related to gillnets is the large amount of scientific evidence demonstrating that lost gear can have major detrimental effects to coral reefs. Given the fragility of corals, their soft tissues can be easily damaged when in contact with lost gillnets (Valderrama Ballesteros, Matthews and Hoeksema, 2018). Several studies show that coral reefs are being substantially damaged by lost gillnets worldwide. For example, 69% of live coral reefs located beneath lost gear where damaged in Thailand, and branching coral were particularly affected because they are easily entangled in nets, lines and ropes (Valderrama Ballesteros, Matthews and Hoeksema, 2018). Similarly, a review study showed that there are at least 32 studies reporting the presence of abandoned, lost or discarded fishing gear, including gillnets, either on beaches or submerged in coastal areas and oceanic islands of

Brazil (Figure 2). These studies pointed out that the gillnets found were used for both legal and illegal artisanal fishing. Finally, a study conducted on Hawaiian coral reefs showed that 'derelict fishing gear (composed of 34% by gillnets) posed a persistent threat to the coral reef ecosystems' (Donohue *et al.*, 2001). Although there are no studies quantifying the impact of lost gillnets on Belize's coral reefs, evidence from other coral reefs across the globe highlight that negative impacts are happening and that they likely add to the stresses on already fragile coral ecosystem that are threatened by increasing temperatures due to global warming.

Conclusions

This report highlights that gillnets have major negative impacts on Belize's marine species including fish, turtles, marine mammals and coral reefs. In addition to direct effects, such as reducing fish stocks, gillnets have detrimental effects related to indiscriminate by-catch and plastic pollution associated to lost gear. Although evidence of these effects in Belize has yet to be quantified, other countries in the Caribbean have experienced gillnets effects that have taken species such as the cetacean vaquita to near extinction. Gillnets are the main threat of several turtle's species, cetaceans and sharks. Gillnets also damage the highly diverse coral ecosystems. likely causing cascade effect for fishing populations and other larger marine animals which depend on these corals. In summary, the available scientific evidence strongly suggests not using gillnets if Belizean marine life is to be preserved for the benefit of both sustainable commercial fishing and its tourism industry.

References

Agrosa, C. D., Lennert-cody, C. E. and Vidal, O. (2000) 'Vaquita Bycatch in Mexico ' s Artisanal Gillnet Fisheries : Driving a Small Population to Extinction', 14(4), pp. 1110–1119.

Aguilar-perera, A. (2006) 'Disappearance of a Nassau grouper spawning aggregation off the southern Mexican Caribbean coast', *Marine Ecology Progress Series*, 327, pp. 289–296.

Breen, P. A. (1990) 'A review of ghost fishing by traps and gillnets', *Proceedings of the Second International Conference on Marine Debris, 2-7 April 1989*, (1990), pp. 571–599.

Donohue, M. J. *et al.* (2001) 'Derelict fishing gear in the Northwestern Hawaiian Islands: Diving surveys and debris removal in 1999 confirm threat to Coral Reef ecosystems', *Marine Pollution Bulletin*, 42(12), pp. 1301–1312. doi: 10.1016/S0025-326X(01)00139-4.

Dulvy, N. K. *et al.* (2016) 'Ghosts of the coast: Global extinction risk and conservation of sawfishes', *Aquatic Conservation: Marine and Freshwater Ecosystems*, 26(1), pp. 134–153. doi: 10.1002/aqc.2525.

Dunn, D. C. *et al.* (2010) 'A regional analysis of coastal and domestic fishing effort in the wider Caribbean', *Fisheries Research*, 102, pp. 60–68. doi: 10.1016/j.fishres.2009.10.010.

FAO (no date) *http://www.fao.org/3/v3210e/V3210E04.htm#ch2.3*.

Frick, L. H., Reina, R. and Walker, T. (2009) 'The Physiological Response of Port Jackson Sharks and Australian Swellsharks to Sedation , Gill-Net Capture , and Repeated Sampling in Captivity', *North American Journal of Fisheries Management*, pp. 127–139. doi: 10.1577/M08-031.1.

Gilman, E. *et al.* (2010) 'Mitigating sea turtle by-catch in coastal passive net fisheries', *Fish and Fisheries*, 11, pp. 57–88. doi: 10.1111/j.1467-2979.2009.00342.x.

Guttridge, T. L. *et al.* (2015) 'Occurrence and habitat use of the critically endangered smalltooth sawfish Pristis pectinata in the Bahamas', *Journal of Fish Biology*, 87(6), pp. 1322–1341. doi: 10.1111/jfb.12825.

Lewison, R. L. and Crowder, L. B. (2007) 'Putting Longline Bycatch of Sea Turtles into Perspective', *Conservation Biology*, 21(1), pp. 79–86. doi: 10.1111/j.1523-1739.2006.00592.x.

Lum, L. L. (2006) 'Assessment of incidental sea turtle catch in the artisanal gillnet fishery in Trinidad and Tobago, West Indies', *Applied Herpetology*, 3(4), pp. 357–368. doi: 10.1163/157075406778905081.

Matsuoka, T., Nakashima, T. and Nagasawa, N. (2005) 'Review Article A review of ghost fishing : scientific approaches to', *Fisheries Science*, (i), pp. 691–702.

NOAA US DEPARTMENT OF COMMERCE (2018) *Estimated Bycatch of Sea Turtles in Sink Gillnet Gear Estimated Bycatch of Sea Turtles in Sink Gillnet Gear*.

Northridge, S. *et al.* (2017) 'Disentangling the causes of protected-species bycatch in gillnet fisheries', *Conservation Biology*. John Wiley & Sons, Ltd (10.1111), 31(3), pp. 686–695. doi: 10.1111/cobi.12741.

Peckham, S. H. *et al.* (2007) 'Small-Scale Fisheries Bycatch Jeopardizes Endangered Pacific Loggerhead Turtles', *PLoS ONE*, (10), pp. 1–6. doi: 10.1371/journal.pone.0001041.

Read, A. J., Drinker, P. and Northridge, S. (2006) 'Bycatch of Marine Mammals in U . S . and Global Fisheries', *Conservation Biology*, 20(1), pp. 163–169. doi: 10.1111/j.1523-1739.2006.00338.x.

Regular, P. *et al.* (2013) 'Canadian fishery closures provide a largescale test of the impact of gillnet bycatch on seabird populations', *Biology Letters*, 9(4). doi: 10.1098/rsbl.2013.0088.

Syrja, J. and Valkeaja, P. (2010) 'Gillnet fishing drives lake-migrating brown trout to near extinction in the Lake Paijanne region , Finland', *Fisheries Management and Ecology*, pp. 199–208. doi: 10.1111/j.1365-2400.2010.00738.x.

Taylor, B. L. *et al.* (2017) 'Extinction is Imminent for Mexico ' s Endemic Porpoise Unless Fishery Bycatch is Eliminated', *Conservation Letters*, 10(October), pp. 588–595. doi: 10.1111/conl.12331.

Valderrama Ballesteros, L., Matthews, J. L. and Hoeksema, B. W. (2018) 'Pollution and coral damage caused by derelict fishing gear on coral reefs around Koh Tao, Gulf of Thailand', *Marine Pollution Bulletin*. Elsevier, 135(March), pp. 1107–1116. doi: 10.1016/j.marpolbul.2018.08.033.

Vidal, O., Waerebeek, K. Van and Findley, L. T. (1994) 'Cetaceans and Gillnet Fisheries in Mexico, Central America and the Wider Caribbean: A Preliminary Review', *Rep. Int. Whal. Commn*.

Ward-paige, C. A. *et al.* (2010) 'Large-Scale Absence of Sharks on Reefs in the Greater-Caribbean : A Footprint of Human Pressures', *PLoS ONE*, 5(8). doi: 10.1371/journal.pone.0011968.

Žydelis, R. *et al.* (2009) 'Bycatch in gillnet fisheries - An overlooked threat to waterbird populations', *Biological Conservation*, 142(7), pp. 1269–1281. doi: 10.1016/j.biocon.2009.02.025.

Žydelis, R., Small, C. and French, G. (2013) 'The incidental catch of seabirds in gillnet fisheries: A global review', *Biological Conservation*, 162(August), pp. 76–88. doi: 10.1016/j.biocon.2013.04.002.