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COMMENTARY

Biodegradable fishing gear: part of the solution to ghost fishing and marine pollution

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Abandoned, lost and discarded fishing gear (ALDFG) cause substantial ecological and socioeconomic problems. Ghost fishing occurs when ALDFG continues to catch and kill organisms, which can contribute to compromising the viability of some populations of at-risk species (Kaiser *et al.*, 1996; IWC, 2013; Gilman, 2015; Gilman *et al.*, 2016). Mortalities from ghost fishing are a source of wastage and reduce the economic viability of the fishing sector. Ghost fishing removes as much as 30% of landed catches of market species in some fisheries (Gilman *et al.*, 2016). There are also social concerns over ghost fishing mortality of flagship megafauna and over the relatively long duration for organisms caught in ALDFG to die (IWC, 2013). Floating marine debris can form mass concentrations, altering ecological communities, while ALDFG that sinks can adversely affect benthic habitats (Derraik, 2002; Macfadyen, Huntington & Cappel, 2009). ALDFG can transport invasive alien species. Synthetic compounds, including microscopic plastic material and toxic chemicals derived from some fishing gear components, and from lead in fishing weights, accumulate in marine food webs (Derraik, 2002; Gilman *et al.*, 2016).

The amount, distribution and effects of ALDFG have risen substantially over recent decades with the rapid expansion of fishing effort and fishing grounds, and the transition to synthetic, more durable and buoyant fishing gear materials (Derraik, 2002; Macfadyen *et al.*, 2009). Kim *et al.* (2016) developed a new synthetic material for monofilament twine of gillnets and assessed its breaking strength, amount of time to begin degrading and fishing efficiency relative to the conventional nylon twine used in the Korean coastal yellow croaker *Larimichthys polyactis* benthopelagic gillnet fishery. Ghost fishing is thought to be most problematic in gillnets and other passive fishing gears, where the capture process relies on the movement of organisms into the gear (Matsuoka, Nakashima & Nagasawa, 2005; Gilman *et al.*, 2013). Kim *et al.* (2016) found that the experimental twine began to be degraded by microbes after 2 years in seawater. Conventional gillnets made of nylon monofilament can take decades to degrade (Carr *et al.*, 1985). Derelict gillnets can maintain some ghost fishing efficiency for several years, especially ALDFG that was set for fishing when lost or abandoned; at a site with low energy, low likelihood of being disabled by a passing vessel or fishing gear and with limited biofoulers, debris and particulate matter; and when they become entangled on objects that hold the net in place (Kaiser *et al.*, 1996; Gilman *et al.*, 2016). The experimental twine, when wet, had a similar breaking strength but was stiffer than the conventional nylon monofilament. Despite being stiffer, which could be expected to reduce fishing efficiency, there was no significant difference in catch rates of the two main market species between the experimental and control nets, indicating that nets made of the experimental twine may be economically viable. Furthermore, the experimental netting had a significantly lower catch rate of unwanted juvenile yellow croaker, supporting improved catch levels of adult age classes of this target species.

Kim *et al.*'s (2016) findings are encouraging, contributing to a small but growing body of literature on the use of weaker and degradable gear to reduce ghost fishing. Many critical questions remain. The possibility that weaker and degradable fishing gear would increase the frequency that gear components require repair and replacement, and increase gear loss, requires investigation (Gilman *et al.*, 2016).

Preventative methods reduce the incidence of fishing gear from becoming abandoned, lost and discarded. Remedial methods reduce ghost fishing efficiency and the duration that ALDFG remains in the marine environment (MacMullen *et al.*, 2003; Gilman, 2015; Gilman *et al.*, 2016). In general, preventative methods, such as separating fisheries using passive and mobile gears, and gear marking to identify ownership and increase passive gear visibility, are more cost effective than remedial methods – it is less expensive to prevent gear abandonment, loss and discarding than it is, for example, to detect and then disable or remove derelict gear (Macfadyen *et al.*, 2009). Furthermore, because some remedial methods, such as the use of less durable materials for fishing gear components, can compromise economic viability and be less practical to use, efforts focusing on preventative methods and remediation via quick recovery of ALDFG are likely most effective (Suuronen *et al.*, 2012; Gilman *et al.*, 2016).

In addition to preventing and remediating ALDFG, improvements are needed in fisheries management systems to

effectively estimate and account for ghost fishing removals and other indirect, collateral sources of fishing mortality (Gilman, Passfield & Nakamura, 2014; Gilman *et al.*, 2016). Errors result when population and stock assessment models do not account for total fishing mortality, including unaccounted ghost fishing mortalities. Despite increasing international recognition of the problem, there remain large opportunities to improve intergovernmental organizations' data collection protocols and management measures to monitor and mitigate ALDFG and ghost fishing (Gilman, 2015).

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