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COMMENTARY

Biodegradable nets are not a panacea, but can contribute to addressing the ghost fishing problem

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For some decades, the capture of marine animals by Abandoned, Lost, or otherwise Discarded Fishing Gear (ALDFG) has been identified as a major issue for both fisheries and marine conservation (Laist, 1987; Macfadyen, Huntington & Cappell, 2009). ALDFG raises a number of issues, including stock depletion for species targeted by the fishery, mortality to non-target species, which in some cases are species of conservation concern (Derraik, 2002; Wilcox *et al.*, 2015), hazards to other vessels due to fouling of propellers or fishing gear, and costs for removal that are imposed on public agencies or other bodies (Macfadyen *et al.*, 2009).

Kim *et al.* (2016) explore biodegradable polymers as a possible solution to the issue, for passive fishing gear such as gillnets and trammel nets. These nets had only slightly lower catch rates than conventional nylon nets in field tests, and yet they showed clear signs of degradation within 2 years of introduction to salt water.

While it is commendable that Kim *et al.* (2016) have developed a nylon substitute for fishing gear that degrades back to the monomer, and eventually the elemental level, leaving no plastic residue in the environment, there are a number of significant issues with the solution they propose, even for ALDFG in the Korean croaker fishery they use as a pilot study. First, the time required for the gear to degrade is likely far longer than the time it effectively fishes. A large study across a number of European gill net fisheries found that derelict gear lost its fishing capacity rapidly, declining to 20% within one to 4 weeks of being lost (Pawson, 2003). This is driven primarily by fouling of the net by currents, bottom obstructions, and organisms attached or entangled in the net. Thus, if a biodegradable net does not show significant evidence of degradation until 2 years after its loss, its degradability is likely to have little impact on its catch of target or non-target species. Second, the authors do not present any comparison of degradation over time as compared to conventional nylon, nor do they test the breaking strength or other characteristics of the biodegradable net over its degradation period. While Kim *et al.* do present high-resolution images of the biodegradable material showing evidence of breakdown, overall the net filaments look largely intact even after 3.5 years (Kim *et al.*, 2016; fig. 7). Thus, it may be that the biodegradable net has an effective lifetime in the sea similar to a conventional nylon net. Third, adoption by fishermen will likely present a significant hurdle. Creating a net that begins to degrade once it encounters seawater will likely increase the costs of fishing, as it will shorten the lifetime of the gear, increasing the cost of maintaining the gear. Fishermen are likely to be acutely aware of this, as one of the primary strains on the gear will be during hauling, and thus nets will be likely to break during the active phase of their operation. Any shortening of gear life will be further magnified by the additional cost of the biodegradable gear, thus further increasing the cost burden born by the fishermen. The authors mention subsidies to entice fishermen to use the biodegradable gear, however, subsidies are generally being phased out of fisheries management and frequently lead to many other negative outcomes such as overinvestment and overcapacity.

The idea of biodegradable gear is not without merit. It needs to be integrated into a larger framework, and Kim *et al.* (2016) largely missed the opportunity to articulate this framework and how their innovation might address an essential need in meeting the ALDFG challenge. There are at least three components to reducing the effect of ALDFG. First, ensuring that gear incorporates components that reduce the chance of loss can significantly reduce the problem. These range from markers, such as lights, underwater acoustic transmitters, and radar reflectors to simply marking the gear with the identity of its owner. Second, innovations that reduce the fishing effectiveness of gear when it is lost can reduce the effect of ADLFG. While biodegradable materials could play a role in this aspect, the time required for Kim and colleagues' design to decompose is likely to be far too long, as most biological impacts from lost gear occur in the weeks to months after loss. An alternative approach would be to design the gear such that it collapses after a short period unattended, minimizing its size and fishing effectiveness. An advantage of this approach is that it would not require weakening the gear in any way that would affect cost. Trap fisheries in many contexts have adopted this approach, using escape hatches that open after a period unattended in salt water (e.g. Bilkovic *et al.*, 2012). Third, incorporating mechanisms that increase the chance of recovery of lost gear can provide a backup for gear that is lost. Marking technologies again can be useful, but also basic information tools such as mapping lost gear can lead to significant improvements. There are a number of trap fisheries around the world that have implemented systems for recovering lost gear, which in some cases have proven to be economically profitable and thus self-sustaining (e.g. Dungeness crab fishery in Oregon, USA; Arthur *et al.*, 2014). In a context where there is gear marking, gear that is automatically disabled after loss, and in which fishers and gear design both contribute to recovery of lost gear, biodegradation clearly has a role. In this context, the small amount of gear that is lost and never recovered at least slowly degrades in a low impact manner. This could be essential in a context where tens of thousands of tons of gear go in the water each year, as in the Korean yellow croaker fishery (Kim *et al.*, 2016).

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