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Food for Thought

We should not assume that fishing jellyfish will solve our jellyfish problem

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Whether jellyfish are increasing or not in the global ocean is a subject of some debate, but the fact remains that when they bloom, jellyfish can negatively affect local economies. Despite this, there has been no robust debate about the idea of deliberately removing jellyfish as a means of population control. Here, we discuss the effects of fishing for jellyfish, either as a sustainable resource and/or as a way to simply reduce their nuisance value, on both individual jellyfish populations and the ecosystem. Given that the drivers influencing each local bloom are different, or that the effects of more widespread drivers may be manifested differently at each locale, our priority at population control/use needs to be more basic research on jellyfish. While we do not advocate a no-fishing approach, we emphasize the need to be cautious in embracing jellyfish fisheries as a panacea and we need to consider the management of each bloom on a case-by-case basis.

Keywords: ecosystem effects, fisheries, impacts, jellyfish.

Jellyfish (Cnidaria, Medusozoa; Ctenophora) blooms often lead to the formation of swarms that can have important direct impacts on our use of the marine environment. Jellyfish at high densities can clog fishing nets and contaminate fish catches. They can block the pump filters associated with coastal power and desalination plants. They can sting people, sometimes fatally, and impact coastal tourism. They can also have indirect impacts on commercial resources by virtue of their zooplanktivorous diet, and can be predators on, and competitors with, valuable finfish and their larvae. Collectively then, the impacts of jellyfish swarms can negatively affect local economies (e.g. Boero, 2013, and references therein).

Jellyfish are a natural component of healthy marine ecosystems. According to species-specific cycles, they produce new individuals seasonally, often deriving from benthic polyps (Boero *et al.*, 2008). If the external conditions are favourable in terms of abiotic factors and/or biotic interactions, some species can develop huge populations that lead to swarms following the concentration of individuals by winds and currents (Graham *et al.*, 2001). Jellyfish outbreaks are mentioned episodically in the old literature (see Russell, 1970, for a review), but evidence is emerging to suggest that jellyfish swarms now tend to be more frequent locally, and the apparent merger of the "local" phenomena gives the impression of a global rise (Brotz *et al.*, 2012). The drivers for these increases, however, are probably manifold and the object of some debate (e.g. Mills, 2001; Condon *et al.*, 2013; Gibbons and Richardson, 2013), but some appear to be linked to various anthropogenic factors. These factors include climate change, eutrophication, overfishing, and the increased availability of hard substrata in coastal systems, among others (see Purcell, 2012, for recent review). Jellyfish are probably able to respond positively to these impacts, individually and/or in synergy, directly and/or indirectly, and as either polyps and/or medusae. Although overfishing and climate change are clearly global issues, their impacts and effects at the local level differ widely across the globe. Consequently, local explanations need to be sought for local population increases, because it is only with knowledge of local drivers (including overfishing and climate change) that we will be in a position to manage local population increases. And we should not forget that a pattern observed at a very broad scale might be driven by multiple causality, with different causes being prevalent at different places.

Some possible management interventions to deal with jellyfish swarms have recently been summarized by Gibbons and Richardson (2013) and Lucas *et al.* (2014). These include the development of proactive, predictive measures such as improved ecosystem and coupled biophysical models, which would be conditional upon new information on jellyfish behaviour, growth, and longevity (etc.), as well as more responsive and preventive tools based on better surveillance. The one measure that neither Gibbons and Richardson (2013) nor Lucas *et al.* (2014) discussed was the reactive one of deliberate fishing or culling (hereafter referred to simply as fishing). Yet, some are suggesting that we expand our use of jellyfish for food and medicine (Purcell *et al.*, 2007; Boero, 2013). It is always tempting to exploit a resource that is abundant, as is happening already for jellyfish in regions like China and Thailand, and if at the same time we can reduce the population size of a problem species then the benefits are further increased. The suggestion is: If you cannot beat them . . . "eat" them. Indeed, Doyle *et al.* (2014) stated that within the media and even among scientists, jellyfish are perceived as "unnatural and unwanted constituents of our oceans" and that therefore the wholesale removal of jellyfish can be easily justified. Some species are widely eaten as a delicacy in Asia, and have been eaten for many centuries. They also contain collagen, which may be helpful for the treatment of arthritis and visible signs of ageing, as well as glycoproteins that could find uses in cosmetics, as food additives or in drug manufacturing (see references in Doyle *et al.*, 2014; Malej *et al.*, 2014a). That said, however, there may also be negative health effects to eating preserved jellyfish, as aluminium is used in their processing and is detectable in the final products (Wong *et al.*, 2010).

While there are certainly direct and indirect financial benefits to be made from fishing jellyfish, is a call for fishing an appropriate strategy to deal with jellyfish swarms generally applicable? What we want to do here is to conceptually expand on the implications of using such a method to control jellyfish populations indiscriminately. Our comments are not directed at the actual physical methods of individual removal (e.g. nets, robots), though concern is expressed about the possible ecological impacts of simply destroying animals *in situ*, thereby increasing fluxes to the benthos, rather than removing them from the system for consumption. Instead, our comments are focused on the potential benefits and costs to the species themselves and to the marine ecosystems of which they are part.

Some of the jellyfish species that have increased in abundance in recent times, and some of the jellyfish that have had the greatest negative impacts in recent times, are invasive aliens. Examples include the scyphozoan *Rhopilema nomadica* in the Eastern Mediterranean, and the ctenophore *Mnemiopsis leyidi* in the Black Sea, as well as the scyphozoan *Phyllorhiza punctata* in the Gulf of Mexico (historically; Graham *et al.*, 2003) and Eastern Mediterranean (Boero, 2013). Like other invasive alien species, these should be controlled expeditiously where possible: identified polyp beds need to be eradicated, adult populations should be fished, and the vectors controlled to prevent further spread. Based on experiences in the Black Sea with *Beroe* and *Mnemiopsis* (Kideys, 2002), bio-control mechanisms should perhaps be investigated, though we would caution against their indiscriminate use and suspect that species-specific agents for scyphozoans will prove hard to find.

However, most of the jellyfish species that have increased in population size appear to be native, such as *Pelagia noctiluca* in the Mediterranean Sea (e.g. Canepa *et al.*, 2014). This makes control problematic because the species themselves evolved in the ecosystems they occupy. As such, natural booms would have alternated with natural busts following internal controls. Even if the long-term data unambiguously demonstrate that populations have increased in size, indicating perhaps a change to the state of the ecosystem, external control requires a thorough understanding of the drivers of population change. Which brings us back to a basic question: what would be the purpose of fishing? Would it be to exploit the resource sustainably, or would it be to simply reduce the population size perhaps with the hope that by doing so, valuable finfish populations might recover? Or both? This apparently win–win strategy, however, might have some profound ecological implications.

Sustainable exploitation of single-species populations

Kingsford *et al.* (2000) have usefully reviewed jellyfish fisheries (with a focus on the paraphyletic Rhizostomeae), and highlighted the problems of ensuring sustainability, given the large number of unknowns. Aside from issues associated with determining growth or natural mortality rates, classical fisheries approaches based on stock–recruit relationships are difficult to implement because there is no clear understanding of what represents the management unit or "stock": is it the polyp population or that of the medusae; or both?

Relationships between the number of polyps and the number of medusae may be intuitive, but they are hard to demonstrate. Having said that, Di Camillo *et al.* (2010) have suggested that there is a correlation between the extent of polyp beds and the abundance of ephyrae of *Aurelia aurita* in the Adriatic Sea. Makabe *et al.* (2014) have recently made similar observations for the same species in the Inland Sea of Japan.

While it is clear that medusae come from polyps, if they are present in the life cycle, nobody has yet been able to show a clear relationship between the numbers of medusae and the number of polyps recruiting to the seabed from planulae. Indeed, the sudden appearance of native species of medusae within a system after many years of absence, such as the hardly inconspicuous *Drymonema dalmatinum* in the Adriatic (Malej *et al.*, 2014b), suggest that polyp populations might remain viable for decades, with no need of new planula settlement. So, if polyp beds are self-maintaining without significant renewal from medusae, due to the long life of this stage (Boero *et al.*, 2008), then the fishing of medusae in 1 year should have little impact on the numbers of medusae that can be fished the next—all other things being equal. In the longer term, however, there will inevitably be a reduction in the genetic diversity of the population as a whole, though in the even longer term, this might encourage speciation should there be any "stock" structure to the population. Boero (1994) has suggested that population flushes followed by sudden crashes might be one of the main mechanisms of speciation, with the onset of mutations during population crashes and their establishment during population flushes. This hypothesis has found some validation in the work of Aglieri *et al.* (2014) and, depending on separation rates, could cause problems for any sustainable jellyfish fisheries based on stock structure.

The arguments presented in the immediately foregoing paragraph are premised on the absence of data linking the size of medusae populations to those of polyps. Under that scenario, fishing could be based on either juveniles or sexually mature individuals. However, as fishers would likely target the larger specimens, removal would not eliminate the release of planulae. Consequently, populations each year could be supplied from both newly recruited and perennial polyps. Effective population sizes are typically orders of magnitude less than natural population sizes in planktonic organisms (e.g. Stopar *et al*., 2010), so should newly recruited polyps contribute to the population of medusa, this could serve to maintain genetic diversity and retard speciation.

If there is a link between the magnitude of planula settlement, polyp development, and the subsequent population size of medusae, as is intuitive, any overexploitation could lead to a decline in jellyfish populations. Such arguments would certainly hold for those holoplanktonic species without polyps, such as *Pelagia*. While this may be the aim for an alien invasive species, for a native species with an evolved place in the ecosystem, this could be a problem not only for any ecosystem approach to fisheries (see below), but for a viable and long-term jellyfish fishery too. A case in point is the fishery for *Rhopilema esculentum* in China, where declining catches in the 1970s and 1980s (potentially due to overfishing: Dong *et al*., 2014) ultimately led to the development of a hatchery programme whereby hundreds of millions of juvenile jellyfish were bred in the laboratory and released into the ocean each year. Any potentially new jellyfish fishery should learn from the Chinese experience, because while the artificial restocking programmes were cost-effective (You *et al*., 2007; Dong *et al*., 2009), this is partly due to an extensive indigenous knowledge and a thorough study of the species in question (Dong *et al*., 2009). Similar attempts in other environments would also require a lengthy research programme and even then there is no guarantee of success. Off China, the catches of *R. esculentum* have been declining recently, despite an increased output from hatcheries (Dong *et al*., 2014). Further, there is likely to be an opposition to the intentional releases of additional jellyfish in regions where they are not celebrated as traditional food. Indeed, the goal of anyone involved in a profitable fishery will be increased or sustained catches, not declining ones that require artificial restocking.

Even if fishing of medusae can reduce a jellyfish population, Brotz (2016) has suggested that without sufficient research, the rapid development of jellyfish fisheries could have unexpected impacts on ecosystems. It could also lead to contention among fishers, as observed in India (Magesh and Coulthard, 2004). Pollution from plants that process jellyfish is also a major concern and can be a barrier to developing a jellyfish fishery in countries with strict environmental regulations. In areas without such regulations, the development of a jellyfish fishery might simply swap one problem (jellyfish) for another (pollution), unless done in an artisanal manner for immediate consumption and without significant processing.

Only a handful of the more than 1000 known species of jellyfish are preferred for human consumption, and the issue of their conservation (sustainable populations) could be aided by making no subsidies available for jellyfish fisheries. If fishing did in fact reduce a jellyfish population to its earlier (lower) abundance, the costs of fishing would then likely exceed the benefits. Indeed, in Spain's Mar Menor, an area where fishers are paid to remove jellyfish that have as yet no economic value (though *Cotylorhiza* is edible), the degree of "success" is questionable and there are pollution concerns about what to do with the jellyfish once they have been removed from the sea (Muñoz-Vera *et al*., 2015).

The concern we are trying to highlight here is not whether we should avoid fishing a jellyfish species because this might lead to its decline. After all, that is what we do, and have done, with many finfish populations. Rather, the problem with jellyfish "fish" is that their populations naturally fluctuate in size so much that an investment in jellyfish fisheries might prove a failure, if we pursue it as a way of making money. Consider if, for example, investment had been put into the development of a fishery for *Chrysaora melanaster* in the Bering Sea following the sustained population increases noted there over a 15-year period by Brodeur *et al*. (2002). Such a fishery would have collapsed within 1 year following population peaks (Brodeur *et al*., 2008a), for reasons completely unrelated to a jellyfish fishery. But if we aim at keeping overwhelmingly abundant jellyfish populations under control, then fishing might be a measure worth considering . . . though very carefully (see below).

Ecosystem implications

Perhaps the biggest problem with fishing jellyfish comes not from the impacts on the jellyfish populations themselves or on the economics of the fisheries, but on the systems in which they are found. Jellyfish are understudied animals and therefore, the effects of removing them from the ecosystem when they are in excess are unknown, and potentially negative. A number of authors have summarized the roles that jellyfish are thought to play within the wider ecosystem including most recently, Doyle *et al*. (2014) and Malej *et al*. (2014a). In essence, some jellyfish can act as "habitats" and nurseries for juvenile fish, they can be agents for carbon sequestration, and they clearly act as both predators and prey: even stinging species such as *P. noctiluca* can be eaten by fish (Milisenda *et al*., 2014). Jellyfish might also represent a keystone guild (Boero *et al*., 2008): by feeding on eggs and larvae of dominant nektonic species, jellyfish might reduce the success of these dominant species, thereby releasing resources for previously outcompeted species, thus enhancing local diversity. Contrary to "traditional" keystone species that are usually at low densities and whose impacts are disproportionate to their abundances, jellyfish might play such a keystone role only when they bloom. This "healthy" role for jellyfish blooms, however, is perhaps only played if the population flushes occur from time to time, whereas if they occur every year, the situation might take unpredictable routes.

The uncontrolled fishing of the jellyfish species that act as habitats or nurseries for juvenile fish would very obviously have a negative impact on the population sizes of (perhaps) the very finfish resources we are trying to regrow. Similarly, if there is any significant spatial and/or temporal overlap in the distribution of finfish and jellyfish, then fishing for the one could affect the size of the other: and there is a body of evidence to suggest that there are significant associations between the two from a number of ecosystems (e.g. Brodeur *et al*., 2008b). Should such be the case, then the fishing of jellyfish should be avoided or very strictly regulated to avoid overfishing. Interestingly, Sato *et al*. (2015) have recently noted that the thick-billed murre (*Uria lomvia*) appears to feed on the fish that are associated with *C. melanaster* in the Bering Sea. Indeed, birds specifically target jellyfish with large numbers of fish aggregating in their tentacles, implying that the removal of jellyfish could impact breeding success of this species.

Jellyfish population increases are likely to be a symptom of wider, anthropogenic perturbations to local systems that have now become pervasive at a global scale. Such changes have impacts through the ecosystem, often to the point that the ecosystems we see today function in a way that is quite different from the way they behaved previously when they were perceived to be "full-of-fish". Our understanding that marine ecosystems can exist in many different states or regimes is improving each year (e.g. Möllmann and Diekmann, 2012), but disentangling natural from anthropogenic drivers of change is still difficult. Our knowledge of how long marine ecosystems may remain in these different states is poor because self-reinforcing, resistance mechanisms may mean that changes are slow (e.g. Hughes *et al*., 2013). There is also much uncertainty about whether or not altered ecosystems can even revert to their former states if attempts to reverse the changes are made, given hysteresis (e.g. Fauchald, 2010). It can thus be argued that the following discussions are perhaps simplistic (see also Cardinale and Svedäng, 2011), but they are premised on the evidence from the Black Sea (Daskalov *et al*., 2007) that reversal is at least partly possible (see below): especially if detected and reacted to early (Nyström *et al*., 2012).

Medusae have strong top-down control on plankton communities and are considered to have a "large footprint" on lower trophic levels (Brodeur *et al*., 2011). The trophic cascades that are induced by the presence of jellyfish can have a multitude of impacts, depending on the ecosystem and the species concerned, as well as on the time of year, and they appear to affect both the conventional and the microbial loops. For example, in the Skive fjord (Denmark), the grazing of herbivorous zooplankton by *A. aurita* results in an increase in phytoplankton biomass, much of which remains uneaten and settles out. This results in decomposition and bottom hypoxia: the latter killing off mussels that would otherwise have contributed towards controlling phytoplankton populations (Møller and Riisgård, 2007). In the Black Sea, increases in the biomass of jellyfish were associated with declines in the biomass of herbivorous zooplankton, increases in the amount of phytoplankton, and reductions in the concentration of dissolved oxygen (Daskalov, 2002; Daskalov *et al*., 2007). Impacts on dissolved oxygen concentrations seem to be a recurrent feature of jellyfish blooms, either directly as indicated above or more indirectly. For example, the results of a study by Condon *et al*. (2011) show that much of the dissolved organic matter (DOM) released by jellyfish and incorporated into bacteria is released by respiration, which again implies an increased oxygen demand and a change to the oxygen status of the water column. In the Mediterranean Sea, predation by *Aurelia* on copepod nauplii and ciliates has also been noted to result in an increase in bacterial biomass (Malej *et al*., 2007). However, the microbial loop too can be facilitated by the fact that the labile C-rich DOM that is released by jellyfish cannot only increase bacterial biomass, but it can change the prokaryotic community composition and increase ciliate populations (Condon *et al*., 2011), which will have its own unknown effects.

The above examples show that if jellyfish are too many they may lead ecosystems into states that we do not like, and a strong case could be made that the fishing of jellyfish might be beneficial to the system. It could lead to a reduction in phytoplankton through an increase in grazers, and thereby a more oxygen-rich seabed environment. But we should be careful because recent mesocosm work by Hosia *et al*. (2015) on the normally medusivorous *Cyanea capillata* has shown that increases in jellyfish result not only in an increased bacterial production, but the increased nutrient regeneration was argued to stimulate primary productivity in nutrient-depleted surface waters. Fishing of some jellyfish species could then lead to a reduction in potential productivity.

It is not only the quantities of materials that jellyfish can change; however, it is also their qualities. In the Black Sea, jellyfish predation impacted the size structure and composition of both the zoo- and (in turn) the phytoplankton communities (Daskalov, 2002). This has also been witnessed in the Mar Menor (Pérez-Ruzafa *et al*., 2002). A reduction in the size structure of plankton communities, favouring the proliferation of the small over the large, will have an inevitable impact on the efficiency of energy transfer in marine ecosystems. Under these circumstances too, it could then be argued that the fishing of jellyfish might be beneficial to the system. That said, however, we should not forget that cultural eutrophication (e.g. Dortch and Whitledge, 1992) and ocean warming (Daufresne *et al*., 2009) can both influence the size structure of plankton communities and care should be taken to disentangle the one from the other before concluding that jellyfish are responsible for the change and financing a fishing programme with the hope of rectifying the situation. After all, if the size structure of the plankton environment and high jellyfish abundance is due to cultural eutrophication as a result of altered N:P:Si ratios in the seawater, then the removal of jellyfish is unlikely to have any impact on the system.

The impacts of jellyfish on community dynamics may vary depending on the taxa and presence of other gelatinous species, with the outcome of interactions depending on the trophic level of the jellyfish and the dynamics within the local ecosystem (Crum *et al*., 2014). In the Chesapeake Bay ecosystem, for example, *Chrysaora quinquecirrha* exerts a top-down control on populations of *Mnemiopsis leidyi*, thereby allowing copepod populations to increase with a concomitant reduction in phytoplankton biomass (Feigenbaum and Kelly, 1984). In the absence of *Mnemiopsis*, *Chrysaora* is modelled to have a significant impact on copepods and (likely also) ichthyoplankton, but in the presence of *Mnemiopsis*, fisheries would probably benefit (Crum *et al*., 2014). Any fishing of the growing *Chrysaora* population within the Chesapeake system, given the presence of *Mnemiopsis*, would likely result in jellification. As a consequence, and so as long as *Mnemiopsis* populations persist, fishing of *Chrysaora* should be avoided.

In the altered ecosystem states where jellyfish have increased in population size, they may now be playing important roles so that overfishing them may not have the desired results (fewer jellyfish and more fish). For example, for the northern Benguella ecosystem off Namibia, the population size of jellyfish is thought to have increased quite rapidly following the overexploitation of small pelagic fish there at the end of the 1960s and populations show no obvious pattern of continued growth (Flynn *et al*., 2012), suggesting perhaps that they are now relatively stable. At the same time, the bearded goby (*Sufflogobius bibarbatus*) has increased in population size and has taken over the role previously occupied by sardines (*Sardinops sagax*) and anchovies (*Engraulis encrasicolus*) as a conduit through which primary production is funnelled to hakes (*Merluccius* spp.) and other commercially valuable finfish resources, as well as to seals and IUCN red-listed seabirds (Roux *et al*., 2013). The goby feeds primarily on detritus, zoobenthos, and zooplankton, but it also consumes significant amounts of jellyfish (Utne-Palm *et al*., 2010). Further, it appears to associate with jellyfish in the water column, perhaps as a way of reducing predation pressure (Utne-Palm *et al*., 2010). Any fishing of jellyfish will reduce the goby population size (and by implication those of hakes, seabirds, and seals), both directly through bycatch and indirectly through changes to their diet and refuges from predation. If Namibia wants a sustainable hake fishery, unfortunately, it currently also needs the jellyfish. And if the Mediterranean wants healthy populations of the sunfish, *Mola mola*, and marine turtles (Boero, 2013), then perhaps we should not be too keen to overexploit jellyfish there either.

Summary

As a result of the fact that many of the jellyfish increases we are seeing at the local level are a likely symptom of local perturbations to the ecosystem, notwithstanding the global drivers of overfishing and climate change, it is only by resolving those local issues that we stand any chance of managing jellyfish fisheries or of bringing jellyfish populations back to "normal". However, given that there is not just one "smoking gun" in most instances, and that the driving factors are inter-correlated and act synergistically, this may not be easy without a multi-pronged approach. For example, the increase in jellyfish (*Mnemiopsis*) abundance during the 1980s in the Black Sea is thought to have been brought about by the combined effects of overfishing, pollution, and ballast water transport of the invasive species. Yet by unintentionally starting to clean up eutrophication and by judicious management of fisheries (aided by a bio-control agent, *Beroe*), fish stocks have partially recovered and populations of the alien ctenophore have declined (Kideys, 2002).

The clean-up of the Black Sea appears to be the exception that demonstrates it is possible to clean-up a jellyfish problem and reverse, in part, a regime shift, because even with knowledge of the potential drivers of change, and a concerted effort to rectify this, there is no guarantee that we will resolve the problem. In the case where overfishing alone may have led to an increase in jellyfish, it could be argued that a better management of fish populations, with the return to pre-decline conditions, could resolve the problem of the abnormally large jellyfish populations. This simplistic line of argument assumes that the biomass that first went in the phytoplankton–crustaceans–fish pathway is now going in the phytoplankton–crustaceans–carnivorous jellyfish pathway (Boero *et al*., 2008), and that the predator-pit created by jellyfish for fish can somehow be alleviated (as Fauchald, 2010). However, for the Benguella, which is perhaps one of the best present examples of the impacts of overfishing on jellyfish (Roux *et al*., 2013), the biomass of pelagic finfish may simply not be there to rebuild. Even if there was a sufficient base to build from, however, it could not be done without an exhaustive and very costly effort to concurrently reduce the population of competing and predating jellyfish. This comes with its own bycatch and ecosystem risks, and uncertainties about the strength of the link between populations of medusae and polyps. It should also be realized that by the time these changes have been made, the system we want to return to has probably changed again and that we will never can go back!

The problems experienced in the Inland Sea of Japan and the East China Sea seem far more intractable because not only are there the local issues of overfishing and pollution, but there is also extensive coastal development about which nothing can meaningfully be done. The global effects of ocean warming are obvious in parts of this region too (Lin *et al*., 2005), which is outside local control. The overexploitation of fish populations is a global problem (Swartz *et al*., 2010) and the removal of many species of fish is very likely releasing many species of jellyfish from both predation and competition. Jellyfish, in their turn, exacerbate our impact on fish by exerting predation on fish eggs and larvae and on the food of juveniles and adults (Purcell and Arai, 2001). While the decrease in fish populations is undeniable, as demonstrated by the steady rise of aquaculture to satisfy commercial demands, the link between it and increasing jellyfish numbers is weak, if logical. We should not assume that eating more jellyfish, or even fishing them, will be an economically viable solution to our jellyfish problems, and it may in fact lead to unfulfilled expectations and unexpected results. After all, the economic implications of setting up an industrial jellyfishery are wide, whereas the certainty of jellyfish availability so as to economically sustain the effort is weak.

Indeed, there are far too many unknowns to simply assume that fishing medusae will negatively impact jellyfish populations without concomitant negative impacts to the wider ecosystem. Jellyfish have persisted relatively unchanged since the Cambrian and they are likely to be very deeply embedded within the communities and systems they occupy. However, they are not invulnerable to catastrophes, so decisions need to be made on a case-by-case basis. It would seem that a far more prudent approach would be to mitigate and minimize the anthropogenic impacts that are suspected of causing increasing jellyfish populations. At the same time, we should employ the precautionary principle and learn as much as we can about our collective impacts on the marine environment and the important roles that jellyfish play in ecosystems. Although humans are indeed "good" at overfishing, we hope that we have illustrated why we should not jump to overfishing jellyfish as a viable solution. While history does sometimes repeat itself, we should not be so bold to assume we can do so intentionally.

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