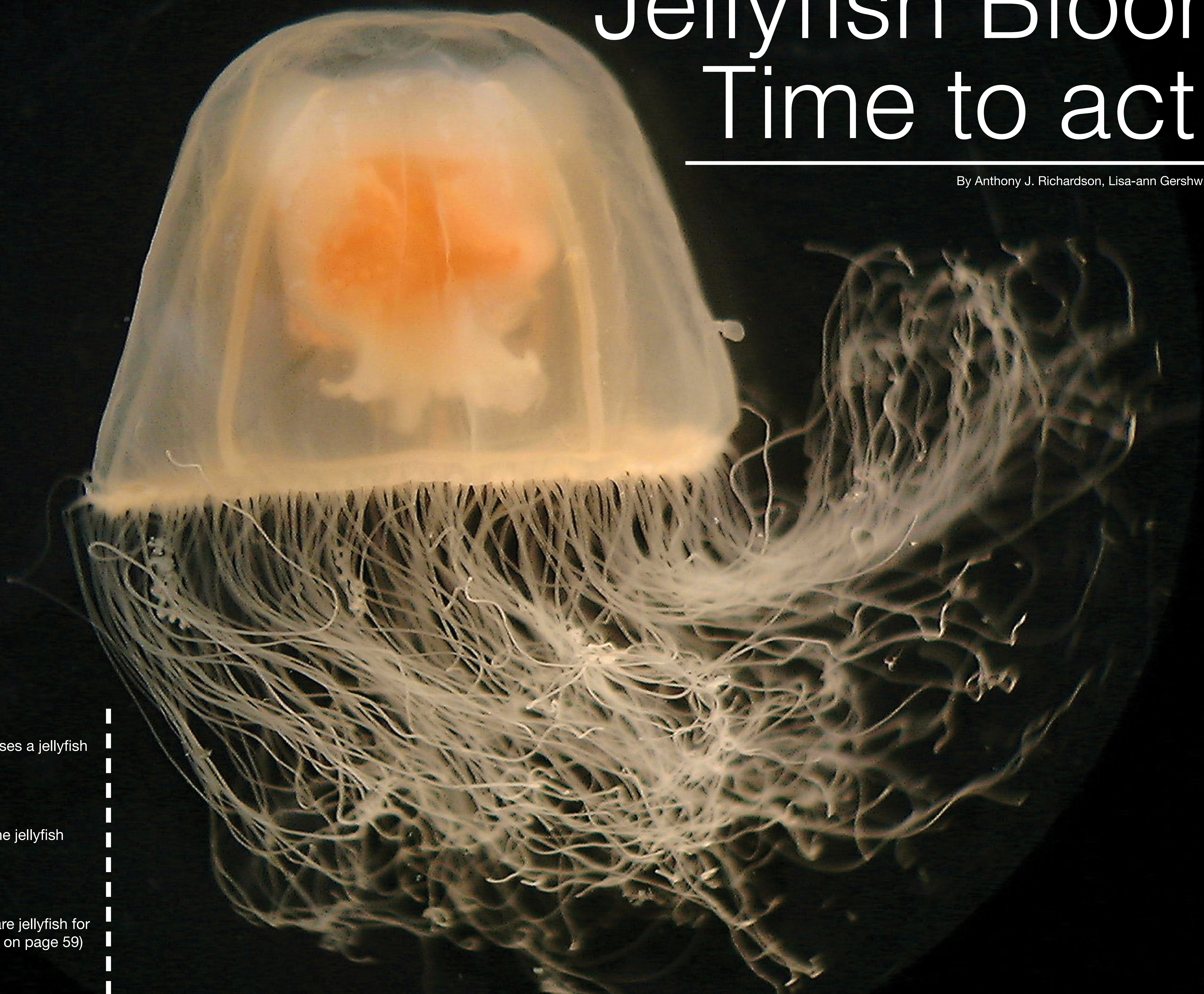
Jellyfish Blooms: Time to act!

By Anthony J. Richardson, Lisa-ann Gershwin, Mark J. Gibbons



95
the percentage of water that comprises a jellyfish body

36.5
the length in metres of the lions mane jellyfish tentacles

40
the number of days it takes to prepare jellyfish for human consumption (see our recipe on page 59)

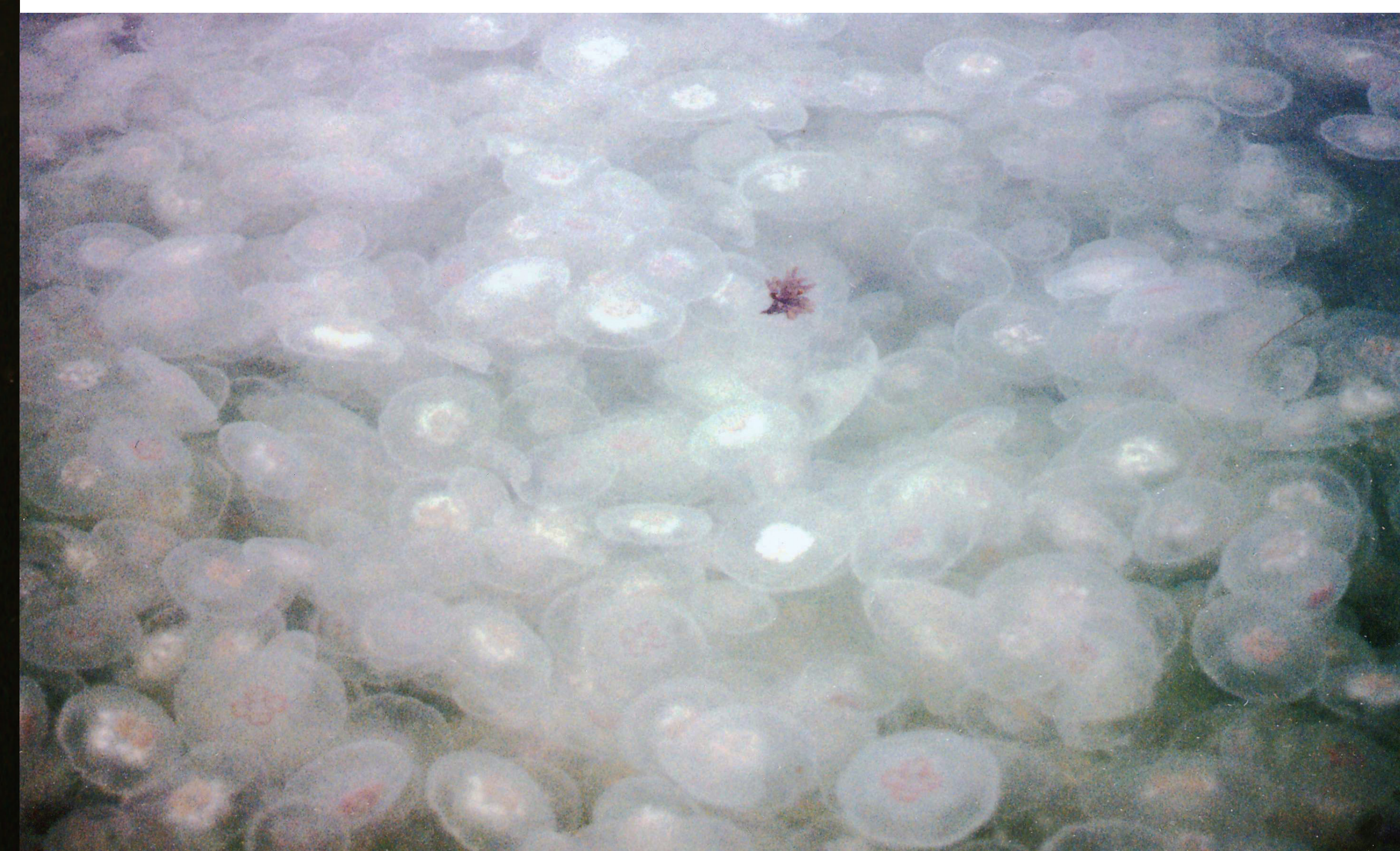
What are Jellyfish?

Jellyfish are an ancient group, stretching back to at least the Ediacaran period 600 million years ago, and perhaps more than 1 billion years. People often encounter jellyfish, as they form conspicuous blooms that wash up on beaches or are seen from boats. About 2000 species are known, and they come in some of the wildest imaginable shapes and colours, as hinted by their often evocative common names. Some of these name include: rainbow jellies, fire jellies, sea walnuts, sea gooseberries, lion's manes, purple people eaters, blue bottles, blue stars, Portuguese man-o'-war, and our favourite, the Long Stingy Stringy Thingy. Many jellyfish alternate their generations between a swimming medusa (the large bell-shaped form we are familiar with) and a tiny polyp stuck to the seafloor. This complex life cycle, reminiscent of the caterpillar and butterfly, is the key to their ability to grow like 'weeds'; medusae bloom during good conditions and polyps hunker down through bad. Here we take a look at the role of jellyfish in ecosystems, how they affect people, and today's and tomorrow's management actions.

Role of Jellyfish in Ecosystems

Jellyfish are carnivorous and feed on anything they can catch in their tentacles, generally plankton. In terms of their position in the food web, jellyfish have a "large footprint" and a "short reach". A large foot print means their feeding patterns have a huge knock-on effect. For example, in the Skive fjord (Denmark), jellyfish blooms are indirectly killing mussels. Jellyfish eat huge amounts of zooplankton, which reduces the predation by zooplankton on phytoplankton, which then die and sink to the seafloor. The decay process sucks oxygen out of the water, thereby killing mussels (and other marine life). Jellyfish have a "short reach" up the food web, meaning they are generally not an important food source for higher animals. However, the overexploitation of specialist jellyfish feeders such as leather-back turtles in the Central North Pacific and possibly butterfishes in the East China Sea have been linked to jellyfish increases. Despite this short reach, jellyfish can negatively impact fish and other higher animals through predation on eggs and larvae and possibly by competing for the same food. Jellyfish can enhance marine microorganisms by releasing substantial quantities of organic matter that bacteria and protozoans use for nutrition. As these microorganisms respire, the dissolved oxygen in the water is used up faster than it can be replenished. Jellyfish can thrive in low oxygen waters where other animals cannot. By altering their environment to make conditions favourable for themselves, jellyfish act like ecosystem engineers – as do corals and kelp.

Jellyfish blooms are natural in healthy marine ecosystems, and boom and bust dynamics are a part of their lifecycle. It appears, however, that the size and frequency of blooms of some species are increasing, particularly in regions where human impacts are severe. Unfortunately data on jellyfish are relatively scarce, owing to their delicate bodies making them difficult to sample. Nonetheless, there is compelling evidence that human impacts are causing an increase in bloom frequency and severity of some species. Excessive sewage effluent and agricultural fertilisers flowing into the coastal ocean stimulate plankton and jellyfish blooms. Overfishing reduces small pelagic fish predators of young jellyfish and leads to jellyfish increases. Ships' ballast water exchange introduces foreign jellyfish species into new areas.



Jellies & Power Plants

Extensive jellyfish blooms can temporarily shut down power plants, with one such incident in the Phillipines in 1999 being mistaken by the media for a coup d'état! There are many examples of shutdowns from all over the world, with financial costs amounting to millions of dollars. Interestingly, different species are implicated in each area, demonstrating that the problem is complex and does not have an easy fix. Because of the propensity of jellyfish to become entrained in intake currents and clog pipes, we can also expect the massive desalination plant at Point Lowly Peninsula near Whyalla (South Australia) to suffer from jellyfish blooms.

While some coastal power plants have regular monitoring programmes in place to warn of imminent jellyfish incidents, most do little in the way of prevention, instead shutting down to avoid compounding the damage. Some plants have invested in exclusion devices such as bubble nets and booms, and although they can be made operational quickly, they tend to have a limited effect given the volumes of water constantly required. At the moment, the response of the industry is largely reactive, and unfortunately, at the last minute – when jellyfish are right on the doorstep.

Jellies & Fishers

When fishers catch large numbers of jellyfish, nets can clog and burst, and occasionally vessels have even capsized. More frequently, commercial fishermen are hard-hit by contaminated catches, which attract lower prices than jellyfish-free trawls. Recently in northwestern Australia, blooms of Sea Tomatoes (Crambione) have been threatening fisheries through their enormous biomass and their likely double whammy of predation and competition. And across northern Australia, irukandji jellyfish are considered the number one OH&S threat in the lobster, beche de mer, and pearling industries, regularly causing serious injury, stop-work events, and downtime.

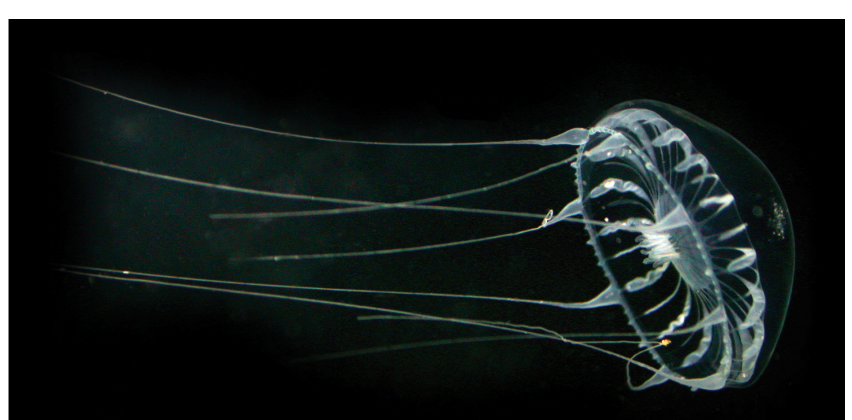
Responses of fishers to jellyfish are largely based on avoidance, and a skipper's decision to throw or not-to-throw a net will vary with fishery type, gear and perceptions of jellyfish abundance. That said, in the case of fisheries impacted by the sumo-wrestler-sized jellyfish off Japan, nets have been designed that effectively exclude jellyfish through escape panels – in much the same way that turtle-exclusion devices are used in prawn fisheries.

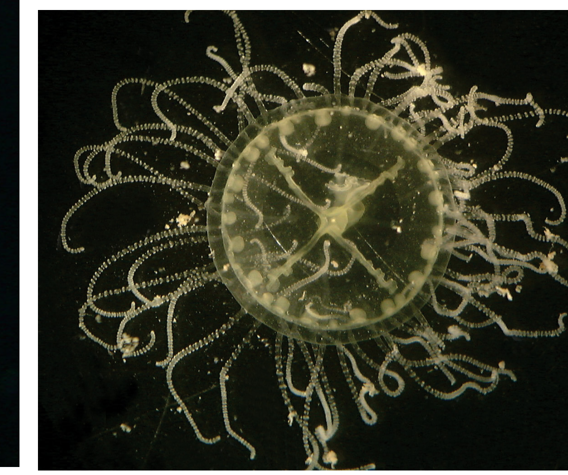
Jellies & Mariculture

Whilst fishing operations on the high seas are mostly plagued by large jellyfish, fish mariculture operations that use floating cages are plagued by large and small coastal species. Salmon farms in Tasmania, New Zealand, and the Irish Sea have suffered repeated jellyfish blooms causing gill disorders and catastrophic fish kills costing millions of dollars. To detect troublesome jellyfish blooms, regular monitoring programs are in place, but excluding stingers from cages is still a major headache. Currently, tarpaulin screens are deployed around cages, but as these keep out everything (including water!), cages need to be aerated (which is expensive) so screens can only be deployed for a few days. One potential mitigation measure that is being explored for mariculture farms is a bubble curtain system, in which a wall of bubbles deflects jellyfish up towards the surface where they are scooped up.

Jellies & Bathers

As compelling as industrial problems are, human health effects of jellyfish blooms are in many cases worse. Queensland tourism lost an estimated $65M due to negative publicity following the jellyfish-related deaths of two tourists on the Great Barrier Reef in 2002. Blooms of box jellyfish (Chironex) and irukandji jellyfish (Carukia, Malo and others) continue to result in regular beach closures, hospitalisations, long-term health effects, and lost tourism revenues. Where human safety is concerned, the only preventative strategies in wide use are beach closures and protective clothing. Nonetheless, medical costs to taxpayers run into the millions of dollars each year.





Tomorrows Management Actions

Research is slowly shifting toward understanding causes of blooms and potential management actions. Currently it is difficult to know when and where jellyfish are going to strike, and this information will be valuable for managing a range of problems. A variety of early warning systems are being developed but few are currently operational.

Many early warning systems try to forecast the occurrence of blooms based on oceanographic conditions such as temperature, chlorophyll, currents and wind. More sophisticated approaches use modelling of jellyfish blooms, and are now able to forecast a week into the future with high skill, making it theoretically possible to give fish farms, power plants and beach authorities warning of potential upcoming blooms.

Management of another marine group that has human health implications, harmful algal blooms, could provide insight into monitoring jellyfish. Mooring systems in the Gulf of Mexico off Texas are now using a technique called 'automated imaging flow cytometry' to identify harmful algal blooms. Another technique used off Florida involves DNA technology in molecular probes for species identification. It may soon be possible to combine high quality imaging and DNA techniques for jellyfish identification.

Finally, one of the most important directions of future scientific growth is applied research into potential follow-on management steps for particular industries. Even with the best monitoring and forecasting systems that provide managers with information on when and where large jellyfish blooms are likely to strike, excluding them and maintaining operations remains a challenge.

About the authors

Associate Professor Anthony J. Richardson has eclectic research interests, working on jellyfish, plankton, manta rays and mathematical modelling to better understand and manage climate change. Dr Lisa-ann Gershwin is a jellyfish taxonomist and ecologist, and has recently written a popular science book on jellyfish blooms, which will soon be available worldwide. Professor Mark Gibbons is a marine biologist, specializing in plankton and jellyfish ecology. We thank Tom Doyle for information on impacts of jellyfish on mariculture.

Further reading

Gershwin, L. Stung! : On Jellyfish Blooms and the Future of the Ocean. University of Chicago Press. [A popular science book, available Soon!]

Richardson AJ, Bakun A, Hays GC, Gibbons MJ (2009) The Jellyfish Joyride: causes, consequences and management actions. TREE 24: 312-322

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