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How science can help fill gaps in the high seas treaty

Agreement heralds a once-in-a-generation opportunity to use every idea and instrument available to preserve the health of the seas.

The United Nations high seas treaty has been a long time coming. Secured earlier this month after almost 20 years of effort, it will be the first international law to offer some protection to the nearly two-thirds of the ocean that is beyond national control. These parts of the ocean currently have few, if any, meaningful safeguards against pollution, overfishing and habitat destruction. The treaty is without doubt a major achievement.

Agreed under the UN Convention on the Law of the Sea, it represents several wins. Among them is the capacity to create marine protected areas through decisions of a conference of the parties to the treaty. It also recognizes that genetic resources of the high seas must benefit all of humanity. Moreover, companies planning commercial activities and organizations considering other large projects (such as potential climate interventions involving the ocean) will need to carry out environmental impact assessments.

Countries will be permitted to profit from exploiting marine genetic resources, but they must channel a proportion of their profits into a global fund to protect the high seas. Although the details are still to be worked out, high-income countries active in marine genetic research will be asked to contribute proportionately more to the fund.

The treaty contains many opportunities for research in ocean science, for building research capacity in low- and middle-income countries, and for improving the evidence available to decision makers. Researchers working with marine genetic resources will need to register their interests with a central clearing house and commit to making data and research outputs open access.

Scientists will have an important role in ensuring the treaty's ultimate success. In part, this will involve gathering or improving the evidence to support the establishment and maintenance of strong marine protected areas and to inform stringent environmental impact assessments. Beyond that, researchers must make every effort to ensure transparency, including declaring the origin and prospective use of any genetic material, and making digital sequence information available through international repositories. This will not only enhance cooperation and capacity-building, but will also help governments to develop their own national regulations and procedures in line with the treaty.

There's also the potential for fresh scientific collaboration — for example, using emerging technologies such as telepresence, whereby scientists can take part in research cruises remotely. Marine scientists travelling to, say, the Pacific Ocean could collect samples under the guidance of colleagues elsewhere in real time. The knowledge gained from such collaborations could lead to the commercialization of new products, benefiting scientists and economies around the world.

However, it is important not to overstate the treaty's potential: notwithstanding its successes, there are deficiencies that the international community, supported by the research community, must now work to remedy.

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As the planet warms, the Arctic's permanent ice cover is melting, and China is planning a shipping route through the Central Arctic Ocean. This could become a regular passageway for shipping between Asia and Europe within a decade. In the Pacific, mining companies are exploring the deep sea bed for metals that they say are needed for the batteries that will power the coming green-energy transition. But these activities won't face scrutiny under the treaty, because the treaty's provisions don't overrule regulations laid down by the authorities that oversee existing high seas activities. These include the International Maritime Organization, which is responsible for shipping; the International Seabed Authority, which oversees deep-sea mining; and some 17 regional fisheries management organizations tasked with regulating fisheries in various parts of the ocean, including Antarctica. Military activities and existing fishing and commercial shipping are, in fact, exempt from the treaty.

This means, for example, that the treaty cannot create protected areas in places already covered by fishing agreements, even if that fishing is unsustainable and depleting stocks. This is a gaping hole. The overexploitation of coastal fisheries has made a frontier of the high seas, as fleets travel farther and fish for longer in search of dwindling resources. One outcome is that stocks of some highly migratory species, such as tuna, have dropped precipitously since the 1950s (M. J. Juan-Jordá *et al. Proc. Natl Acad. Sci. USA* **108**, 20650–20655; 2011). By 2020, the Pacific bluefin tuna, for instance, was at 10.2% of the levels before fishing began (see go.nature.com/3n2q5th). Oceanic sharks and rays have also declined globally by 71% since 1970 (N. Pacoureau *et al. Nature* **589**, 567–571; 2021). Once the treaty becomes law (after it has been ratified in the national parliaments of at least 60 countries), it can demand that proposed ocean activities — such as climate-intervention experiments — are subject to stringent environmental impact assessments. But it cannot do the same for activities already under way.

Nor will the treaty end current offshore environmental violations. Farming waste, in the form of excessive nutrients, routinely ends up in rivers and coastal waters. From there, it makes its way to the open ocean, where it results in the formation of dead zones — vast areas devoid of life. Between 2008 and 2019, the number of these zones nearly doubled, from 400 to 700 (see go.nature.com/3mpigh1). So much plastic is now entering our seas that the oceans are thought to contain around 200 million tonnes. Meanwhile, cruise ships legally discharge more than one billion tonnes of raw sewage into international waters every year.

Nonetheless, as humanity's first serious attempt to challenge the carnage that prevails offshore, the high seas treaty is a triumph for diplomacy, particularly at a time when multilateralism is under sustained pressure. At present, just 1% of international waters are protected. That proportion is now set to grow, and this will help to maintain the health of our oceans and stem biodiversity loss. In securing this deal, the international community has given itself a fighting chance of coming good on earlier promises – most recently reiterated under the UN Convention on Biological Diversity – to protect 30% of the ocean by 2030.

Full implementation, although some years away, offers scientists a once-in-a-generation opportunity to use their knowledge to support offshore conservation. In redressing our 'out of sight, out of mind' relationship with the oceans, the high seas treaty will allow us – supported by a burgeoning research effort – to rethink how we use our ocean commons in ways that benefit the majority.

Asteroid collision shows how much amateur astronomers have to offer

Astronomy, like other scientific fields, continues to benefit from working scientists collaborating with amateur colleagues.

When NASA's Double Asteroid Redirection Test (DART) spacecraft slammed into an asteroid on purpose last September, many telescopes were trained on this one-of-a-kind celestial event. Some were operated by teams of amateur astronomers – skilled skywatchers for whom astronomy is not their full-time day job (or, more accurately, night job). Three such teams on France's Réunion island in the Indian Ocean, plus one in Nairobi, managed to watch the impact in real time.

These skywatchers are among the authors of a study in *Nature* that describes how the asteroid, named Dimorphos, became temporarily brighter and redder as the spacecraft hit it[1]. One of five papers about the impact published in *Nature*[1–5], it describes a real-time view of a cosmic collision – similar to that when Comet Shoemaker–Levy 9 slammed into Jupiter in July 1994.

The four telescopes were of a type that has become popular in the amateur-astronomy community, with 112-millimetre-diameter mirrors. Manufactured by Unistellar, based in Marseille, France, they come with an app that uploads observational data to the company's server, so professional astronomers can quickly combine and analyse records of an event made by their amateur associates.

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It's the latest example in the long-running story of how amateur stargazers have assisted in making observations of the night sky. In the past, for example, astronomers have improved their understanding of variable stars – those whose brightness as seen from Earth changes with time – by tapping into an extensive database of observations built partly by amateur astronomers as part of a global network called the American Association of Variable Star Observers. Other such community-science efforts include helping working astronomers to categorize galaxies, and sifting through cosmic signals in search of any that might be coming from extraterrestrial civilizations. Amateur astronomers routinely discover comets and other celestial events, as well as identify previously undescribed phenomena and objects from old photographs of the night sky. In 2020, for instance, Italian amateur astronomer Giuseppe Donatiello discovered three dwarf galaxies orbiting a distant galaxy, just by going through public data from the Dark Energy Survey, recorded by a telescope in Chile.

Coordination between amateur and professional researchers is not unique to astronomy. In January, researchers unveiled a model called BirdFlow, which uses machine learning to predict where 11 North American bird species will migrate to[6]. They explained that this was made possible because of the amateur ornithologists who contribute several million records of bird sightings to an online database called eBird every year.

Whatever the discipline, community science collects data from many contributors, which must be checked and calibrated. The payoff is that the more people can confirm an observation, the more robust that observation becomes. In the case of the DART impact, the amateur scientists were able to rapidly gather, distribute and publish information about the event. Other teams of amateurs continue to monitor the DART asteroid system. For example, a French–Greek effort supported by the European Space Agency includes amateur observations and aims to refine our understanding of the system's orbit around the Sun.

As science becomes ever-more specialized and dependent on ever-more-specific instrumentation, it is tempting to think that the day of the amateur scientist is over. But this would be wrong. More working researchers in more fields should think about how they can harness the enthusiasm of their amateur colleagues in creative ways.

The next time you're looking for an observation partner or someone to help crunch data, consider the amateur.

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Correction
This Editorial has been modified to update the data for the decline in Pacific bluefin tuna.

Updated 17 March 2023