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Staying ahead of the wave: predicting fishing efforts in a changing world to save biodiversity

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ABSTRACT

Recent advancements in fishing technologies are unbalancing global marine ecosystems. Our spatio-temporal model to predict global fishing efforts may allow fishers to prevent detrimental overlap of fleets, which eventually helps to save

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An ecosystem is a community of all living organisms in a certain area, including human beings. In the marine ecosystem, for instance, every organism living in the ocean (fish, animal, plant, etc.) has its own role within the community. This balance can be ruined by environmental factors such as pollution, ocean salt or oxygen concentration, and climate. Beyond this, increasingly, fishing is tipping the scales to unbalance the marine ecosystem and diminish its biodiversity.

Throughout history, most fishing activities took place close to shore. However, as commercial exploitation began depleting coastal resources in the mid-20th century, and fishing technologies advanced, fishers started venturing deeper and further offshore. Today, commercial fisheries have a global and dynamic footprint. A number of fishing fleets in the open ocean (high seas), the portion of oceans that does not belong to any country, are unmonitored due to a lack of international fisheries policies, and the depth of their footprint has remained unknown for many decades. Studies on the impact of such unmonitored fishing on oceanic ecosystems has been limited.

Today, ecologists use computer models to define and predict areas of suitable habitats for terrestrial and marine species. Suitable habitats have environmental conditions which are conducive to the survival and reproduction of a species. In recent years, there has been an increase in the use of data from vessel tracking technologies, such as Vessel Monitoring System or Automatic Identification System (AIS). These systems, which were originally designed to prevent vessel-to-vessel collisions, are being used to study the distribution and behavior of the global fishing fleet. In this study, the newly available AIS data were applied to these computer models. These new models could allow us to predict where humans are expected to fish in the open ocean, giving us an understanding of how they may overlap with marine biodiversity in a changing world.

To create spatial models of fishing effort, we used information on the global distribution of fishing vessels from AIS, focusing on pelagic longliners. Pelagic longliners are the most widespread form of fishing in the world, typically used to catch commercially valuable fish such as tuna and swordfish. However, the baited hooks used to attract these commercially valuable fish also attracts non-targeted marine species like sharks and seabirds, this is referred to as bycatch. Understanding where and when longliners may overlap with target and non-target marine species is very useful information that could help future fisheries management.

Longline fishing effort estimates for the top five longline fishing nations in the high seas (China, Japan, South Korea, Spain and Taiwan) were statistically linked to static and dynamic environmental variables. The static variables included distance to the continental shelf break or oceanic seamount, which are physical features known to attract pelagic predators. The dynamic variables included sea surface temperature, oxygen concentration or primary productivity (how efficiently plants produce oxygen from carbon dioxide through photosynthesis). Using this information, we built a new model that allows to predict the fishing effort into the future. The results demonstrate that the global pelagic longline fleet not only shows distinct monthly preferences of areas to fish, but that these are dynamic over time, so that where and when they fish in the future can be accurately predicted by these spatial models.

As we grapple with rapidly changing oceans and ocean uses, advancements in predictive modeling aided by new technologies will help us move away from outdated methods in area-based management, and towards more dynamic predictive approaches capable of delivering global ecosystem-based management. This use of habitat models may allow fishermen to predict future areas of fishing effort and account for and prevent the overlap of fleets with non-target biodiversity. Future research includes the creation of fleet-specific and region-specific models as well as analyses of overlap with target and non-target species, which eventually helps to save global natural resources and biodiversity.