New study maps how ocean currents connect the world's fisheries

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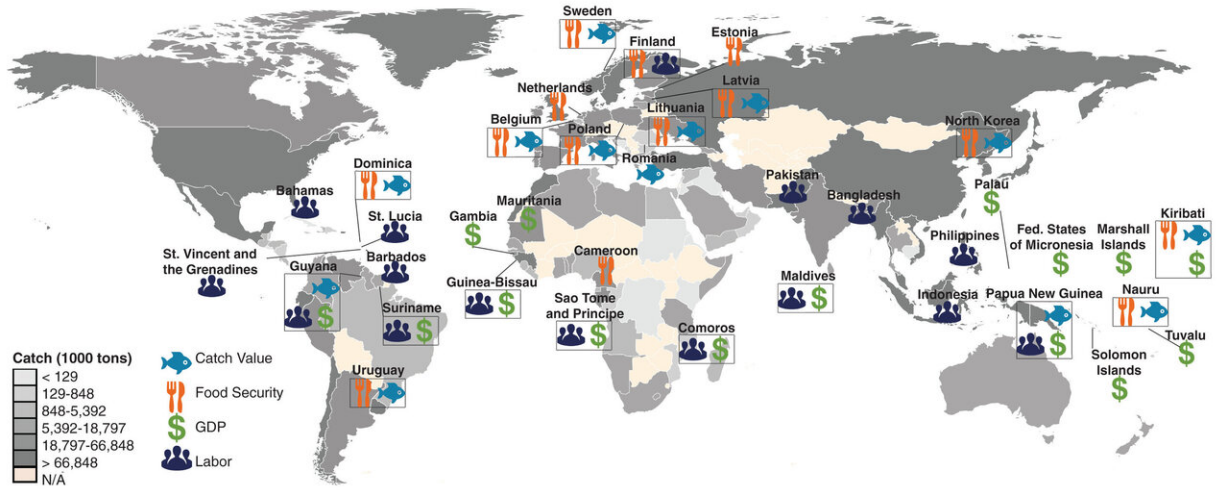


Jobs and GDP in the Tropics depend more on larvae coming from neighboring waters than other regions. These regions are the most vulnerable to disruptions in the network. However, some countries in Europe, Asia and South America, that rely heavily on their own fisheries for protein, also have high economic and food security dependencies. Credit: Kimberly L. Oremus, University of Delaware

A new study published in the journal *Science* finds that the world's marine fisheries form a single network, with over $10 billion worth of fish each year being caught in a country other than the one in which it spawned.

While fisheries are traditionally managed at the national level, the study

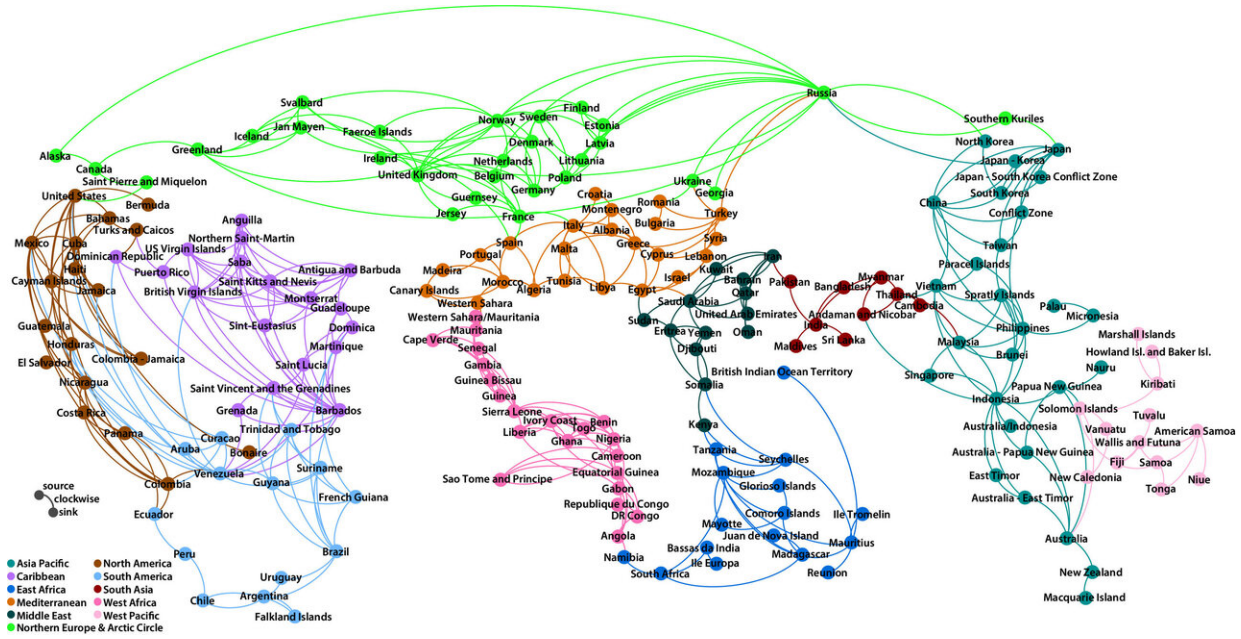
reveals the degree to which each country's fishing economy relies on the health of its neighbors' spawning grounds, highlighting the need for greater international cooperation.

Led by researchers at the University of California, Berkeley, the London School of Economics, and the University of Delaware, the study used a particle tracking computer simulation to map the flow of fish larvae across national boundaries. It is the first to estimate the extent of larval transport globally, putting fishery management in a new perspective by identifying hotspots of regional interdependence where cooperative management is needed most.

"Now we have a map of how the world's fisheries are interconnected, and where international cooperation is needed most urgently to conserve a natural resource that hundreds of millions of people rely on," said co-author Kimberly Oremus, assistant professor at the University of Delaware's School of Marine Science and Policy.

The vast majority of the world's wild-caught marine fish, an estimated 90%, are caught within 200 miles of shore, within national jurisdictions. Yet even these fish can be carried far from their spawning grounds by currents in their larval stage, before they're able to swim. This means that while countries have set national maritime boundaries, the ocean is made up of highly interconnected networks where most countries depend on their neighbors to properly manage their own fisheries. Understanding the nature of this network is an important step toward more effective fishery management, and is essential for countries whose economies and food security are reliant on fish born elsewhere.

The authors brought together their expertise in oceanography, fish biology, and economics to make progress on this complex problem.



The global network of flows of fish spawn across international boundaries. The circles represent ocean territories and the lines indicate flows between them. The lines are curved such that the clockwise direction represents flows from source to sink. Credit: Nandini Ramesh, University of California, Berkeley

"Data from a wide range of scientific fields needed to come together to make this study possible," said lead author Nandini Ramesh, a post-doctoral researcher in the Department of Earth and Planetary Science at the University of California, Berkeley. "We needed to look at patterns of fish spawning, the life cycles of different species, ocean currents, and how these vary with the seasons in order to begin to understand this system." The study combined data from satellites, ocean moorings, ecological field observations, and marine catch records, to build a computer model of how eggs and larvae of over 700 species of fish all over the world are transported by ocean currents.

The research shows that ocean regions are connected to each other in

what's known as a "small world network", the same phenomenon that allows strangers to be linked by six degrees of separation. That adds a potential new risk: threats in one part of the world could result in a cascade of stresses, affecting one region after another.

"We are all dependent on the oceans," said co-author James Rising, assistant professorial research fellow at the Grantham Research Institute in the London School of Economics. "When fisheries are mismanaged or breeding grounds are not protected, it could affect food security half a world away."

A surprising finding of the study was how interconnected national fisheries are, across the globe. "This is something of a double-edged sword," explained lead author Ramesh, "On one hand, it implies that mismanagement of a fishery can have negative effects that easily propagate to other countries; on the other hand, it implies that multiple countries can benefit by targeting conservation and/or management efforts in just a few regions."

"By modeling dispersal by species, we could connect this ecosystem service to the value of catch, marine fishing jobs, food security and gross domestic product," Oremus added. "This allowed us to talk about how vulnerable a nation is to the management of fisheries in neighboring countries."

They found that the tropics are especially vulnerable to this larval movement—particularly when it comes to food security and jobs.

"Our hope is that this study will be a stepping stone for policy makers to study their own regions more closely to determine their interdependencies," said Ramesh. "This is an important first step. This is not something people have examined before at this scale."

More information: N. Ramesh el al., "The small world of global marine fisheries: The cross-boundary consequences of larval dispersal," *Science* (2019). science.sciencemag.org/cgi/doi … 1126/science.aav3409

Provided by University of Delaware