



OUR BLUE PLANET: CONNECTING HUMANS AND THE OCEAN

Michael Kriegl^{1,2*}, Sophia Kochalski³, Tanja M. Straka⁴, Philipp Gorris^{5,6}, Achim Schlüter^{1,7} and Lotta C. Kluger^{2,8}

¹Leibniz Centre for Tropical Marine Research (ZMT), Bremen, Germany

²Center for Ocean and Society, Kiel University, Kiel, Germany

³CRETUS, Department of Applied Economics, University of Santiago de Compostela, Santiago de Compostela, Spain

⁴Institute of Ecology, Technische Universität Berlin, Berlin, Germany

⁵Institute of Environmental Systems Research (IUSF) and Institute for Geography (IfG), University of Osnabrueck, Osnabrück, Germany

⁶Stockholm Resilience Centre, Stockholm University, Stockholm, Sweden

⁷Constructor University, Bremen, Germany

⁸Department of Agricultural Economics, Kiel University, Kiel, Germany

YOUNG REVIEWERS:



ELLIANA

AGE: 10



JULIET

AGE: 12



WILLIAM

AGE: 11

Dive into the incredible world of the ocean, a place full of wonder and beauty! The ocean is like a superhero, providing us with tasty seafood and other vital “services”. But trouble looms: climate change, plastic pollution, and intensive fishing endanger the ocean’s superpowers. Your help is needed to save the day! To keep the ocean healthy, we must understand how it works. Get ready to explore its mysteries through gigantic “webs” of interactions that reveal how we are connected to the ocean, how our actions impact the environment, and how the environment affects us. These webs are called social-ecological networks, and they are like maps that help us



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ECOLOGICAL

Everything about how animals and plants interact with each other and their environment.

SOCIAL

Everything about how people live, communicate, and work together in groups and communities.

solve the ocean's problems. Together, we can use social-ecological networks to secure a sustainable future for our blue planet. So, put on your diving mask, grab your snorkel, and let us make a splash for the ocean!

THE INTERCONNECTED WORLD OF THE OCEAN

The ocean is a place full of wonder. From colorful coral reefs to majestic whales to the tiniest creatures floating through the water, it is teeming with life. But there is more to the ocean than just its beauty. In fact, for us humans, the ocean is like a superhero by our side, providing us with essential "services" that we depend on for our very existence. For example, the ocean regulates the climate by absorbing carbon dioxide, and it produces oxygen for us to breathe. And think of all the delicious fish and seafood that we can enjoy thanks to the ocean!

But here is the challenge: the ocean is facing some serious issues, and humans are often responsible for them. Climate change is causing the water to warm up and sea levels to rise. When people catch too many fish, the balance of the ocean ecosystems can get messed up. In addition, millions of pieces of plastic trash find their way into the ocean every single day. If we are not careful, our ocean hero could lose its superpowers!

So our mission is crystal clear: We must keep the ocean healthy and strong.

To do that, we first need to understand the ocean and its mysteries. Imagine putting on your diving mask and exploring the underwater world. Hold your breath as you observe crabs, octopus, and fish in their natural habitat. Watch as these animals move across the seafloor, hunt for a tasty lunch, and interact with each other. These interactions in the natural world make up the **ecological** side of the ocean's story [1].

But humans are part of the ocean, too. Think about fishers casting their nets along the coast and exchanging ideas about the best fishing spots, or families enjoying beach holidays and collecting seashells. The ocean offers so many opportunities, but here is the thing: everything we do can have an impact on the ocean. This is the **social** side of the ocean's story, where we can see how our actions, choices, and interactions matter to the ocean's health [2].

Solving problems in the ocean is hard. That is why scientists usually try to break these problems into smaller pieces, to better understand each part on its own. But sometimes this can be like trying to solve a puzzle with missing pieces! Imagine tackling the issue of overfishing by only looking at the biology and behavior of a specific type of

fish, but ignoring their important role in the food web, or the actions of fishers.

So, here is the big secret: We cannot just focus on one side of the ocean's story and ignore the others. We must discover how everything in and around the ocean is connected, from tiny creatures on the seafloor to the people who live along the coast. This way of thinking is called **systems thinking** and it helps us better understand the web of relationships that shape the ocean. Through a combined understanding of all related aspects, we can find the best solutions to keep the ocean healthy.

SYSTEMS THINKING

A way of understanding how things fit together to form a bigger picture (and not just looking at the individual parts).

SOCIAL-ECOLOGICAL NETWORK

A network of the connections between people as well as animals, plants, or ecosystems.

NODE

A thing in a network, like a person or fish, that is connected to other things.

LINK

A connection between two things in a network, such as people talking to each other or one fish eating another one.

WHAT ARE SOCIAL-ECOLOGICAL NETWORKS?

How do scientists think about and study the different parts of the ocean's story and their connections? They use something called **social-ecological networks** [3]. Picture a **gigantic web** connecting all the parts of the ocean system that we just discussed (Figure 1). In the language of networks, the different components of the ocean system, such as marine animals and people, are called **nodes**. The arrows or **links** connecting the nodes show their interactions. One part of a social-ecological network shows the relationships between people (the social network), like fishers sharing knowledge about fishing spots. The other part shows how ocean inhabitants, such as fish or crabs, interact with each other and the environment (the ecological network). This is like a big puzzle of who eats whom. The network also includes the connections that cross these two worlds, for example when people catch fish or pollute the ocean with plastic trash.

In essence, a social-ecological network is like a map that reveals how everything in and around the ocean is connected. It helps us understand how our actions affect the ocean and how the ocean affects us.

WHAT HAPPENS WHEN WE IGNORE SOCIAL-ECOLOGICAL CONNECTIONS?

Let us look at two examples to see what happens when we ignore these connections.

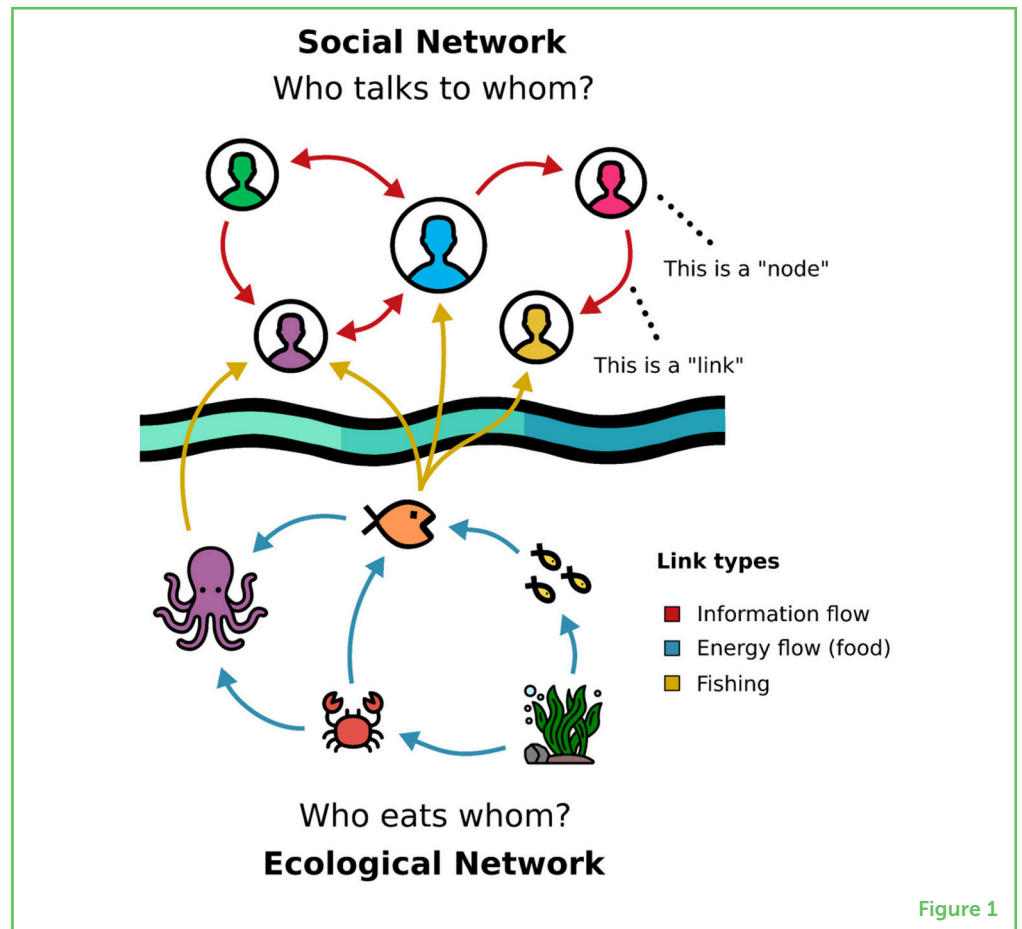
First, Canada used to have one of the largest cod fisheries in the world, providing a livelihood for many fishing communities. But because people caught too many fish without thinking about what might happen, the cod disappeared. This had a big impact on the animals that relied on cod as their food and set off a chain reaction in the local food web. The ecosystem was permanently changed and the effects for local fishers were devastating. Thousands of people lost their jobs, and

Figure 1

A social-ecological network shows the connections between people and nature. Each component is a node and the interactions between them are called links. The top half shows a social network, with red arrows illustrating the flow of information between people. The bottom half shows an ecological network, illustrating the relationships between ocean inhabitants. The blue arrows highlight the flow of energy, for example when one species eats another. Activities like fishing create a bridge between the ecological and social sides of the network, as shown by the yellow arrows. All of the connections together form a complete social-ecological network.

MARINE PROTECTED AREA

A place in the ocean where special rules, like "No Fishing!", help to protect the underwater world.



the local communities suffered greatly. Despite considerable efforts, the fishery has not recovered to date.

As another example, **marine protected areas** are special zones in the ocean designed to preserve marine life. They can be safe havens for fish and other animals when there is excessive fishing. But if we create marine protected areas without considering the people that depend on fishing for a living, this can cause problems. To make ends meet, fishers might turn to destructive fishing techniques or continue to fish illegally, harming marine life. This worst-case scenario has already occurred in several places around the world.

Both examples show why it is important to consider the links between people and nature: could the fishery collapse in Canada have been prevented if we had considered the ecological side of the story? Or can involving local fishers in decision-making prevent negative outcomes of marine protected areas? To make better decisions that will lead us toward a sustainable future, we must understand social-ecological connections.

Of course, it is not just fishing that affects the ocean. Other activities like tourism, shipping, and trash disposal also impact the ocean

and the people who depend on it. All of these factors make the social-ecological network of the ocean very large and complex. To understand it, people who know a lot about the ecological side of the ocean and people who know a lot about its social side need to work together.

MANAGING OUR OCEAN USING NETWORKS

As we dive into the world of social-ecological networks, we begin to see hidden patterns and relationships. Like a game of “What if...?”, we can ask questions such as: “What if we eat too much of a certain kind of fish or seafood?”. They might disappear from the network, affecting people and animals that rely on them for food, such as seals, which in turn are important for tourism. Or, “What if the ocean becomes too warm for mussels, due to climate change?”. They could vanish, the people who collect and sell mussels could lose their jobs and the role of mussels as cleaners of the ocean ecosystem could be disrupted. See how changes in one part of the network can have a domino effect on other parts of the system (Figure 2)?

Social-ecological networks can not only shrink, but also grow. Imagine more and more tourists discovering a new vacation spot. As they arrive and hotels open, the social part of the network grows bigger. But how many tourists can fit in the network without having a negative impact on other parts? And what happens when there are simply too many people in one place, or if they all throw their trash in the ocean?

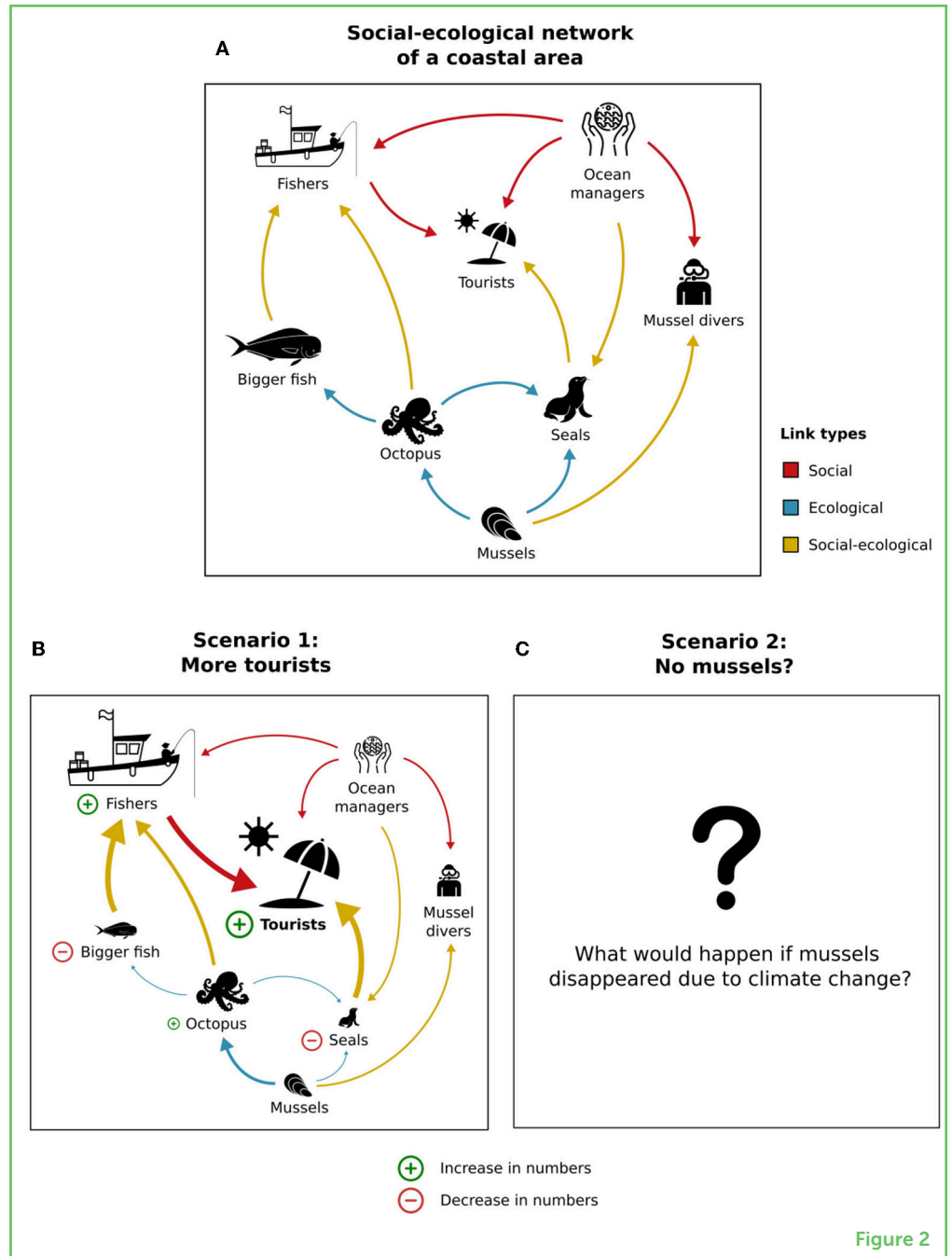
Sometimes even small changes in one part of the network can have big effects on the whole system [4]. That is why it is important to keep an eye on the network and its essential components to make sure that our interactions with the ocean are sustainable.

When everything is in balance, life in and around the ocean is like paradise! People can enjoy delicious seafood, explore beautiful coastal places, and swim in clean waters. But when things get out of balance, it is a cause for concern. In those situations, we must come together to find solutions. Each of us can play a role in reducing pollution, supporting sustainable fishing, and respecting the people who rely on and work closely with the ocean.

Protecting the ocean is a big job, but we can team up with scientists, fishers, conservationists, community members and politicians to collaborate, share ideas and knowledge, and find solutions that keep the ocean healthy. Everyone has a role to play. Together we can use social-ecological networks to better understand the ocean and ensure a bright future for both people and nature.

Figure 2

(A) A social-ecological network of a coastal area that shows the connections between people and animals living in the ocean. (B) What happens if more tourists (+) arrive along the coast? Seals are stressed and move away (-). A higher demand for seafood leads to more fishers (+), but fewer bigger fish (-). The numbers of octopus rise slightly (as there are less seals and bigger fish to eat them), making them the main predator of mussels. (C) Can you imagine what would happen if mussels slowly disappeared from the network due to climate change?

**Figure 2**

CONNECTING THE DOTS

On our blue planet, everything is connected: from the smallest ocean creatures to the food we eat in a restaurant, and from the choices we make in the supermarket to the activities of fishers along the coast. Understanding all these links empowers us to be more mindful and caring toward nature. Together, we can make a positive impact on the ocean. Using social-ecological networks, we can uncover the web of relationships between people and nature. These networks provide us with a big-picture perspective and help us to make smart decisions to

keep the ocean in balance. So, let us use this powerful tool to protect the ocean and all the living things that call it home!

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YOUNG REVIEWERS

ELLIANA, AGE: 10

I am in 5th grade and 10 years old. I like swimming, gymnastics, and hiking. I also like to do arts and crafts.





JULIET, AGE: 12

I am 12 and in the seventh grade. I enjoy going to the beach and playing golf on the weekend.



WILLIAM, AGE: 11

I am 11 years old and in the 6th grade. I love swimming, singing, dancing, and gaming.



YALE PATHWAYS TO SCIENCE PROGRAM, AGES: 11–13

We are seven middle school students from New Haven, CT who love learning about science! We are excited about protecting the environment and want to do more for preserving our future. Most of us have pets we like to play with, such as dogs, cats, birds, and even reptiles. For fun, some of us enjoy playing sports, making crafts, or cooking new things.

AUTHORS



MICHAEL KRIEGL

Michael Kriegl is a marine social-ecologist and network scientist fascinated by the connections between people and the ocean. He wants to understand how social and ecological systems work together and what this means for the management of ocean resources. In addition, Michael is passionate about communicating science and sparking curiosity in young minds. He has worked along the Pacific coast, the Baltic Sea, Red Sea, Mediterranean, and the Arctic Ocean. *michael.kriegl@outlook.com



SOPHIA KOCHALSKI

Sophia Kochalski is an interdisciplinary fisheries scientist and she combines various methods to understand social processes in fisheries. She has worked with small-scale fisheries in Peru as well as in various European countries.



TANJA M. STRAKA

Tanja Straka is an urban ecologist with a passion for wildlife, conservation, and the natural world around us. In her work, she combines ecological research with social science theories. Tanja strongly believes that conservation is much more effective if we also understand people, as most threats to nature and wildlife are caused by human behavior.



PHILIPP GORRIS

Philipp Gorris is a social environmental scientist working on sustainable development and environmental governance. He studies how integrative approaches can be designed to effectively address environmental problems through socially just policies.



ACHIM SCHLÜTER

Achim Schlüter is a professor of social systems and ecological economics. He is interested in processes of institutional development and change, privatization, and what influences human behavior. In his work, he focuses on coastal regions in Indonesia, Peru, and Senegal as well as other countries.



LOTTA C. KLUGER

Lotta C. Kluger is an interdisciplinary researcher working on social-ecological dynamics and the sustainability of marine resource use, with a focus on aquaculture and fisheries. She has lots of experience working in coastal regions in Peru, Brazil, and other countries.