

On Species Roles in the Marine Ecosystem – The Key to Wellbeing and Survival of Humanity

Honourable Chancellor, Rector, Vice-Rector, Deputy Vice-Rectors, distinguished scholars, colleagues, and friends of science,

In 1859, **Charles Darwin** published *On the Origin of Species*. He provided an answer to one of science's greatest questions: *Where do species come from?*

Nearly 170 years later, on a planet still covered by 70% ocean, but in a world simultaneously confronting three planetary crises, climate change, pollution, and biodiversity loss, we face a question that is at least as important:

What happens when species disappear?

What does a mussel, a polychaete worm, or a bladderwrack algae plant actually mean for the functioning of the sea? What does their existence mean for us as human beings?

And how can we ensure that the roles species play in marine ecosystems are not merely objects of scientific inquiry, but are also integrated into the decisions that shape our society?

In one way or another, my research has revolved around these questions. Today's talk is also a story of how I connect ecological basic research with the interdisciplinary marine research that we have built at Åbo Akademi University through THE SEA profile and now carry forward within the Centre for Sustainable Ocean Science.

But let us begin with the fundamentals. What do we mean by a species' "role", and how can we study it?

A species, whether an animal, a plant, or a bacterium etc., influences its surroundings through its characteristics, what we in ecology call *traits*. Its size, growth rate, lifespan, reproductive strategy, diet, behaviour, movement, and interactions with other organisms are all examples of such traits. Together, these traits determine the functions a species performs within an ecosystem and how it contributes to the processes that sustain life in the sea.

A species may filter water, recycle nutrients and oxygen, create habitats that benefit other organisms, regulate populations, or connect different levels of the food web.

Did you follow that?

Perhaps we need a more concrete example. Fortunately, professors are still allowed to perform a little magic from time to time.

I have always been particularly fascinated by the animals living on the seafloor, so I brought a few with me today.

Here you see *Pecten maximus*, the great scallop, also known as the king scallop. This particular specimen is dead, of course. Yet even its shell tells us something about its traits, namely its size. This specimen measures 13 cm.

Some traits can be measured directly. Others require us to examine internal organs, observe behaviour in nature, or conduct experiments.

King scallops bury themselves just beneath the sediment surface and can swim by rapidly clapping their shells together using their powerful adductor muscle, incidentally the part that many of us enjoy eating. In this sense, the scallop makes a direct contribution to human society by providing food, often appearing as a delicacy in fine restaurants.

However, through the way it moves in and across the sediment, it also helps oxygenate the seafloor.

The scallop performs other important functions as well. By filtering large volumes of seawater and extracting microscopic plankton, it helps clean the water and transports nutrients from the water column to the seabed.

This is a function shared by one of the Baltic Sea's key species, the Baltic clam, *Macoma balthica*.

The first thing you may notice is that it is almost invisible. Compared with *Pecten maximus*, it is considerably smaller, measuring only 1.5 cm. Its shell is fragile, and unlike the scallop, it must remain completely buried within the sediment to protect itself from predators such as fish.

The Baltic clam can live as deep as eight centimetres beneath the seabed. It feeds through two tubes, called siphons, which it extends up through the sediment into the water above.

Depending on environmental conditions, it can switch feeding strategies. Like the scallop, it may filter plankton directly from the water column and function as a filter feeder. Alternatively, it may vacuum organic matter from the sediment surface, acting instead as a deposit feeder.

I could, of course, pull many more creatures from my hat, worms, crustaceans, and others, but that might become rather messy, so we shall leave it there.

By studying not only how many species occur on the seafloor, but also their traits, we can quantify what is known as the ecosystem's *functional diversity*.

So what happens when species decline or disappear?

Sometimes, surprisingly little.

Our studies of functional diversity in the Baltic Sea show that although marine species richness declines drastically, and naturally, from south to north, the relatively few species inhabiting the northern Baltic Sea are, however, capable of performing a wide range of functions. There is a degree of redundancy in the system, and such redundancy can be crucial when ecosystems are exposed to multiple stressors, such as eutrophication and rising temperatures.

At other times, however, the consequences are more substantial.

The functioning of benthic ecosystems often differs between environments. For example, we observe a loss of both species and functions when moving from the outer archipelago to the inner archipelago, largely as a result of eutrophication.

Similarly, our recent studies of Arctic fjords and deep offshore ecosystems reveal significant differences in the functions performed by benthic communities.

We can also examine how ecosystem functions change over time and identify when functions such as water filtration have declined.

Today, we are increasingly interested in understanding the links between specific traits and ecosystem functions. In the context of climate change, one particularly important question concerns the role of benthic organisms in transporting carbon from the atmosphere to the ocean floor and ultimately contributing to its long-term storage in deep marine sediments. This process represents one of the few natural pathways through which atmospheric carbon dioxide can be removed and stored over meaningful timescales.

Species, their traits, and the functions they perform are therefore fundamental to human wellbeing in numerous ways.

As Finland's first female professor, **Alma Söderhjelm** demonstrated, new knowledge is not only about describing the world; it is also about changing the way society thinks.

Biodiversity research today faces a similar challenge. It is not enough to understand how species function within ecosystems. That knowledge must also find its way into the decisions that shape our societies.

One example among many is our work within a multidisciplinary European project aiming to establish an ecologically coherent network of marine protected areas across the Baltic Sea.

The protection of species functions has been explicitly proposed as a guiding principle in the design of these protected areas.

To support this process, we have developed methods for mapping species' traits, functions, and ultimately the benefits that marine ecosystems provide to society. We have successfully included more

than 200 species from across the Baltic Sea, a scale that I could hardly have imagined when we first began.

This allows us not only to identify areas of high functional diversity, but also to prioritise regions that provide particular benefits to people.

Alma Söderhjelm was also a pioneer who challenged disciplinary and institutional barriers when she assumed her professorship at Åbo Akademi University nearly one hundred years ago, in 1927.

That Åbo Akademi continues to believe in crossing disciplinary boundaries in order to address the complex challenges of our time is, in many ways, reflected in my own professorship.

What began in 2018 as a small team of three researchers tasked with exploring interdisciplinary collaboration on marine issues has grown into a core group of 25 people, along with many affiliated researchers and knowledge holders, representing eight academic disciplines.

Being part of this journey is something I am deeply proud of.

Over these years, we have not only developed a research programme focused on marine biodiversity, as well as shared methods and approaches for bridging disciplinary divides and collaborating with companies, associations, non-governmental organisations, public authorities, and other societal actors.

We have also helped create something larger: a new, more thoughtful way of approaching ocean sustainability challenges.

I would like to believe that together we have laid the foundations for a movement whose significance extends far beyond academia and which can contribute to lasting change, both in Finland and internationally.

I would like to conclude with the words of marine biologist **Sylvia Earle**, whose life and work have inspired generations of ocean scientists, myself included:

“Knowing is the key to caring.”

Knowledge leads to understanding. Understanding fosters care. And care is a prerequisite for the decisions required to preserve the functional diversity of our oceans and, ultimately, the wellbeing and survival of humankind.

Thank you for listening!