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OCEAN ACCOUNTS: HOLDING OURSELVES RESPONSIBLE FOR A BRIGHTER OCEAN FUTURE

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AGE: 12

YOUNG SCIENTIST ACADEMY

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We are dependent on our oceans for food, transport, and fun, to name just a few things. However, misuse of the oceans is affecting many communities that depend on ocean resources for their livelihoods. Similar to the way we track students' grades with report cards, we need to start keeping track of and scoring exactly how our oceans are doing. Ocean accounts are a way to measure the financial, environmental, and social dimensions of ocean wellbeing. Looking at these combined aspects can help us measure and monitor the state and overall functioning of Earth's oceans. In this article, we look at what ocean accounts are and how they can aid ocean conservation and ocean health. Healthy oceans ultimately equal healthy and thriving humans!

WE START WITH A RIDDLE...

What do a squid, a cargo ship, a fisherperson, and a runner have in common? The OCEAN, *and* their need for it! Without the ocean, life as we know it would not exist—the oxygen in the air we breathe would be reduced by at least 50%, and Earth would be an unfriendly place for most living things. Approximately half of the planet's oxygen comes from marine organisms, predominantly **phytoplankton**, through photosynthesis (Figure 1A). The ocean also helps regulate Earth's climate and acts like a giant sponge, soaking up carbon dioxide and helping to slow down climate change. It is also home to countless amazing creatures. Additionally, the ocean is a source of food, jobs, and fun recreational activities for humans (Figure 1B). So, you see, oceans play a crucial role in sustaining life on Earth, providing us with food and oxygen, and regulating the planet's climate. However, Earth's oceans are facing numerous threats such as pollution, overfishing, and climate change.

PHYTOPLANKTON

Microscopic, plant-like organisms (algae) that live suspended in water, both freshwater and saltwater. They are crucial for marine ecosystems as they form the base of the food chain.

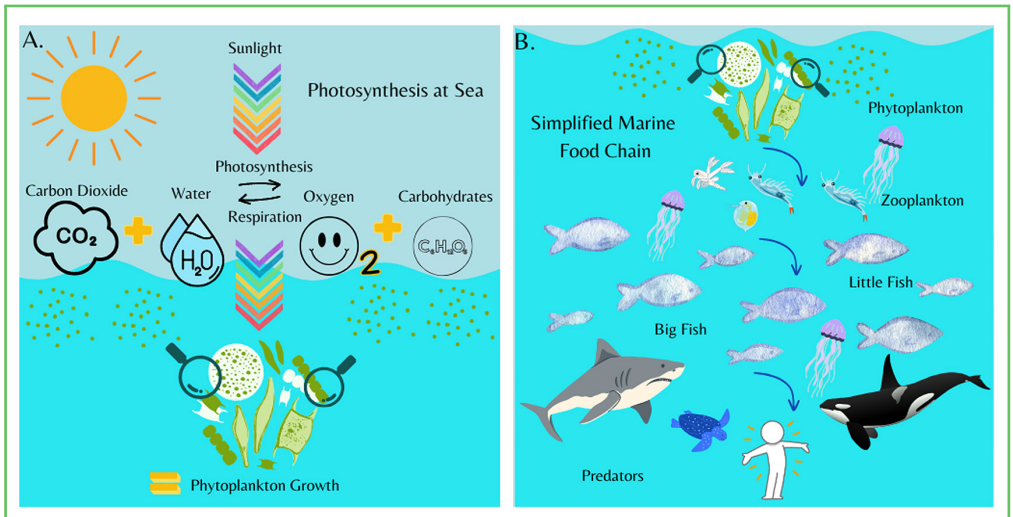

Figure 1

(A) Tiny green sea plants known as phytoplankton use photosynthesis to grow and produce the oxygen we breathe. In the process, they take up carbon dioxide—a greenhouse gas that contributes to climate change. **(B)** A simple marine food chain showing that humans sit right at the top with other apex predators like sharks. Humans eat and use many marine resources, including fish and sea plants.

ORGANIZING OUR PRIORITIES

Think for a moment about what is most important:

- A home for a fish
- A meal for a human
- Building materials for a new development
- A fun experience
- A healthy environment for a dolphin
- Fuel for your parent's car
- Fertilizer to grow the world's food
- A sacred place to practice your spiritual beliefs

OCEAN ACCOUNTS

A way to organize and track information about oceans and coasts—like maps, data, and stats—showing how nature, people, and the economy are connected and changing.

Is it possible to put this list in order of priority? **Ocean accounts** can help. They are a valuable tool that can help us understand, prioritize, map, and measure the health and wealth of our oceans. In the rest of this article, we will explore the concept of ocean accounts and monitoring and supporting Earth's precious oceans.

WHAT ARE OCEAN ACCOUNTS?

Imagine you have a piggy bank, if you were an adult, a bank account, where you save all your money, and you count the contents weekly to keep track of how much savings you have. Ocean accounts are similar but instead of money, they help us keep track of valuable information (data) about the ocean. Ocean data helps scientists and policymakers understand how the ocean is doing and what areas or ecosystems need to be prioritized for better management. Data is collected about things like the health of coral reefs, the number of fish, the amount of oxygen being produced by phytoplankton, and even how much pollution is in the water. All this data is recorded in table format on spreadsheets also called accounts. Importantly, all data is standardized so that someone in South Africa can compare accounts with someone in Canada, if need be. This is like having a report card for the ocean, and we use this information to make sure the ocean remains healthy and life-sustaining (Figure 2).

Figure 2

Like bank accounts track our savings, keeping track of important ocean species, water quality, and habitat health are key functions of ocean accounts. These accounts can be thought of as a type of report card for the sea, standardized so that people all over the world can understand the "grades". If measuring and monitoring show that aspects of the ocean are improving, this positive change is like a "good" report card for the ocean.

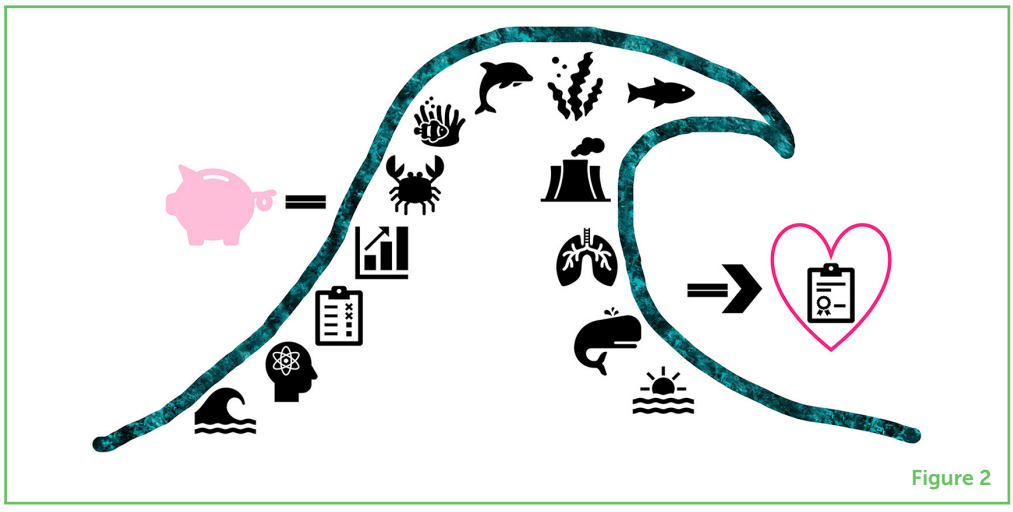

Figure 2

WHY ARE OCEAN ACCOUNTS IMPORTANT?

Ocean accounts give us a standardized way to measure how the ocean is changing over time. Just like you might measure your height on a growth chart to see how much you have grown, ocean accounts help us measure things like the increase in pollution, the decline in certain fish populations, or the change in kelp forest coverage. Additionally, **indicators** (something that shows the status or quality of what you are tracking) of water quality, resource use, and conservation

INDICATORS

Are measurements that show the condition of the environment, like salinity indicating how salty the sea is and revealing its overall health.

measures can be tracked, such as measuring sea temperature over time (warming or cooling?) or salinity of the ocean (becoming fresher or mare saline) to indicate how it might be changing.

By keeping tabs on the ocean's health, we can identify problems and find solutions. This is like going to the doctor for a check-up. If the doctor notices something wrong, they can give you medicine or advice to help you feel better. Similarly, ocean accounts help us take care of the ocean by capturing measurements of its vital signs and making sure it stays healthy for all the creatures that call it home or rely on it to support life.

WHAT DO OCEAN ACCOUNTS LOOK LIKE?

When we look out to sea, we only see a flat blue expanse—but we know that beneath the surface there is a huge, vibrant underwater world full of plants and animals living in diverse habitats. Ocean accounts are a bit like that, too. On the surface, they are just tables of numbers used by scientists and statisticians. But behind those numbers are real-world maps and models based on measurements like ocean depth, oxygen concentration, and fish populations. Mapping and modeling the ocean is like solving a highly complex, multidimensional puzzle. It is challenging, but exciting! So how do we make sense of a fluid, boundary-less environment and count what exists within it? That is where marine mapping comes in.

Imagine a map of a local bay, like False Bay in Cape Town, South Africa. Ocean accounts use maps illustrating the various **ocean assets** such as ecosystem types, water depth, types of marine users and uses, sea-floor habitat types, water quality, nutrient concentrations, current direction, and more. These data are used to create a visual representation of a particular part of the ocean, which is broken up into equally proportioned, 3-D space using mesh-like blocks. For each block of space, a series of numbers is created that count each of the assets listed above that are found within that block [1, 2].

You can picture this process like building a 3D jigsaw puzzle of your local bay (Figure 3A). For each puzzle piece or block, we have a measure of the ocean assets that are part of that area, as well as the size of each block. To calculate the total area, we add all the pieces together or calculate some portion or area of interest, depending on our needs or questions. For example, we can calculate the size of the kelp forest ecosystem type, and, from this, we can establish total **biomass** (weight of all the kelp) or **carbon uptake**. This is useful information because we then know how much kelp forest we have in the ocean at present, in comparison to another timepoint in the past—which tells us how the amount of kelp forest changes over time *and* how healthy it is. Is it increasing or decreasing? Is it healthy or dying? Is it a source of carbon dioxide or a **carbon sink**, meaning

OCEAN ASSET

Something in the ocean—like fish, coral, or clean water—that has value for nature, people, or the economy. It can be naturally found or created through human activity.

BIOMASS

The total mass of living (or dead) biological organisms in a given area or ecosystem at a specific time.

CARBON UPTAKE

The process by which oceans, seaweed, land plants, and forests absorb carbon dioxide from the air, helping reduce climate change by storing carbon in nature.

CARBON SINK

Anything that absorbs more carbon from the atmosphere than it releases – for example, plants, the ocean and soil.

does it draw carbon dioxide down to the sea floor or not? Indicators of change are a key component of ocean accounts and give us information about the services oceans provide for our benefit [3].

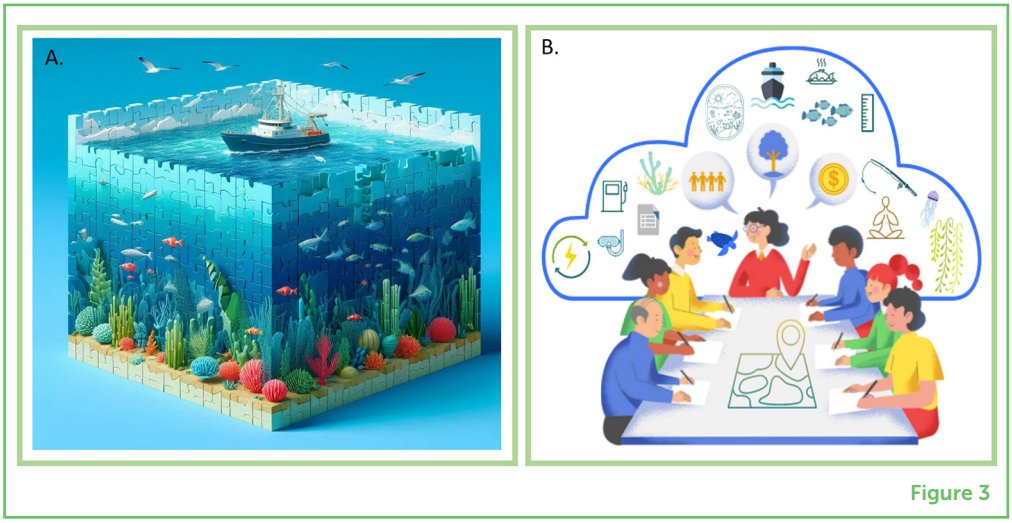

Figure 3

Figure 3

(A) This 3D puzzle map shows how ocean spaces can be broken into measurable units for tracking and accounting ocean assets. For example, we can use such a map to calculate the amounts of certain habitat types or ways the ocean is used, and to determine how they change over time (Image generated by Copilot v1.0.4.0 AI on 19 August at 12:00). **(B)** In good ocean governance, many players hold discussions and make decisions on all aspects of ocean health, wealth, and sustainable development. Thinking beyond just the economic (money-related) aspects of ocean-related decisions is a critical step forward in ocean accounts and how we track changes over time, to keep the oceans healthy and resilient.

OCEAN GOVERNANCE

The rules and decisions countries and groups make to protect the ocean, use its resources responsibly, and keep marine life and habitats healthy for the future.

ECOSYSTEMS, SOCIETY, AND ECONOMICS IN OCEAN GOVERNANCE

To provide sound and consistent decisions, which is known as good **ocean governance**, we need information about all parts of society that interact with the ocean. Ocean accounts must consider and "account" for the environmental or ecosystem component as well as the social interactions and needs, and financial matters associated with the sea (Figure 3B). In the past, people tended to put too much emphasis on the financial or economic aspects of ocean-related decisions—such as allowing the gradual collapse of the Atlantic cod fishery for the sake of economic gains which ultimately had negative environmental, societal, and economic impacts [4]. If these three parts were considered from the beginning perhaps the fishery would not have collapsed to within 1% of extinction [4]. Accordingly, to ensure that our oceans stay healthy as our societies continue to develop and use ocean assets, we must think beyond just economics and keep track of each facet. If we allow the environment to deteriorate, then the social and economic components will be impacted. However, if we do not think about economics enough, people's livelihoods could be impacted. Finally, if we do not consider the social aspects, people's quality of life and wellbeing will be impacted. Each pillar has a vital part to play, and monitoring these interconnected components is what sets ocean accounts apart from traditional accounting practices which historically only factors in the financial component of sea-based resource use [3].

OUR ROLE IN ACCOUNTING FOR THE OCEAN

Using ocean accounts, the health of our oceans and the impact of human activities on marine ecosystems has become visible. With this invaluable tool, we can track and measure changes in the ocean environment and its inhabitants in a standardized and meaningful way that will support sustainable ocean practices and development. It is up to each one of us to become stewards of the ocean. Some simple ways to do so are by reducing pollution (create less waste!), combating climate change (ride your bike or walk more!), adopting better ocean-related practices like sustainable fishing (ask your parents to buy only sustainably caught fish!) or only using reusable plastics (if any at all!). We can also support initiatives that protect marine life, and we can spread awareness about the importance of ocean conservation. Through combined actions, we can contribute toward a healthier, thriving ocean ecosystem. Remember that the future of our planet depends on the health and wellbeing of our oceans, and it is our responsibility to ensure that they are preserved for generations to come. Learning about ocean accounts teaches us that globally standardized measuring, monitoring, and data collection is critical for marine environments. Together, we can make a difference and create a brighter future for our magnificent oceans.

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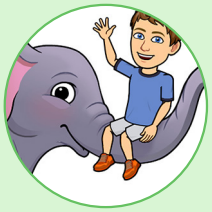
YOUNG REVIEWERS



CALEB, AGE: 12
Caleb enjoys all things science, animals, reading, exploring the outdoors, playing the violin, and curling. When he grows up, Caleb wants to be an architect focusing on eco-friendly and animal oriented buildings. He has tried four sports and is always up for trying something new. Caleb's favorite foods are macaroni and cheese or lasagna. He enjoys traveling and would like to go to an animal reserve.

YOUNG SCIENTIST ACADEMY, AGES: 12–14
The young reviewers are 6th graders at Rose Hill-Magnolia Elementary School and participants at Young Scientist Academy (YSA) all aged 12–14 years old: Drea, Susan, Indica, Jayleah, Isabella, Megan, Threisy, Leonardo, Daniela and Nicolas. YSA is a

youth science NGO located in North Carolina and Moldova that empowers the next generation to become ambassadors in science and technology.

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Erika is a freelance marine consultant and cartographer at S.A.E.O.N. and Nelson Mandela University. She draws on her experience as a marine ecologist and Geographic Information Systems (GIS) specialist to foster better understanding of marine spaces from the coasts to deep sea environments in the southern African region, using ocean modeling, mapping, and data visualization. Her passion is sharing her knowledge of sea environments and complex interaction systems with anyone keen to listen or look, and ideally management and decision makers—but often she appeals to a much younger audience. In her free time, she likes to surf, read, and make seaweed soap. *erikabrown.gissa@gmail.com

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Nicole is a science officer, working across the spheres of industry, science, and policy. She has expertise in regional ocean governance focused on sustainable development. She is the coordinator for the South African Chapter of the Indian Ocean Rim Association, where she fosters collaboration and innovation among scholars and policymakers. She also leads the South African Marine Research and Exploration Forum, engaging with maritime industry to collaborate on research. As a team leader for the National Research Foundation Community of Practice: Ocean Accounts Framework, Nicole is invested in assisting decisionmakers in managing ocean resources.

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Tommy is a specialist in the ecology of coastal marine plants and phytoplankton. He works at the Elwandle Coastal Node of the South African Environmental Observation Network (SAEON) and manages the Shallow Marine and Coastal Research Infrastructure (SMCRI), which develops long-term research observatories and infrastructure platforms to improve understanding of how coastal ecosystems function and respond to global environmental change. In addition, Tommy is a professor at Nelson Mandela University, where he is passionate about teaching and mentoring the next generation of scientists.

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Juliet leads a team focusing on observations, modeling, and research in the marine environment around southern Africa, as part of the National Research Foundation's South African Environmental Observation Network. Juliet also manages the South African Polar Research Infrastructure and is a professor at the University of Cape Town and the Nelson Mandela University. She has significant experience with developing and managing multidisciplinary ocean observations. Her passion is in fostering regional and international collaborations as well as capacity development. Juliet focuses attention on leading, teaching and growing a diverse network of marine scientists.