

OBSERVING LIFE IN A CHANGING OCEAN:

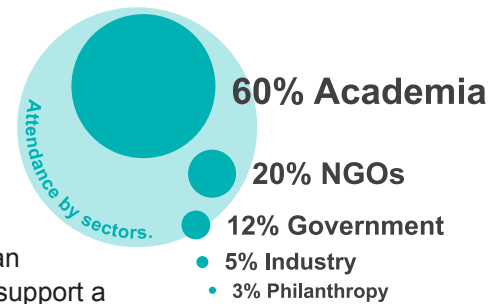
EXPLORING A CENSUS OF MARINE LIFE TODAY

Report on the Virtual Symposium held January 27, 2021

SYMPOSIUM SUMMARY AND KEY FINDINGS

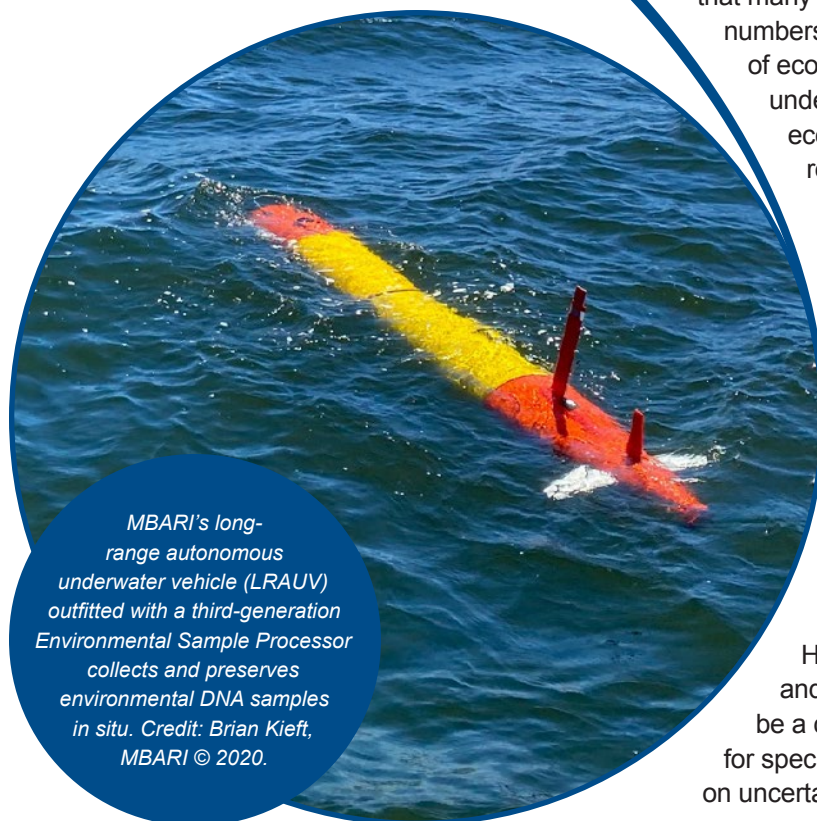
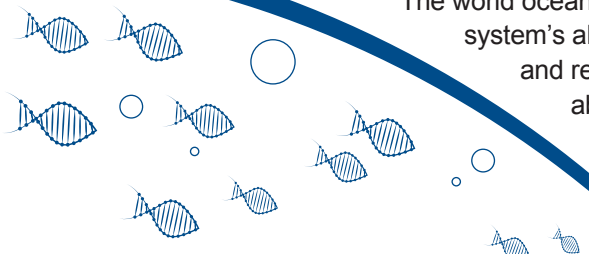
On January 27, 2021, the Consortium for Ocean Leadership (COL) hosted the [virtual symposium](#) *Observing Life in a Changing Ocean: Exploring a Census of Marine Life Today*. This event celebrated the 10-year anniversary of the conclusion of the [Census of Marine Life](#), an international program which ran from 2000 to 2010 to assess the diversity, distribution, and abundance of life in the ocean. More than 230 representatives from academia, industry, government, philanthropy, and other nonprofit organizations attended the symposium. Community-oriented discussions considered the reasons a new *Census*-like program is needed, novel technologies that are available, and current opportunities to advance a modern initiative.

The overarching outcome of this event is that a new *living marine census* program is immensely needed to support sustained, systematic, and coordinated marine biodiversity research and observation in the coming decade, and beyond. The *Census of Marine Life* demonstrated the impact that intentional investments in coordination and partnership-building can bring to this field. Many new technologies for observing marine life have been developed and proven over the last decade that make it more feasible and cost-effective than ever before to undertake this kind of initiative. The scientific foundation exists to support a program that meets the United States' needs for information on marine species and leverages an already engaged and energetic community. International collaboration is also important in this regard, as ocean ecosystems do not adhere to political boundaries. A globally concerted effort, with U.S. leadership by Congress, is essential to initiate and maintain this kind of broad scientific endeavor.



The world ocean hosts a staggering number of organisms which are central to the Earth system's ability to provide essential services to humanity, such as food resources and regulation of climate and the carbon cycle. However, the total diversity and abundance of life in the ocean — from whales to microbes — is still unknown.

There is much to learn about what life is out there and how specific organisms may support critical ecosystem functions; a need to better understand heat-resistant zooxanthellae that protect corals from climate warming is one notable example. Further, there is concern that many species are being lost or declining to unsustainable numbers due to human activities, with correlating losses of ecosystem functions before they are even known or understood. Knowledge of marine species and the ecosystems they support are essential to predict resilience and ensure sustainable management of these marine resources. Understanding the capacity of individuals, communities, and populations of marine animals to tolerate, acclimate to, evolve with, and adapt to rapid changes in their environment, whether physiologically or by altering their behaviors in search of more suitable conditions, is critical in this regard. This includes understanding the connectivity and interactions between species in food webs. Decision makers need this information to assess what is at greatest risk in a changing environment, especially as it relates to human economic activities including seafood provision, fossil fuel use, and commercial shipping. However, measuring changes in marine biodiversity and abundance and ascribing drivers of that change can be a costly and time-intensive process. Our current models for species diversity, distribution, and abundance are based on uncertain estimates and informed by measurements from



MBARI's long-range autonomous underwater vehicle (LRAUV) outfitted with a third-generation Environmental Sample Processor collects and preserves environmental DNA samples in situ. Credit: Brian Kieft, MBARI © 2020.

only a fraction of the ocean and a fraction of the kinds of organisms that exist. Even so, we know that marine biodiversity is changing, and important kinds of marine organisms (e.g., corals and many large vertebrates) are clearly declining.

Previous programs, including the *Census of Marine Life*, have made great strides in filling the gaps in our collective knowledge. However, there is much that remains to be discovered and understood. Now, more than ever, benchmark information as well as sustained, coordinated observations to understand trends and patterns in marine biodiversity are needed to mitigate the impacts of climate change, ensure fisheries and seafood sustainability, support conservation and preservation, predict species and ecosystem resilience, promote sustainable economic development, and more.

THE GOALS OF A *LIVING MARINE CENSUS* MUST STRIVE TO:

TECHNOLOGY

- Develop, implement, and promote innovative and efficient technologies, as well as develop standards for emerging technologies, to drastically reduce the time, effort, cost, and specialized expertise needed to monitor and explore all aspects of marine biodiversity, particularly abundance.

DATA

- Prioritize data collection to understand and monitor total fauna at local to global scales. Questions of whether diversity and abundance, for both microorganisms and macroorganisms, is in decline — and what drives that — must be answered.
- Make standardized marine biological data and metadata publicly available in near-real time, ensuring data accessibility and interoperability across projects using the Findability, Accessibility, Interoperability, and Reusability (FAIR) principles.
- Establish a community of best practices for existing technologies and methods (e.g., [Ocean Best Practices](#)) to make data more interoperable and observations comparable over time and space.
- Build a digital, open-access library of ocean life by 2030 that enables efficient monitoring and research on species diversity, distribution, abundance, and interactions (e.g., range shifts, phenology, trophic interactions, co-occurrence networks, monitoring non-indigenous species).
- Sequence the genomes of “keystone” marine eukaryotic species by 2030 (~50,000 species) in collaboration with ongoing efforts such as the [Earth BioGenome Project](#). Understanding the full functional diversity of species in an ecosystem is essential for management, restoration, and ensuring resilience of fisheries, marine protected areas, and other critical habitat, and scientists should work with managers to identify these keystone species and the questions that genome sequencing can address.
- Quantify the within-species genomic diversity and microbiomes of the 10% most ecologically important species throughout their entire geographic and depth ranges (~5,000 species). Understanding how genetic diversity and microbiomes vary within species and influence the health, physiology, behavior, and ecology of marine animals will inform our understanding of how these animals adapt to climate-related and human-induced changes in the ocean environment.

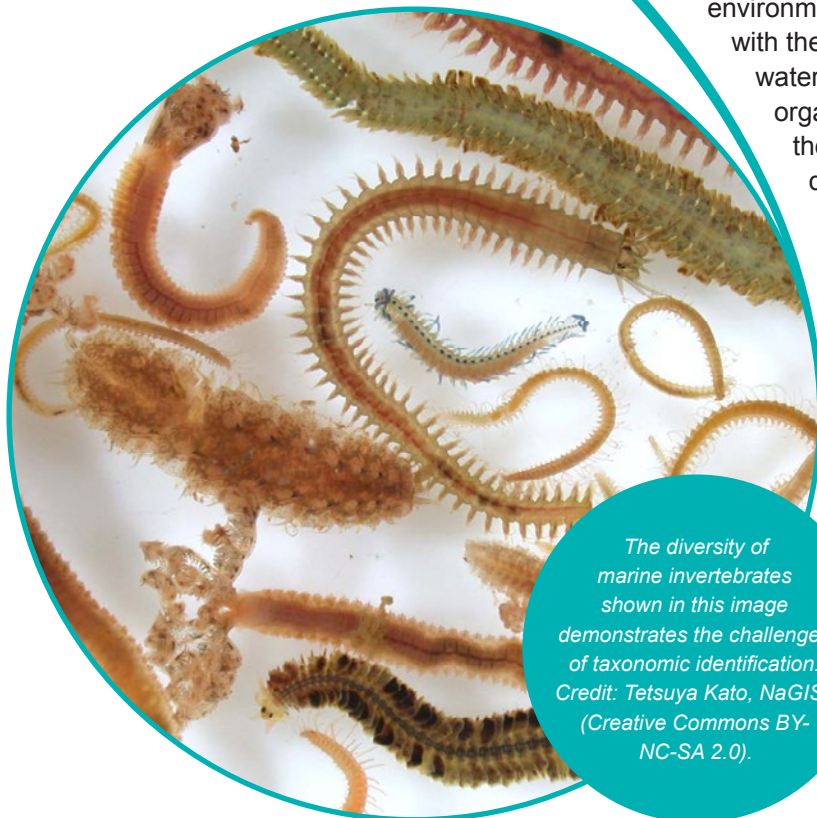
PROGRAM OPERATIONS

- Balance exploration and discovery with investment in sustained, systematic, coordinated cross-sectoral marine biological observing systems and programs to monitor change in diversity, distribution, and abundance.
- Develop, implement, and promote innovative and efficient organizational and institutional processes to share data, resources, and capacity to meet global needs for information about marine life.
- Prioritize implementing new practices to build workforce capacity and human diversity across the entire scientific and observation value chain to support shared values and build trust.
- Connect science with solutions through boundary-spanning organizations, roles, and/or joint positions, bringing co-creation and co-design forward into the planning and implementation of observing systems.
- Identify dedicated funding sources for developing and sustaining partnerships, collaboration, and stakeholder engagement.

THE IMPORTANCE OF SPECIES DIVERSITY, DISTRIBUTION, AND ABUNDANCE

Efforts to understand marine biodiversity require information on the **diversity, distribution, abundance,** and interactions of marine organisms. This includes organisms large and small, from mammals to microbes, in all ocean realms. We must also understand the processes that drive diversity, distribution, and abundance, so that we can explain and predict changes due to climate change and other human activities.

Recent advances in technologies related to 'omics, artificial intelligence, satellite imaging, bioacoustics, and autonomous surface/subsea imaging and sensing are accelerating our capabilities to observe and monitor marine life on large scales and cost-effectively. Novel technologies and robust data libraries also provide new capabilities; environmental DNA (eDNA) is positioned as a powerful tool, with the ability to detect genetic material floating freely in the water column in a noninvasive way that does not require organism collection. It is critically important to bring these technologies to the forefront by refining methods, developing standards, and implementing them as tools in both ocean exploration and sustained observation. Some of these tools were available when the *Census of Marine Life* launched in 2000 but were still relatively expensive even when that program ended in 2010. For example, the cost of high-throughput DNA sequencing continues to decline, increasing its feasibility for regular biodiversity monitoring. Additionally, the availability and spatial resolution of commercially available satellite imagery has greatly improved, and massive amounts of previously collected data can now be repurposed for training advanced computer algorithms. These tools are readily available for a new coordinated effort aimed at characterizing life in the ocean through sustained and systematic observing, monitoring, and modeling.



The diversity of marine invertebrates shown in this image demonstrates the challenges of taxonomic identification. Credit: Tetsuya Kato, NaGISA (Creative Commons BY-NC-SA 2.0).

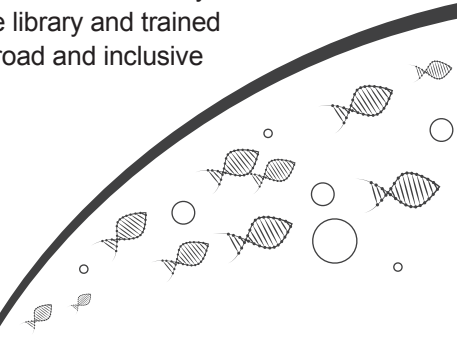
Broadly, **diversity** addresses species- and genome-level knowledge and provides information about the kinds of life found in the ocean. The [Convention on Biological Diversity](#) more specifically defines “biological diversity” as “the variability among living organisms...and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.” There is still so much that is unknown in this regard, including significant uncertainties in estimates of how many marine species may even exist.

The *Census of Marine Life* provided the first global maps of the richness of marine species diversity and led to the discovery of many new organisms. Yet, there are still hundreds of thousands of species undiscovered, particularly in the deep ocean. What is the total diversity of ocean life, what is being lost, and how is that changing species' interactions and ecosystem functions? How do oceanic processes drive and support diversity — and vice versa? These are questions that a *living marine census* can address in novel and transformational ways. Physical sampling and direct observation through *in situ* images/video and acoustic monitoring will continue to be important in this regard, though greater utilization of artificial intelligence and high-performance computing (e.g., to enable automated classifications) has the potential to revolutionize the useability of raw data by drastically reducing the time, effort, and knowledge needed to accurately identify and predict marine life patterns. These tools have the potential to rapidly improve our understanding of biological variance, connections, functions, and interactions among species in marine communities and help predict responses to environmental disturbances. This robust information can then aid in management and restoration decision making by creating a benchmark for understanding the resilience of marine life.

Microbial diversity must not be overlooked, as it is estimated to account for 90% of biomass (the total mass of biological materials) in the oceans. Questions of how the diversity of microorganisms and macroorganisms connect and influence each other, and the environment around them, must be addressed. Further, the question of whether global marine microbial biodiversity is increasing, decreasing, or staying the same must be answered. It will be necessary to not only incorporate microbes of all kinds into ongoing biodiversity surveys, but also the key interactions between organisms and their microbiomes. There is a growing literature hinting at the role microbiomes might play in host adaptation and resilience to environmental change.

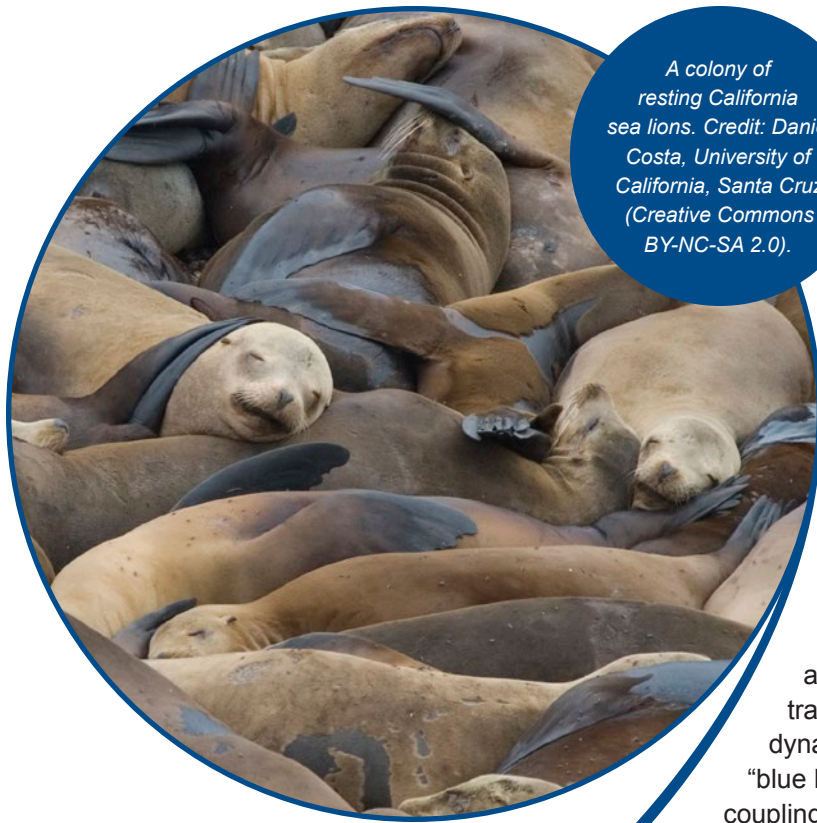
Various 'omics methodologies (including eDNA) can provide critical information about the functions and interactions of marine species as well as microbes. This approach to identifying species and operational taxonomic units can be thought of as scanning an ecosystem to give a powerful snapshot of what kinds of organisms are present at a given time and place. The use of such technologies scales up our ability to survey and monitor marine life on both individual as well as population and community levels. Technologies such as eDNA are ready for implementation in ocean observing and monitoring programs. However, the real promise of eDNA and other 'omics methodologies rely on massive improvements to reference libraries that connect genetic information to the organisms they come from and, thus, what their presence means for ecosystem function and services. A global DNA-based library of known ocean life, including microbes, would be possible within the timeframe of a decade and would dramatically increase the usefulness of scientific tools, such as eDNA, and for other sciences across disciplines and sectors. Building an 'omics-based library of ocean life depends critically on building capacity for taxonomic expertise — the science of classification, in this case, of biological organisms. Reinvestment in taxonomy and taxonomic training are important to improve reference libraries, provide context for DNA occurrences in the environment, and understand the morphology and physiology of organisms and their roles in marine ecosystems. If practical and useful real-time knowledge of marine life is a priority, then a universal reference library and trained taxonomists are essential. This also presents an opportunity to build workforce capacity in broad and inclusive ways, incorporating individuals from a diversity of backgrounds.

Distribution focuses on where organisms are in the ocean's three dimensions — where they live and migrate, across geographic locations and water depths, which may naturally vary through time. Information about species distribution reveals horizontal and vertical ecosystem connectedness, which is critical for establishing benchmark conditions as well as understanding and predicting changes and trends over time. There are currently major gaps in our understanding of marine biodiversity distribution, especially from the deep sea, the vast midwater, the polar regions, and the waters surrounding developing countries. Where are biodiversity hotspots? What physical, biological, and environmental processes create biodiversity hotspots? Can we connect genetics to species migratory behaviors? These are additional questions that a *living marine census* can address.

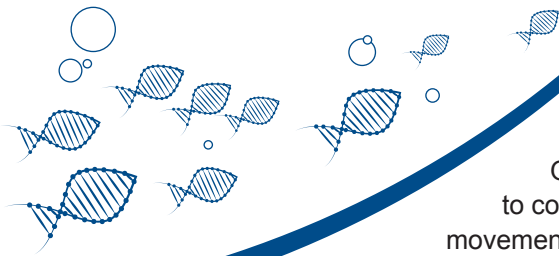


Gentoo penguins, Pygoscelis papua, are part of the local landscape in Antarctica. The distribution of penguin colonies can be tracked using satellite imaging. Credit: Daniel Costa, University of California, Santa Cruz (Creative Commons BY-NC-SA 2.0).





A colony of resting California sea lions. Credit: Daniel Costa, University of California, Santa Cruz (Creative Commons BY-NC-SA 2.0).



Novel technologies, such as “The Gravity Machine” developed by researchers at Stanford University, offer new ways to study the behaviors of free-swimming microorganisms. A *living marine census* can serve to merge new research with existing data to create improved dynamic maps of where animals are found, and how their geographic ranges and migratory behaviors may be changing, providing comprehensive information to inform marine habitat and species conservation. History has shown the challenges of species protection when populations are found in many different regions and national jurisdictions. However, these challenges have also resulted in opportunities for international and cross-sectoral collaborations and improved management structures, through sharing of new information about where animals are migrating as well as where biodiversity hotspots and [Key Biodiversity Areas](#) are located. For example, tracking apex marine predators, such as sharks, in the dynamic ocean has revealed connectivity in the forms of “blue highways” and biological “neighborhoods” as well as coupling between different species in food webs. Dynamic tracking of marine species through monitoring can also help us to understand the effects of human activities and impacts from offshore infrastructure, such as wind farms and oil platforms. Before installation, there are opportunities to leverage biodiversity data to inform the siting, permitting, design, and engineering of infrastructure. Once installed, the infrastructure itself can be outfitted with instrumentation to complement other ocean observatories and platforms that detect animal movements and migration patterns.

It is also critical to understand animal life histories as there is often a need to develop remote-sensible proxies when organisms cannot be directly observed. This highlights the importance of a *living marine census* with an “observatory” component as well as an “inventory” one. In this regard, recent advances in satellite imaging offer increased capabilities for monitoring megafauna in remote locations. Seabird colonies, seal herds, and whale pods can now be identified in satellite imagery, which paves the way for large-scale surveys that were previously unattainable. For example, several exceptionally large penguin colonies in the Danger Islands, Antarctica were discovered when Landsat imagery picked up the signature of their guano. These small and remote islands are perpetually surrounded by thick sea ice and difficult for researchers to survey directly. However, hundreds of penguin colonies are now being tracked annually using satellite imaging techniques. Satellite-based seabird surveys such as this have garnered considerable public attention and are now informing the design of marine protected areas in Antarctica. Satellite imaging technology will only become better and more widely available as new sensors, including smaller Cubesats, are deployed, with widespread potential to improve our monitoring of seabirds and marine mammals globally. For example, satellite imaging is starting to support resolutions that enable identification of large individual animals (such as whales) from space. The “observatory” and “inventory” approaches also align well with the leveraging of existing infrastructure that is already being monitored, is already instrumented, and could be further instrumented with biodiversity interests in mind.

Abundance describes the number of individual organisms in a defined area, as well as populations of each species found. This can be particularly difficult to measure in the dynamic conditions of the ocean. Still, abundance is perhaps the most important frontier in marine biodiversity research and observation due to defaunation and drastic reductions in the numbers and biomass of many species. The *Census of Marine Life* highlighted the importance of abundance in this regard by revealing the shrinking populations as well as reduced average sizes of various species of fish, whales, sea turtles, and coastal birds.

While there is certainly a great need for data on marine species diversity and distribution, information on abundance is especially lagging. However, new technologies bring significant potential for monitoring abundance as our utilization and understanding of these tools grows. The historical practice of trawling to survey species abundance is extremely invasive and can negatively impact marine ecosystems. Other proven and less invasive methods of studying abundance are effective for observing many kinds of organisms and can be used in combination to improve efficiency. For example, eDNA is showing a lot of promise for surveying and monitoring relative abundance of fish and can be utilized frequently to complement and reduce reliance on trawl surveys. Acoustics is another technology that can be widely implemented in measuring abundance. Echosounders (active acoustic technology) have been used to investigate abundance of fish and zooplankton through acoustic backscatter. Passive acoustics, which presents no harm to organisms, allows us to listen for changes in soundscapes and track the relative acoustic contributions of various species. These technologies can be used in combination and widely deployed through autonomous platforms to generate massive amounts of data that, through artificial intelligence applications, will support significant increases in our ability to model and forecast changes (e.g., defaunation) in abundance of species.

Other possible solutions to effectively measuring abundance lie in the unification of remote sensing and high-performance computing. For example, autonomous surface and subsea platforms with remote sensing technologies can be used to measure the size, and other properties, of fish schools. Further, software tools are being developed that will improve simultaneous coordination among many autonomous platforms (i.e., coordinated groups of autonomous underwater and surface vehicles). The use of *in situ* imaging and video for population counts, as well as eDNA technology, can be enhanced when coupled with these types of platforms. However, realizing the promise of these approaches will require investment in systematic testing and development of standards to confidently demonstrate effectiveness.

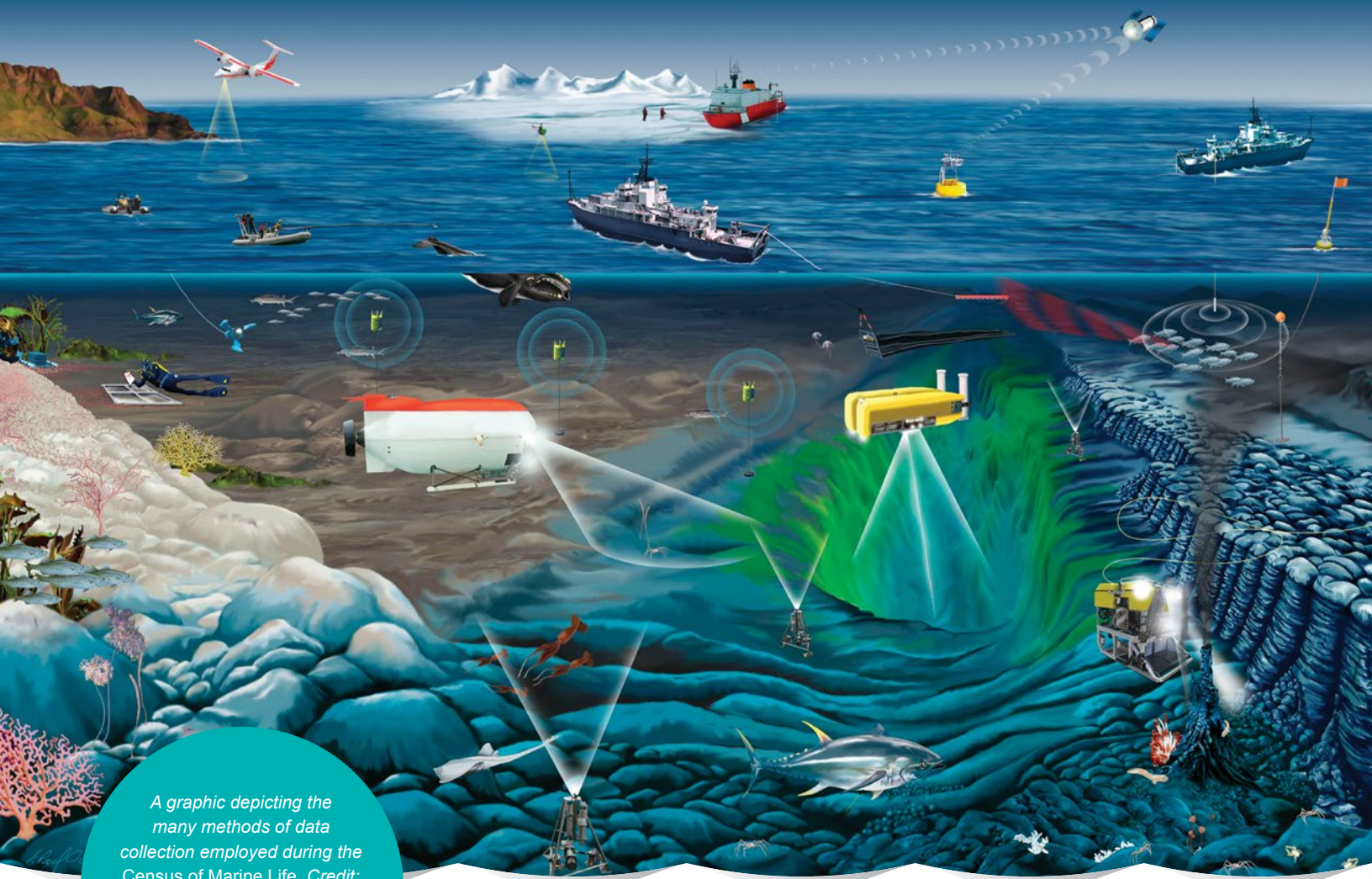
All the tools utilized to study diversity, distribution, abundance, and interactions of marine organisms are generating massive amounts of data that require storage and analysis. This presents a challenge in that the approaches discussed here will be a large burden on existing data processing and storage capacity, which need to be developed together with the biological research. Fortunately, artificial intelligence can play a crucial role in quickly processing enormous amounts of data and overcoming this problem. The scientific communities exist outside of ocean science with the expertise and capacity to solve the marine biodiversity community's data challenges, especially in terms of tools capable of automating image/audio interpretation and facilitating analyses. This presents an opportunity to champion open data that enables crowdsourcing of advanced computing solutions.

COLLABORATION IS ESSENTIAL TO MAXIMIZE IMPACT

The ocean is deep, vast, and still mostly unexplored. Its basins and ecosystems are interconnected by currents and the movement of organisms that do not follow political boundaries, and what happens in one region can impact another or the whole connected system. Therefore, to address the challenge of understanding the biodiversity of our ocean, collaboration is essential — particularly in inaccessible areas such as the deep ocean, midwater, and polar regions. The *Census of Marine Life* proved that scientific collaboration for this application is possible — both domestically and internationally — and can be effective in maximizing efficiency and value in a traditionally costly and time-consuming field of science.

There are numerous initiatives around the world collecting data on the diversity, distribution, and abundance of marine life. The Global Ocean Observing System ([GOOS](#)), through its Biology and Ecosystem Panel (BioEco), has provided a framework based on biological Essential Ocean Variables (EOVs) to prioritize biodiversity data collection at the global level based on societal impact and technical feasibility. Governments and many sponsor organizations require data be made openly accessible; however, this is not always done in a systematic or centralized way, leading to redundancy of effort and a lack of transparency around what data may already exist. Additionally, the individual priorities of industry and other privately-owned organizations can complicate data sharing. Enhancing data interoperability and accessibility will certainly increase efficiency of the overall effort and accelerate the pace of marine biodiversity analysis. This can serve to better inform policy and management decisions, especially when data is utilized in a systematic and coordinated way that enables comparisons across regions and programs.

Existing data represent significant past investments and opportunities for new analyses. A *living marine census* should incentivize data sharing and accessibility using the FAIR principles. A good model for this is the National Microbiome Data Collaborative (NMDC), funded by the U.S. Department of Energy, the U.S. Department of Agriculture, and the



A graphic depicting the many methods of data collection employed during the Census of Marine Life. Credit: E. Paul Oberlander, Woods Hole Oceanographic Institution (Creative Commons BY-NC-SA 2.0).

National Science Foundation, which works with datasets from humans to ocean microbes (such as iMicrobe) utilizing FAIR principles. A *living marine census* can build upon relevant efforts such as the NMDC. The Ocean Biodiversity Information System (OBIS), developed by the *Census of Marine Life* and now managed by the United Nations Educational, Scientific, and Cultural Organization (UNESCO), offers a centralized portal for marine biodiversity datasets and is expected to serve as the data repository of biological EOVs as these are implemented by GOOS BioEco.

Other collaborative programs that continue to build upon the work of the *Census of Marine Life* include the Marine Biodiversity Observation Network (MBON), the Integrated Ocean Observing System's Animal Telemetry Network (IOOS ATN), and the Deep Ocean Stewardship Initiative (DOSI). These are examples of programs that could serve as foundations for a global, coordinated effort that enhances discovery, data standardization and sharing, partnerships, technology development, stakeholder engagement, and more. The United Nations Decade of Ocean Science for Sustainable Development ("UN Ocean Decade"), launched in January 2021, also provides a framework for the ocean science and technology community to work together. Community-driven proposals to the UN Ocean Decade, such as Marine Life 2030 and Challenger 150, build upon the collaborative model of the *Census of Marine Life* and recognize that scalable cooperation is essential to address the scientific information needs of our changing world. Participation in a *living marine census* should be as global as the ocean is, and the UN Ocean Decade is an opportunity to work across nations and across sectors toward a common set of goals. However, formalizing and sustaining a globally collaborative program for marine biodiversity research and observation will require leadership and capacity from the world's most developed nations. In the United States, Congress can both lead and support such an effort to benefit national and international sustainable development goals.

BROADENING OCEAN SCIENCE ENGAGEMENT AND ACCESSIBILITY

The public is intrigued and inspired by the variety of life in the ocean, which includes many types of organisms not found on land. This was evident in the uptake of media from and about the many discoveries of the *Census of Marine Life*. Exemplary of this is the Yeti crab, discovered by researchers in 2005, which became a muse for artists and artisans. Its image appears in [artwork](#), stuffed animals, [television shows](#), and the creature even inspired a [Pokémon character](#). Telepresence was being widely adopted in ocean exploration as the *Census of Marine Life* was sunseting, and today it is a powerful tool to transmit underwater video to students and the public around the world in real time.

Telepresence also enables remote science, which removes some barriers to science due to the cost of at-sea operations, limited berth space, and accessibility issues. Finally, augmented reality and virtual reality are now able to bring nature to the public in new and interactive ways.

Connecting tools like augmented/virtual reality, telepresence, and autonomous platforms for data and image collection, and making them more widely used and accessible assets, will enable scientific discovery and learning for anyone with a smartphone, making access to ocean biological knowledge more equitable and inclusive, and generating new audiences, both professional and amateur.

Citizen science — active public engagement in scientific research — has benefits in terms of increasing scientific productivity (e.g., data collection, analysis) and improving public understanding and appreciation for science. Low-cost tools make it easy to put technology in the hands of the public, democratizing science in a way that will engage diverse participation, to solve the world's problems. One example is the PlanktoScope, which is an inexpensive microscope with an open-hardware and open-software design. The PlanktoScope offers a new way for anyone, notably Indigenous coastal communities, to engage in ocean science, contribute to a global dataset of plankton diversity and ecology, and understand more about the ecosystem on which their livelihoods depend. Similarly, by distributing low-cost filtration syringes to citizen scientists, the proposed Great Global Fish Count puts the power of eDNA in the hands of anyone with a smartphone. Similar solutions could be deployed on commercial vessels (e.g., shipping, cruise, and fishing vessels) thereby facilitating the collection of eDNA from a vast global network of nontraditional platforms as they transit around their regions or the world.



Scientists tag a Northern elephant seal as part of the *Census of Marine Life* program. Credit: Daniel Costa, University of California, Santa Cruz (Creative Commons BY-NC-SA 2.0).

The *Census of Marine Life* engaged early career researchers in leadership positions across the program. The governance and coordination structure of the program provided these early career researchers with skills in program management and broad networks both within and outside of their direct fields of study. Many scientific societies and programs, including the UN Ocean Decade, are deliberately creating opportunities for early career researchers to have a voice in the scoping, planning, and implementation of science. A *living marine census* should build on these examples — with diversity of people, experiences, and culture in mind — to provide leadership opportunities and skills for early career scientists by prioritizing their representation in program leadership. These opportunities will help to cultivate the next generation of diverse ocean leaders.

NEXT STEPS FOR A *LIVING MARINE CENSUS*

The *Census of Marine Life* was so successful in building collaboration and partnerships to achieve its goals because of administrative “glue” funding that was provided by the Alfred P. Sloan Foundation, \$70 million over the program’s 10 years, that leveraged almost \$600 million in additional research support. The glue funding allowed participating scientists and projects to build and maintain the collaborations needed to do innovative and systematic work at scale over the period of the program, as well as to raise the needed research funding. Many programs that continue as legacies of the *Census of Marine Life*, as well as those currently proposed to the UN Ocean Decade, rely on voluntary participation

in leadership and coordination. These programs and the passionate volunteer contributions produce a wealth of meaningful science and impact, but they must rely on opportunistic (i.e., no cost) collaboration and participation that is often unstable and always subject to competing priorities. To ensure programmatic and policy goals and metrics (e.g., annual, decadal, etc.) are met, a new initiative of the scale and scope presented here must secure administrative glue funding (~\$100 million over 10 years) for network building, maintenance, and coordination. Program funding is not guaranteed with endorsement by the UN Ocean Decade, and will rely on leadership and commitment from the United States and other partner nations and funding organizations.

A successful *living marine census* will require the participation of all “ocean shareholders,” across sectors and disciplines. Such a program should strive to link knowledge providers with knowledge users, from industry and philanthropy to resource managers and policy makers. Although there are barriers to overcome, particularly the challenge of funding an effort at the scale needed to inform our most pressing marine biodiversity issues, previous programs such as the *Census of Marine Life* prove that success is possible. With such widespread potential application and use for information collected through marine biodiversity research and observation, there are plentiful opportunities to engage with new collaborators across interests and political boundaries.

The needs are pressing.

The opportunities are numerous.

The time for a *living marine census* is NOW!

For more information, please visit the [COL website](#).

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