Ulva (seaweed) as a biofuel feedstock

Sebastiaan "Bas" de Vos

Abstract

Ulva, a green macroalgae (seaweed), has been identified as a highly suitable biofuel feedstock, particularly for bio-LNG in shipping applications in Africa. It exhibits exceptional growth rates and has been successfully cultivated on a large scale using low-tech methods, in various regions including in Southern Africa. Notably, the production of Ulva is over ten times greater on a dry weight basis for a given area than the average annual maize/corn production.

Ulva offers numerous potential applications, such as aquaculture and agriculture feeds, biofiltration, pharmaceuticals, fertilizers, ocean acidification mitigation, carbon sequestration, bioplastics, and biofuel production. Recent research has identified Ulva as a highly suitable feedstock for producing bio-LNG specifically for the shipping industry, enabling the utilization of existing fossil fuel infrastructure while significantly reducing greenhouse gas emissions and meeting carbon neutrality targets.

The growing demand for liquefied natural gas (LNG) in the bunker market, where LNG-powered vessels represent 30% of new builds, presents a promising opportunity. Additionally, Africa's extensive desert shores, particularly in MENA and Southern Africa, offer strategic geographical advantages due to their central location along the Asia-to-Europe trade route, spanning approximately 18,000 kilometers. Compared to terrestrial crops, Ulva demonstrates several advantages as a biofuel feedstock, including higher yields and reduced reliance on arable land and freshwater resources, mitigating conflicts with food production and water scarcity.

Various opportunities are associated with Ulva derived Bio-LNG, such as achieving high yields at scale using proven low-tech methods, meeting the growing demand for LNG and decarbonizing bunker fuel, capitalizing on the advantageous geospatial characteristics of indigenous seaweed, and facilitating just energy transitions through local upskilling and the use of underutilized African ports.

Nevertheless, challenges remain, including the need for large-scale anaerobic bio-digestion validation in saline conditions and bridging a limited finance gap (approximately $100k) to attract private capital and accelerate commercialization efforts.

Substantial evidence indicates the vast potential of Ulva as a biofuel feedstock for the shipping industry in Africa, providing carbon-neutral alternatives to fossil fuels, leveraging existing infrastructure, and contributing to sustainable economic development and environmental protection.

Keywords: *Ulva*, biofuel, bio-LNG, shipping industry, Africa, sustainable energy, carbon neutrality.

Zero Emissions Ship Technologies and Ocean Health's Impact on Climate Change

Until recently, little has been understood about the ocean's surface microlayer (SML) and it's role in global change. Latest research shows it is crucial. However, this has not been factored into the climate change model. This SML layer promotes the formation of aerosols and clouds; it also reduces the escape of water molecules and slows the transfer of thermal energy to the atmosphere. It regulates the climate. However, the SML layer attracts toxic forever, lipophilic chemicals, microplastics, and black carbon soot from incomplete combustion of fossil fuels. This destroys the SML. 50% of marine plankton has been lost since the 1950s and decline continues at 1%/year. Without action, pH 7.95 level will be reached by 2045, even if we achieve net-zero by 2030, and the collapse of the marine ecosystem could lead to the loss of most seals, birds, whales, fish, and food supply for 3 billion people.

Elimination of both GHGs and pollutants such as black carbon, particulate matter (PM), NOx, SOx, trace metals and hydrocarbons can only be achieved by a number of technologies on a ship: electric systems, hydrogen fuel cells, wind propulsion and supplementary energy efficiency technologies. All have seen deployment on ships and commercialised to different levels. Absolute zero GHG vessels of greater sizes and power can be achieved by combining different commercialised technologies.

Madadh MacLaine

Secretary General

Zero Emissions Ship Technology Association

See also:
Climate Disruption Caused by a Decline in Marine Biodiversity and Pollution

IMO Intersessional Meeting of the Working Group on Reduction of GHG Emissions from Ships 15th session (ISWG-GHG 15/INF.2): Reduction of GHG Emissions from Ships; Commercial Readiness of Absolute Zero GHG Technologies; ZESTAs

Abstract
ICES Perspectives on New Maritime Technologies

ICES is an intergovernmental organisation providing a platform for science cooperation with 20 member countries, all neighbouring the North Atlantic Ocean. We provide scientific advice to member countries and several regional and international organisations.
Our community comprises 3400 active experts from member countries and beyond. We are actively reaching out to increase our network to include relevant experts for the increasing knowledge needed to provide advice on sustainable use and protection of the ocean, its ecosystems and living resources. And we aim not only to broker the best available science to quality assured advice but also to build capacity in data storage, data handling and analysis, and offering capacity building efforts through our Training Programme. We recognise the importance of gender equality in marine science and have committed to working towards specific objectives in our new Gender Equality Plan. This presentation provides a short overview of ICES observation, data and technology activities to support the discussion for the Twenty-third meeting of the United Nations Open-ended Informal Consultative Process on Oceans and the Law of the Sea: "New Maritime Technologies: Challenges and Opportunities".

New Maritime Technologies for the Future of Ocean Observations

Panelist: Kathleen C. ONeil, NOAA NWS National Data Buoy Center

ABSTRACT:
The development of oceans and seas for safe and efficient marine transportation, production of offshore energy, aquaculture and seafood competitiveness, and resilient coastal communities depend on competent marine science and engineering. Ocean observations are foundational to marine stewardship and resource management, they enable us to better understand, predict and respond to natural events, and promote the sustainable development of the Blue Economy. As a result, the maritime industries are highly reliant on technology that can efficiently and safely monitor the ocean, and without negatively impacting the marine environment.

New uncrewed maritime systems (UMS) technologies, including remotely operated, autonomous ocean surface and underwater vehicles and platforms, such as gliders, and floats, are revolutionizing how we gather critical data in ocean data sparse areas across all aspects of marine science and have significant roles to play in sustained ocean development in several areas. UMS can collect meteorological and oceanographic parameters to improve our understanding of tropical cyclone dynamics, ocean ecosystems, and the air-sea interactions which drive our climate and weather. They can provide information for scientific research and monitoring of real-time monitoring of harmful algae blooms. In addition, ocean temperature, waves, currents, and wind data collected by UMS can provide information to support and enable the development of offshore energy production technologies. UMS can be used to explore and map the ocean floor and identify new areas for potential resource extraction, such as minerals and fossil fuels. UMS can be used to monitor and manage fisheries, including tracking fish populations, identifying fishing hotspots, and enforcing fishing regulations. These technologies can also improve maritime transportation by providing efficient, continuously optimized voyage guidance.

There are advantages of utilizing UMS, over more traditional crewed and uncrewed observing systems such as research vessels and moored buoys that are deployed and maintained using large crewed vessels. UMS can access locations that are hazardous or inaccessible for crewed vessels to conduct operations. UMS can operate 24x7x365, not limited to specific working hours constrained through labor agreements. They can be piloted actively or autonomously to “chase” and explore the environment that is the subject of the mission, moving to the locations to fill data gaps, and conducting detailed data collection in tropical cyclones or in fish habitats.

However, there are also several challenges that need to be addressed to fully realize the potential of UMS in sustained ocean development. UMS technology is still in its early stages, and there are limitations in terms of range, endurance, operating environment, and sensor capabilities. UMS can be expensive to design, build, and operate, which can limit their deployment and adoption. There could be legal and regulatory barriers to deploying and operating UMS in certain areas, such as marine protected areas, areas with high shipping

traffic, and proximity of territorial boundaries. UMS can also pose risks to other vessels, marine life, and the environment.

UMS will benefit from the concurrent development of other new technologies, such as artificial intelligence (AI) and machine learning (ML) capabilities that can address some of the challenges with piloting operations, and also with data analysis and management. AI methods will provide advancements in the piloting and operation of UMS, improving the quality and timeliness of weather and ocean observations and aiding marine weather warning generation.

New maritime technologies have the potential to revolutionize marine science and foundational ocean observations and support the sustainable development of oceans and seas for safe and efficient marine transportation, production of offshore energy, aquaculture and seafood competitiveness, and resilient coastal communities.

“Best Available Technology (BAT) for Mitigating Three Noise Sources: Shipping, Seismic Airgun Surveys, and Pile Driving”

by Lindy Weilgart

OceanCare, Switzerland

&

Department of Biology
Dalhousie University

Abstract

The application of Best Available Techniques/Technology (BAT) and Best Environmental Practice (BEP) is required under several international agreements and conventions. For shipping noise, this generally includes minimizing cavitation by various techniques such as better maintenance and optimizing the propeller design to the hull and to usual operating conditions, which often improves efficiency as well. Focusing quieting on the 10-15% of the noisiest container and cargo ships will go furthest in reducing overall shipping noise. For seismic airgun surveys, quieting technologies, such as Marine Vibroseis (MV), that could replace airguns show the most promise, as much of the energy (the mid- or high-frequencies) emitted by airguns is wasted and unused. A controlled sound source, like Marine Vibroseis, tailor-made to the specific environmental conditions and without the damaging sharp rise time of airguns would also likely be more environmentally friendly towards marine life. Quieting technologies would almost certainly require much fewer additional mitigation measures. Many new quieting technologies and alternative low-noise foundation concepts have been developed for pile driving, mainly due to the German government setting an action-forcing standard and noise limit. The great variety of quieting technologies and noise abatement systems for pile driving is in stark contrast to the lack of innovation that is occurring for quieter alternatives to the seismic airgun, where, for instance, MV has been in development since 2008 and yet little progress is evident. At least 150 marine species have shown impacts from ocean noise pollution, but it has been difficult to specify the exact scenarios where ecosystem and population consequences from underwater noise will occur. Therefore, managing this threat requires a precautionary approach. Application of quieting technologies that reduce sound at source will likely be the most effective way to reduce the environmental impacts of underwater noise, and those that also reduce greenhouse gas emissions or encourage technological innovation should be especially encouraged.

Technology developments in distributed acoustic sensing are now offering significant opportunities for submarine fiber optic cable owners and operators. Increasing critical infrastructure resilience, broadening environmental monitoring capabilities and harnessing economic benefits of digital transformations are all positively impacted by these sensing technologies.

Forecasting for sustainable development of marine economy

Nguyen Ba Thuy
Vietnam National Centre for Hydrometeorological Forecasting

As Vietnam has 28/63 coastal provinces with high population density, the marine economy contributes about 20% of the GDP. Promoting marine economic development is one of Vietnam's sustainable development strategies, with priority to: maritime shipping, oil/gas exploitation, fishing and aquaculture, tourism and renewable energy. However, in recent years, due to climate change, the marine weather phenomena become more variable. Thus, the offshore and coastal areas are vulnerable to disasters such as typhoon, strong winds, high waves, spring tides, saline intrusion, etc., which greatly affect socio-economic development, ecological environment. At present, marine forecasting information is still limited, not meeting the increasing demands of society for safety, accuracy and timeliness. Despite of many efforts by the government individually and in cooperation with other states, the marine weather forecasting in Vietnam is facing several difficulties, including: (1) a shortage of robust forecasting technologies; (2) the marine observing station network is sparse and simple, this doesn't meet research and operation demands; (3) Capacity of computational is still limited; (4) a lack of forecasters with experiences and in-depth knowledge.

This presentation will focus on the marine weather and oceanographic conditions in Viet Nam, a typical coastal developing country in search of sustainable development, the current status of observation and forecasting. It will providesuggestions on international cooperation initiatives to faccilitate access to new maritime technologies to coastal developing states and states vulnerable to climate change impacts, including observing equipment and forecasting technologies that contribute to a sustainable development.

Presentation title: Changing the world with billions of bubbles

Abstract: What does it take to truly change the world? For Silverstream Technologies and the company's CEO Noah Silberschmidt, it begins and ends with bubbles.

Silverstream Technologies was established more than a decade ago. It is now one of the major disruptors of the maritime sector, having scaled clean technology to make a real impact on the industry today. Silverstream's air lubrication technology, which uses the power of bubbles to reduce friction between ships' hulls and the water and improve their efficiency, is set to be installed on more than 150 vessels across the global fleet, with 500 targeted by 2025.

Over the course of the last ten years, Silverstream has moved from start-up, to scale-up, to established market leaders, building the team, processes and procedures required to service a global industry like shipping. This has seen the company grow to encompass more than 120 multidisciplinary experts across two hubs in London and Shanghai and reach a cumulative order intake of more than €200m. Despite considerable scepticism from a conservative sector, Silverstream has been able to prove and commercialise its technology. The company has been named the 4th fastest growing in Europe by the Financial Times.

During this presentation, Noah Silberschmidt will explore the dynamics at play within the global shipping industry and tell Silverstream's story so far.

He will outline how, over more than ten years, Silverstream has effectively created the market for maritime clean technologies from scratch and explore the blueprint for success Silverstream has built for other clean technology providers to emulate as they work to bring solutions to market.

He will do this while explaining the mountain that the shipping industry has to climb, and how we must collectively meet the challenge of decarbonising this largely invisible contributor to our modern way of life. He will prove how individual companies, when driven by a clear goal and strategy, can really make a difference and change the world – one air lubrication system and billions of bubbles at a time.

Shaping the Future Ocean Observing & Services Market – Maturing the Ocean Enterprise

***Peer Fietzek**, Kongsberg Discovery, peer.fietzek@kd.kongsberg.com*
Emma Heslop, Global Ocean Observing System – IOC/UNESCO
Zdenka Willis, Marine Technology Society

In September 2022 - January 2023, The Global Ocean Observing System (GOOS), Marine Technology Society (MTS), National Oceanic and Atmospheric Administration (NOAA), and industry partners organized an Ocean Decade action - a forum for compact and meaningful dialogue with new and established companies, academia, and government. Through a successful and thriving mix of the public and private technologies and players, Dialogues with Industry aimed to dismantle barriers and highlight opportunities towards achieving a mature, vibrant Ocean Enterprise. The curated conversations brought together 87 invited participants and more than 400 observers from 40 countries, and included representatives from private entities, governmental and other public bodies, as well as the academic sector. The participants provided insights, identified issues, barriers, and opportunities; offering actionable recommendations that will help to unlock the potential of the Ocean Enterprise and ensure its capacity to support meeting increasing requirements for ocean data, information, and knowledge.

This presentation describes the background and motivation that led towards the realization of the Dialogues with Industry. The current status of the Dialogues' synthesis work is presented with a focus on emerging technologies.

Natalie Andersen

Scientific Lead, International Programme on the State of the Ocean (IPSO)

Presentation Title: *Is the ocean our climate savior? Emerging maritime technologies and the need for a precautionary approach.*

Abstract

As we look set to sail past the 1.5 degree target established by the Paris Agreement, those working in industries tackling climate change are increasingly looking towards the ocean to save us. The ocean, which is often perceived by many as a vast and endless resource, is becoming the new frontier for the emerging industries of deep-sea mining and ocean-based climate interventions, with very little recognition of the essential role the ocean plays in the functioning of our planet, and the risks to the services it provides. The ocean is amongst our greatest allies in the fight against climate change and we need to ensure emerging technologies do not allow us to continue under a business-as-usual climate scenario at the expense of the health of the ocean and the planet as a whole. Not only do we risk impacting the communities who depend on the ocean for nutrition and livelihoods, but we also risk exacerbating the climate crisis and global weather patterns by disrupting the climate mitigation services the ocean provides and potentially contributing to the biodiversity crisis - another major crisis facing our planet. As deep-sea mining and many abiotic ocean-based climate interventions have not yet started at a commercial scale, there is still time to adopt a precautionary approach and thoroughly research these activities and their potential impacts on the ocean, before incorporating them into governance and decision-making. This presentation will introduce the ocean's vital role in global climate regulation, explore the challenges associated with emerging maritime industries and discuss pathways forward needed to ensure a healthy and functioning ocean for future generations.

Gavin Allwright

Secretary General, International Windship Association (IWSA)

Presentation Title: Wind Propulsion: Meeting the Sustainable Shipping Challenge

Abstract

The need to decarbonise shipping and create a sustainable industry is often viewed as a daunting challenge in what is classed in policy making circles as being a 'hard-to-abate' sector. However,

the re-introduction of wind propulsion into commercial shipping has the potential to up end these pre-conceived notions and is an opportunity to deliver a fast track, deep decarbonisation of the fleet

utilising a free energy source that will not only pay for itself but potentially release enough in fuel savings to fund the entire energy transition in the sector.

Adopting an integrated, holistic approach to this transition also helps deliver on the promise of a just and equitable transition for LDCs and SIDs with an accessible and easily transferred and co-designed

cluster of technologies and designs. The market is already growing with over 1.5 million dwt of shipping utilising wind-assist to-date, a number that will double over the coming year and early signs of maturity

and dissemination of the technologies and capacity are also becoming evident.

The potential for zero-emissions and even climate positive ships in the future facilitated by the harnessing of the wind is also explored, highlighting a potential new paradigm for shipping by mid-century.

Abstract: The need to decarbonise shipping and create a sustainable industry is often viewed as a daunting challenge in what is classed in policy making circles as being a ‘hard-to-abate’ sector. However, the re-introduction of wind propulsion into commercial shipping has the potential to up end these pre-conceived notions and is an opportunity to deliver a fast track, deep decarbonisation of the fleet utilising a free energy source that will not only pay for itself but potentially release enough in fuel savings to fund the entire energy transition in the sector.

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The potential for zero-emissions and even climate positive ships in the future facilitated by the harnessing of the wind is also explored, highlighting a potential new paradigm for shipping by mid-century.

Abstract Title: Role of Marine Technologies in the Implementation of marine Carbon Dioxide Removal

Technologies for carbon dioxide removal are critical for meeting our climate goal of limiting warming to 1.5C. Marine or ocean-based carbon dioxide removal (mCDR) is a subset of negative emission technologies that focuses on enhancement of the ocean's role as a sink for anthropogenic carbon. Implementation of this maritime technology (various techniques for removing carbon from the ocean which in turn removes carbon from the atmosphere as it equilibrates) will also require simultaneous advances in other technological fields such as ocean observing, marine energy, marine infrastructure, and even green marine shipping to reduce the carbon footprint of the approaches. In the US, NOAA plays a critical role in ocean observing and research which is used to determine the changing concentrations, sources, sinks and fate of greenhouse gas (GHG) emissions in the atmosphere and ocean. NOAA also has developed efforts to encourage public-private partnerships that will remain critical to advancing ocean technologies for mCDR.

Technology for vessel detection, localization and identification based on wake measurements

Presented by Estonia

Motivation. The increase in the density of maritime traffic, with more ship types and designs gradually adds to the complexity of offshore and coastal sea management. It also raises pressures on the marine and coastal environment and increases the probability of accidents. In particular, the introduction of unmanned Marine Autonomous Surface Ships additionally increases the related risks due to a reduced recovery capability. Specifically, losing contact with a ship can severely limit the options for maintaining control in critical applications. To cope with this and other risks (e.g., smuggling, human trafficking, etc.), the ability of coastal services to detect a vessel and estimate its position, speed and course are essential.

The task. The process of assessing these three properties (position, speed and course) is referred to as 'localization'. An adequate estimate of these parameters is a key part of composing a Recognized Maritime Picture (RMP) which represents a set of information necessary for creating situational awareness in maritime operations.

The technology. We propose a set methods to (i) evaluate the position and speed of vessels using single-point measurements of properties of its wake, (ii) estimate the course of vessels based on similar measurements using an array of sensors, and (iii) recognition of the category of vessels based on spectrograms of such measurements.

The principles. This fairly robust technique is a generalization of the classic method of estimation of ship's speed from the properties of its wave wake (Tuck et al., 1971; Wu, 1991; Wu and Meadows, 1991). The core new advances are the use of (i) decomposition of one-point recordings of far-field wake signals into time-frequency representations (3D compositions of time, frequency and power, here referred to as spectrograms) by utilizing Short-Time Fourier Transform and (ii) a grid of sensors to synchronously retrieve the wave signal in several locations.

A major improvement over earlier attempts is the use of the properties of several well-defined lines (asymptotes) in the time-frequency representation (Pethiyagoda et al., 2017) to estimate vessel speed and the travelling distance of the wake. The vessel course is evaluated using the arrival times of the incoming wake at the sensor locations, equivalently, based on cross-correlations of the signal at neighbouring sensors.

The approach is tested using a sensor array of 9 sensors in a 3 × 3 rectangular grid with 2.5 m spacing between the instruments, deployed at a depth of 3 m approximately 2.5 km from the fairway (Rätsep et al., 2021).

The technique of spectrograms is also able to distinguish several known vessel types from the characteristics of their wakes (Torsvik et al., 2015). Based on this advance, the proposed technique has been extended towards automatic wake detection (Rätsep et al., 2020). This method is preferable in many situations for traffic monitoring and/or for improving situational awareness of e.g., naval operations, because wake sensors are inexpensive and can be easily mounted and concealed. The data can be recorded using simple pressure sensors at a distance of many kilometers from the sailing line.

Applications. This technology can be used to detect the region and time of generation and thus the source of particularly dangerous components of ship wakes, such as extremely high leading waves of the ship wave system or long-living deep depressions that endanger both people and the ecosystem many kilometers from the sailing line.

Contact: Prof Tarmo Soomere, tarmo.soomere@taltech.ee, Prof Kevin Parnell, kevin.parnell@taltech.ee, Tallinn University of Technology, Estonia.

Presenter: Prof Tarmo Soomere, tarmo.soomere@taltech.ee

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08 May 2023

Title: New Technology to Enable Sustainability in the High Seas and Deep Ocean

Lisa A. Levin, Scripps Institution of Oceanography, UC San Diego, USA

Revised Abstract:

Increased use of the open ocean and deep sea for extraction of living and non-living resources, as a sink for heat and carbon, and for disposal of waste and carbon dioxide has created information needs that generate novel applications of ocean observing. While many ocean activities are intended to address current global crises in climate, food, or energy, sound research is needed to ensure that they do not exacerbate the biodiversity crisis. This presentation will focus how new and repurposed technologies in imaging, acoustics, chemical sensing, genetics, AI and modeling can contribute knowledge underpinning sustainability. Ecosystem, habitat and resource mapping, documenting variability, and change projections all are needed to inform on siting new activities, environmental impact assessments, areas and features needing protection, verifying effectiveness, and monitoring and remediating impacts. Examples will be drawn from the arenas of climate intervention, deep-seabed mining, fisheries and conservation. Marshalling the technologies needed to meet the challenge of sustainability in the open ocean and deep sea will require efficient, coordinated use of existing observing assets and integration of novel technologies. Stewardship of open ocean and deep-sea ecosystems remains an imperative as we develop and deploy new marine technologies.

New maritime technologies: the technologies, their uses and their contributions to sustainable development - the Mariner's Perspective

Panelist: A.J. Reiss, NOAA-NWS Ocean Prediction Center

Abstract:

In 2021 international shipping accounted for ~2% of global energy-related CO2 emissions, making it the world's sixth-biggest greenhouse gas (GHG) emitter if it were its own nation. To address these GHG contributions to climate change, the International Maritime Organization (IMO) established aggressive policy and goals to steer the industry onto the pathway to cut total GHG emissions by at least 50% by the year 2050 compared to 2008 levels. A complementary goal requires reducing the carbon intensity (CO2 emissions per transport work) of shipping 40% by 2030 and working towards 70% by 2050 compared to 2008 levels. For violators or over-emitters, the economic penalties of fines, potential port denial, or detainment are too costly to ignore. Even worse, the bad publicity and economic costs of being a 'dirty shipper' could be catastrophic. In response, the maritime industry is undergoing a massive transformation to adapt to more sustainable shipping. Besides seeking alternative fuels and hybrid propulsion design vessels, the industry is also looking for authoritative marine weather guidance beyond avoidance of extreme weather, but also to that which provides skillful nuanced guidance to 'optimally' harness sun, winds, waves and currents to burn less fuel while still achieving their commercial objectives. The world's National Meteorological and Hydrological Services (NMHS) are uniquely positioned through international maritime treaty obligations to provide marine safety information. However, the current state of the marine numerical weather prediction guidance is inadequate to provide the skill and resolution necessary for the most 'optimal' routing and GHG reductions. Besides more powerful supercomputing, better earth system prediction models of the marine environment, and more of the critical ocean observations that drive them are needed. This brief presents the context and impetus for these changes as well as a few examples of how ocean observations could be increased in a sustainable way.

The ocean, inclusive of the high seas, has become increasingly busy in recent decades as our global blue economy has grown and diversified. This transition has been likened by some to a belated Industrial Revolution for the ocean. New maritime technologies provide an exciting means for collecting near-real time data about this growth and intelligently planning out a sustainable future in the ocean for people and biodiversity.

The newly agreed upon text from the Intergovernmental Conference on Marine Biodiversity of Areas Beyond National Jurisdiction (BBNJ) provides a meaningful opportunity to utilize area-based management tools, including marine protected areas, to more effectively protect and manage biodiversity in the high seas.

In this panel presentation, Professor McCauley will offer a demonstration of how data and insight from next-generation maritime technologies can be put to service of the United Nations, States, Indigenous Peoples, and local communities during the development and evaluation of proposals for area-based management on the high seas as the BBNJ implementation process advances.

Accelerating the Power and Reach of eDNA for Ocean Observation

Abstract

12 May 2023

Professor Ellen K. Pikitch, Stony Brook University, Stony Brook, N.Y. USA
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The ocean provides a multitude of services crucial to life on earth, yet is facing a grave and worsening biodiversity crisis. There is an urgent need to monitor the number and changing abundances of ocean species, and to understand the impacts of management and conservation interventions. Currently, scientific monitoring of ocean life typically takes place on large vessels carrying many crew members and scientific investigators. The ships typically run on fossil-fuels and often use sampling methods that are highly selective, intrusive, destructive of habitat, and cause unintentional mortality of the very life forms they are seeking to study. The cost of conventional scientific surveys is very high and thus limits the area of ocean explored. The goal of the research to be described is to combine three cutting-edge technologies to increase the scope of ocean biodiversity monitoring while decreasing the cost through automation of eDNA sampling and processing on-board autonomous research vessels.

The first technology – eDNA analysis – enables identification of species ranging in size from individual cells to blue whales through fragments of their DNA left in the ocean and collected in water samples. Professor Pikitch has published on this technology in the journal *Science* and has successfully applied this methodology in her research on Shinnecock Bay, NY. The second technology to be deployed is an Uncrewed Maritime System (UMS) which can effectively and efficiently collect biological and physical information in tandem with appropriate sensors. The UMS to be used is under evaluation. The third piece of the puzzle is to adapt automated eDNA sampler/processors to work on the AUV/SUV selected.

The case for testing and deployment in Shinnecock Bay, New York
Professor Pikitch has been working in Shinnecock Bay, NY for more than a decade, and has been employing eDNA technology there for the past three years. A restoration program has been ongoing in the bay since 2012, and partly as a result of its success, the bay designated as a Hope Spot by Mission Blue, with IOCS, Stony Brook University and The Explorers Club serving as nominating organizations and now Hope Spot Champions. Stony Brook University has a state of the art marine research laboratory and a fleet of research vessels on Shinnecock Bay. It is a well-studied ecosystem, and thus an excellent test bed for new technologies. In addition, the Shinnecock Indian Nation has it's reservation on a peninsula which is within Shinnecock Bay. The Shinnecock Nation supported the nomination of Shinnecock Bay as a Hope Spot and we are planning a joint expedition of the bay – which will encompass all waters and be a comprehensive ecosystem level study – to take place in the near future. The Shinnecock Indian

Nation has expressed a keen interest in using eDNA in this expedition as it is non-destructive, non-invasive, and has been proven to be useful to characterize aquatic life in the bay.

The objectives of this work are:

1) To pilot test combined technologies SUV/AUV and eDNA sensors, in Shinnecock Bay; a well-studied system.

2) To characterize the biodiversity in all waters of Shinnecock Bay – including those within the Shinnecock Indian Nation Reservation.

3) To also use the SUV/AUV to measure important environmental variables (temp, salinity, pH, DO) and to develop an updated "Habitat map" of Shinnecock Bay that can be used to understand the relationship between habitats and their occupancy and use by various species that reside within the bay. Ideally, the SUV/AUV would be able to map bathymetry, and to record habitat type with an underwater camera, and the potential to periodically collect bottom samples for further analysis of habitat type.

   Ultimately, the project would also provide proof of concept and enable the technologies tested to be deployed more widely.

ABSTRACT

This presentation adopts an action research methodology to examine the recently established CBTT Committee and its influence on the implementation of the legal framework. This study identifies the originators, timing, and contextual factors surrounding the committee's creation by conducting a chronological analysis of relevant literature and scrutinising the proposed language presented during the IGC-BBNJ. Additionally, UNGA resolutions are examined, drawing parallels with the content generated within the BBNJ context. The presentation aims to critically evaluate the strengths and weaknesses of the provision that established the CBTT Committee, with the ultimate goal of enhancing its effectiveness in facilitating the implementation of the transfer of marine technology legal framework.

Abstract

Promoting ocean based renewable energy and decarbonization in island countries and local communities – Enabling factors and challenges

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Renewable energies can be promoted based on solar, wind, tide and wave. They have their own characteristics and are not endowed evenly around the world. Small island countries and local communities need to assess the availability of renewable energy sources. Ocean energy thermal conversion (OTEC) is a part of the ocean based renewable energy sources. However, its initial investment cost is high, and its generated power is limited. Nonetheless, deep sea water, a by-product of OTEC, can be used for multiple purposes such as aquaculture, heat exchange, cosmetics production and thalassotherapy. The subsequent multiple use of deep sea water generate additional economic returns that will help recoup the initial investment cost. Aquaculture requires expertise and markets. Island countries and local communities need to develop strategies to multiply co-benefits of renewable energy promotion. Electrification of boats and maritime transport is an avenue for renewable energy and decarbonization. To pursue such a direction, it is vital to connect sectors and infrastructure. Existing ports are not connected with renewable energies through grids. A lifecycle assessment framework needs to be applied. It is vital to develop partnership between producers, sellers, buyers and users including the recycling of the used devices and equipment after the long term use. Social collaboration, partnership and innovation are vital. And long term financing schemes need to be developed with multilateral financing institutions, partner countries, and private sector. The government's overall policies and targets are also useful. And capacity development, science-policy-field action nexus, leadership/human resource development, start-up support are essential. It is useful to promote good practice case studies and pilot projects.

The SAvE Whales Project

Challenges and required policy steps

Nicolas Entrup, Director International Relations, OceanCare

In many regions, ship strikes pose a serious conservation and welfare problem for large whales. Fin whales and sperm whales in the Mediterranean Sea are classified as endangered and threatened by ship strikes due to intense maritime traffic. Between 2019 and 2021 a multi-disciplinary pilot project was undertaken with the objective of developing and testing a real-time acoustic observatory for sperm whale localization in the Eastern Mediterranean Sea, one of the high-risk regions for collisions with these large-toothed whales. Three autonomous solar powered buoys were placed one nautical mile offshore south-west of Crete, Greece. Sperm whale clicking sounds were recorded, filtered, and processed. The data from the buoys were sent every three minutes by mobile broadband to a land-based analysis center and "translated" into a 3D localization which was sent to Marine Traffic, a ship tracking intelligence site, which combines this information with ship traffic data, identifies and alerts vessels to the presence of whales and the risk of a collision. The system has proven to be effective and successful with small localization uncertainties at distances of up to 7 kilometers. Challenges for future deployment have been identified and depend on the potential geographical location. All year-round operation, mooring options, energy supply and storage capacity are among those aspects that will need adjustment and further development. Given tests were successful, its deployment is strongly recommended by OceanCare, but such technology needs to be put into perspective, cost-benefits and limitations need to be considered and the actual measure to be taken resulting from the localization needs to be taken into account. Separating whales from vessels in space and time by changing shipping routes and, where not possible, reducing vessel speed have been identified as the only measures demonstrating a reduction in fatal collisions. Therefore, localization technologies can be helpful in high-risk areas as a complementary measure. Vessel speed reduction is recommended as a core operational measure to be promoted for the multi-environmental benefits of reducing the risk of collisions with endangered whales, reducing emissions, including greenhouse gas (GHG) and other air pollutants, as well as quieting shipping noise.

United Nations Open-ended Informal Consultative Process on Oceans and the Law of the Sea
Twenty-third meeting
5–9 June 2023

New maritime technologies: challenges and opportunities

Observing the oceans and Earth with submarine telecommunication cables

Bruce M. Howe
Chair, JTF SMART Cables
Professor, University of Hawaii at Manoa

The goal of the JTF SMART Subsea Cables (Joint Task Force, Science Monitoring And Reliable Telecommunications) is to have SMART cables become the world standard, leading to a global network integrating environmental sensors (temperature, pressure, seismic acceleration) into submarine telecommunications cables. SMART Subsea Cables will allow climate change monitoring including ocean temperature, circulation, and sea level; tsunami and earthquake early warning for disaster risk reduction; seismic monitoring for earth structure and related hazards; quantifying risk to inform sustainable development of coastal and offshore infrastructure, and warning of external hazards to cables and improve routing of cable systems for improved resilience of this critical infrastructure. SMART Cables will contribute to achieving Sustainable Development Goals 13 Climate, SDG 14 Oceans, and SDG 9 Infrastructure.

Regional SMART cable pilot systems include the underway SMART Atlantic CAM ring system connecting the Portuguese mainland, Azores and Madeira, and cables planned between islands of Indonesia; from New Zealand to the Chatham Islands as well as Antarctica; between Vanuatu and New Caledonia; and others. These first steps to trans-ocean and global implementation will influence the final standards and policies for the industry, as well as setting positive precedents in all areas including technical, science, financial, permitting, legal, and security. In addition to the diverse scientific and societal benefits, the telecommunications industry mission of societal connectivity will also benefit because environmental awareness improves both individual cable system integrity and the resilience of the overall global communications network.

JTF SMART Subsea Cables is sponsored by the United Nations organizations: the International Telecommunications Union, the World Meteorological Organization, and the UNESCO Intergovernmental Oceanographic Commission (ITU/WMO/UNESCO-IOC), is an endorsed Project of the UN Decade of Ocean Science for Sustained Development, 2021-2030, and is a Project of the Global Ocean Observing System.

ABSTRACT

Ocean life - from viruses to whales - is built from "biomolecules". Detection of biomolecules is expanding our ability to explore, monitor, and understand biodiversity, including the hidden world of the marine microbiome. The microbiome is an ensemble of microscopic organisms that inhabit all aspects of the environment, with members ranging from viruses through tiny animals. Together, the microbiome forms the base of the food web, helps maintain health, and regulates most fluxes of energy and matter. Marine microbiome discovery is part of a great campaign to explore the earth's oceans, and rapid advances in high throughput sequencing are allowing a glimpse into this hidden world. Furthermore, 'omics techniques detect higher-level organisms from the DNA they have left in the environment (eDNA). Demand for the affordable, large-scale biological observations provided by biomolecular detection is reflected in United Nations Ocean Decade endorsed programs such as the Ocean Biomolecular Observing Network (OBON). A key goal is the development of autonomous eDNA collection, and progress is being made to develop this observing capacity. Further advancement of ocean microbiome/eDNA observations requires robust development of reference sequence databases. Harmonized methods from sample collection through data delivery will accelerate the establishment of biodiversity baselines that can be used to monitor changes in biodiversity.

2023 United Nations Open-ended Informal Consultative Process on Oceans and the Law of the Sea

"Capacity-Building and the Transfer of Marine Technology under the BBNJ Agreement"

European Union

Discussion Panel on International cooperation and coordination in promoting new maritime technologies for sustainable development

7 June 2023

Abstract

On 4 March 2023, the international community reached a milestone with the political agreement on the text of Agreement under the United Nations Convention on the Law of the Sea for the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction (BBNJ Agreement).

The text of the BBNJ Agreement includes a capacity-building and transfer of marine technology (CBTMT) component to support developing countries in their participation in and implementation of this Agreement.

The CBTMT component aims to support the implementation of the BBNJ Agreement in all its dimensions in a balanced way with a view 1) to achieving its objectives of conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction and 2) to contributing to sustainable development.

The presentation will focus on two main points. First, it will discuss certain CBTMT elements agreed in the BBNJ Agreement, such as the concept of marine technology, the obligation to cooperate in the CBTMT context and the role of the needs-based approach for the effective implementation of the CBTMT component under the BBNJ Agreement. Secondly, the presentation will provide a quick overview of the European Union's support for the ratification and implementation of the BBNJ Agreement.

ISA's Technology and Monitoring Road Map

Jose Dallo Moros & Ulrich Schwarz-Schampera

ISA is an autonomous international organization established under the 1982 United Nations Convention on the Law of the Sea (UNCLOS) and the 1994 Agreement relating to the Implementation of Part XI of the United Nations Convention on the Law of the Sea (1994 Agreement). ISA is the organization through which States Parties to UNCLOS organize and control all mineral resources-related activities in the Area for the benefit of mankind including the mandate to ensure the effective protection of the marine environment from harmful effects that may arise from deep-seabed related activities, as well as the technology transfer and capacity building, the promotion of marine scientific research, and data compilation. Marine exploration, potential future exploitation for marine minerals, and effective environmental monitoring are emerging fields of activities to ensure future access to raw materials for low-carbon industries from common sources with less environmental impact. Activities attract advanced technology, intelligent, low-impact and remotely operated solutions which allow for environmentally sustainable recovery and environmental monitoring.

ISA secretariat develops a technology roadmap with concrete results and partnerships that facilitates the full implementation of UNCLOS, allowing ISA and States Parties to initiate and promote (UNCLOS, art. 144) (i) Programmes for the transfer of technology to the Enterprise and to developing States, (ii) Measures directed towards the advancement of marine scientific research and the technology of the Enterprise and the domestic technology of developing States. The potential technological design for remote surveys and monitoring includes (i) in situ instruments, mobile assets and supporting infrastructure; (ii) communication systems for infrastructure management and data transmission; (iii) central database for information storage and real time access to the data; (iv) algorithms for QA/QC, analytics, event detection, alerting, data mining, artificial intelligence, modelling; (v) established indicators and thresholds with predefined courses of action and mitigation.

The draft technology roadmap identifies five areas of priority for technological advances including ocean observation and communication, monitoring, autonomy, automation, robotics, machine learning and artificial intelligence, mining, energy, and metal processing. ISA is seeking partnerships for the development of all five technological priorities leveraging the full potential of modern technology for the blue economy.

Ocean Technologies for People & the Rest of Nature

Twenty-third meeting: "New Maritime Technologies: Challenges and Opportunities" 5 to 9 June 2023

Kim FRIEDMAN, Senior Fishery Resources Officer FAO

The Food and Agriculture Organization (FAO) is a specialized agency of the UN and a global repository of technical knowledge and expertise on fisheries and aquaculture. In regards ocean resources, aquatic foods are sourced from an extremely diverse baseline of over 3000 species and remain some of the most traded food commodities in the world. While production from fisheries and aquaculture has grown at twice the rate of human population growth over the last 50 years, the ocean continues to come under an extensive range of anthropogenic pressures. This presentation talks to a few of the many technological innovations in place, and on the horizon, that give hope to reversing any negative trend in overexploitation of fish stocks. It centres on novel developments in research as well as actions to join forces amongst traditional fisheries instruments to help to reverse food insecurity, a concerning global problem that is again on the rise.

Dr. Jon Kaye

Gordon and Betty Moore Foundation, Program Director (Science)
Member of the UN Ocean Decade Technology and Innovation Informal Working Group

Presentation: *Roles for Philanthropy in Supporting Technology Development*

Abstract

Private funders of scientific research may choose to orient financial resources towards high-risk projects that do not carry a guarantee of success. Creating new gadgets and technology development are thus a natural fit for many science philanthropies, including the Gordon and Betty Moore Foundation, based in Silicon Valley, whose interests in the ocean range from supporting discovery-oriented research on aquatic symbioses to efforts to conserve and sustainably manage marine ecosystems.

Across our programmatic areas, we recognized that technology advancement was not necessarily moving ahead at a pace fast enough to meet urgent conservation needs and not necessarily moving ahead carefully enough with demonstration of added value for newly created measurement and observation approaches. To address this challenge, we recently partnered with other philanthropies to launch a technology test bed in Monterey Bay, California under the leadership of the Central & Northern California Ocean Observing System (CeNCOOS). A primary aim of the test bed is to accelerate the rate of technology assessment relative to its stated promise for scientific research or stated ability to provide a conservation solution. The approach is one of co-design, which will bring together technology developers, academic scientists, policymakers, resource managers and others to collaboratively prioritize which technologies to test and then tap into the brain trust and infrastructure of institutions that line Monterey Bay to carry out the assessments. If the approach is successful, a broader aim is to share this technology test bed model with communities in other ocean regions.

Evolving global ocean observing with the private sector

Emma Heslop, Act. Director of the Global Ocean Observing System (GOOS)

Ocean observing is essential for a better understanding of our planet's climate system and weather patterns, as well as to preserve marine life, enable coastal communities to flourish, and support blue economic growth and sustainable development. The Global Ocean Observing System (GOOS) leads, coordinates and supports ocean observing around the globe, with 84 countries and 13 observing networks involved. However, the system faces key challenges in expanding observations and enhancing its fit for purpose - and new participants from the private sector have the potential to accelerate its development across the whole ocean information value chain.

From September 2022 to January 2023, GOOS, the Marine Technology Society (MTS), National Oceanic and Atmospheric Administration (NOAA), and industry partners undertook a series of Dialogues with Industry to understand the barriers and the opportunities for the private sector in closer collaboration and participation in the ocean observing system. The sessions looked at these across the value chain from supplying technology for observing, to taking the observations and delivering the data and also ocean information services. The Dialogues formed a set of compact meaningful discussions between new and established companies, academia, and government, to understand these barriers and opportunities from different perspectives. Four key areas for action were identified - improving the market, societal/governmental change, collaboration to grow, and market elements shaping the future. This presentation will outline where international collaboration and cooperation can best act towards achieving a mature, vibrant Ocean Enterprise, to enable blue economic growth and support nations in climate adaptation and sustainable ocean management, underpinned by ocean data and public-private sector collaboration.