United Nations Educational, Scientific and Cultural Organization

Intergovernmental Oceanographic Commission

2021 2030 United Nations Decade of Ocean Science for Sustainable Development

Summary Report of the Regional Planning Workshop for the North Pacific and Western Pacific Marginal Seas

Tokyo, Japan, 31 July 2019 - 2 August 2019

October 2019

Report and Document No.

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1. Background

The United Nations General Assembly (UNGA) proclaimed **the UN Decade of Ocean Science for Sustainable Development (2021-2030)** in December 2017, which offers a *once-in-a-life-time opportunity* for all ocean stakeholders to reverse the cycle of decline in ocean health and ensure ocean science can fully support countries in achieving the sustainable development of ocean. Under the framework of the Decade, scientists and stakeholders from all relevant sectors will be convened to generate scientific knowledge, underpin infrastructure and partnerships, and bridge the science-policy interface to support a well-functioning, productive, resilient and sustainable ocean-***the Ocean We Need for the Future We Want***.

The Decade Roadmap offers an initial guide for the steps and processes needed to develop the Implementation Plan of the Decade, and also formulates a preliminary set of globally defined objectives and research and development (R&D) Priority Areas. Global and regional consultative workshops are essential mechanisms to achieve the objectives and to engage various communities through a multi-stakeholder process and structured dialogues. The first Global Planning Meeting (GPM) took place in Copenhagen, Denmark, 13-15 May 2019, which brought key stakeholders with an interest in the Decade to the same level of information, encouraged stakeholders to take ownership of the Decade, and further developed its scope, and identified collaborations.

Following the first Global Planning Meeting, the Decade Regional Planning Workshop for the North Pacific and Western Pacific Marginal Seas was held in Tokyo, Japan from 31 July-2 August 2019, with the financial support of the Government of Japan, through its Ministry of Education, Culture, Sports, Science and Technology (MEXT). This Regional Planning Workshop was organized by the IOC Sub-Commission for the Western Pacific (WESTPAC) in close cooperation with the North Pacific Marine Science Organization (PICES), the Japan Agency for Marine-Earth Science and Technology (JAMSTEC), the Japanese National Committee for IOC/UNESCO, the University of Tokyo and other partners in the region.

2. Unique Characteristics of the North Pacific and Western Pacific Marginal Seas

The North Pacific and Western Pacific Marginal Seas are of high social, economic and cultural importance to human's livelihoods and global prosperities. The region is the most densely populated area and home to the highest level of marine biodiversity and endemism in the world. Humans' activities have been inextricably linked to the ocean with large impacts on the surrounding coastal waters and marine ecosystems.

The oceanographic processes in the region such as ENSO, Indonesian Throughflow, Western Boundary Currents, play a key role in regulating the global climate system. The region is especially prone to natural disasters. Marine disasters including tsunamis, typhoons, storm surges, sea level rise, have been posing serious challenges to people's lives, property safety and sustainable social-economic development.

While the region's position as the growth engine of the world economy has intensified in recent years, escalating human activities associated with the rapid economic development, coupled with climate change and ocean acidification, have been putting the ocean under the risk of irreversible damages. To protect marine environment and ensure the ocean's sustainability in the region remain at the center of marine scientific conversations.

3. Aims and Objectives

The Regional Planning Workshop aimed to provide a valuable platform for regional, international, interdisciplinary and multi-stakeholder dialogues to contribute to the preparation phase of the Decade and the development of the implementation plan.

The objectives of the Regional Planning Workshop were to:

- *Communicate the purpose and expected results of the Decade to all stakeholders in the region, including the marine scientific community;*
- *Identify the knowledge gaps and scientific priorities or questions in the region, including additional R&D priorities, that need to be tackled in order to meet the six societal outcomes[1] that the Decade aims to achieve by 2030;*
- *Elaborate plans to address these science priorities/questions, including existing and potential programmes, partnerships and resources;*
- *Address cross-cutting priorities that are crucial to the success of the Decade, such as capacity development and marine technology transfer, financing and partnerships, data and information sharing and knowledge exchange, and communication;*
- *Connect with key stakeholders in the region, including the marine scientific community, to build ambition and amplify engagement with the entire ocean communities to prepare for the Decade.*

4. Conduct of the Workshop

The workshop received an overwhelming interest. There were a total of 160 participants and representatives from 18 countries and relevant United Nations bodies/programmes, intergovernmental/international organizations, regional marine scientific institutions and fishery organizations, spanning communities from scientific community, ocean policy and management, business and industry, civil society and NGOs, and donors and foundations.

Before the event, an online registration website opened five months prior to the workshop for a wider participation. Owing to tremendous efforts, a diverse assemblage of participants by stakeholder community, gender and age, geographic coverage and representation were identified. Participants were grouped into six working groups (corresponding to the six societal outcomes of the Decade), based on their priority interests expressed upon online registration. Meanwhile, a co-conveners group was formed accordingly for each working group, with several rounds of tele-conferences conducted to ensure a common understanding of the planning process and expected outputs. A standard questionnaire was also developed around the workshop objectives, and sent to all participants in advance with a view to soliciting their inputs to working group discussions.

The Regional Planning Workshop opened on 31 July 2019 with perspectives from a group of prestigious representatives on the Decade and their expectations for future efforts in the region. These were followed by a keynote entitled "UN Decade of Ocean Science for Sustainable Development: Building and inclusive and participative agenda to deliver action",

[1] The six societal outcomes:

A clean ocean *whereby sources of pollution are identified, quantified and reduced and pollutants removed from the ocean.*

A healthy and resilient ocean *whereby marine ecosystems are mapped and protected, multiple impacts, including climate change, are measured and reduced, and provision of ocean ecosystem services is maintained.*

A predicted ocean *whereby society has the capacity to understand current and future ocean conditions, and forecast their change and impact on human well-being and livelihoods.*

A safe ocean *whereby human communities are protected from ocean hazards and where the safety of operations at sea and on the coast is ensured.*

A sustainably harvested and productive ocean *ensuring the provision of food supply and ocean resources.*

A transparent and accessible ocean *whereby all nations, stakeholders and citizens have access to ocean data and information technologies and have the capacities to inform their decisions.*

and the major results of the 1st Global Planning Meeting (13-15 May 2019, Denmark): *I. A Clean Ocean; II. A Healthy and Resilient Ocean; III. A Predicted Ocean, IV. A Safe Ocean; V. A Sustainably Harvested and Productive Ocean; and VI. A Transparent and Accessible Ocean*.

Subsequently, participants broke out for working group discussions. The WG I-III (societal outcomes I-III) conducted their parallel sessions (1400pm, 31 July-1230pm, 1 August), followed by another three parallel working groups discussions: WG IV-VI (societal outcomes IV-VI) from 1400pm 1 August, until 1230pm 2 August.

Each WG conducted their discussions, building on the results from the 1st Global Planning Meeting (GPM) and feedbacks received on the questionnaire. Selected presentations were made during the discussions to provide background to the audience on the major topics of discussions.

On the afternoon of 2 August, participants gathered again to further examine all discussion results, and were invited to reflect on their preparations, willingness, and potential commitments to the Decade.

The Regional Planning Workshop finally culminated in a wide range of actions, potential initiatives, programmes and partnerships needed to advance ocean knowledge for sustainable development. This summary mainly covers major discussions and results structured around the workshop objectives (i.e., knowledge gaps/research priorities, existing initiatives/programmes/partnerships, and cross-cutting priorities), and includes the recommendations for potential initiatives/programmes/partnerships in support of the Decade. The workshop programme, working group reports, and other meeting documents are available at the workshop website. A list of acronyms and abbreviations is attached to this report as the **Annex 1**.

5. Major Results

Throughout the three-day workshop, participants highlighted the unique characteristics of this region in both its oceanographic environment and significant contribution to the global social-economic development. In addition to reviewing the relevant results of the 1st GPM, each working group deliberated region-specific issues or priorities which should be addressed in order to achieve the six societal outcomes in the UN Decade of Ocean Science for Sustainable Development (2021-2030).

Working Group I: A Clean Ocean *whereby sources of pollution are identified, quantified and reduced and pollutants removed from the ocean*

The WG I conducted its discussions through plenary and break-out sessions, with Day 1 focusing on knowledge gaps and research priorities, existing programmes, partnerships & resources, and cross-cutting themes. In view of the identified regional priorities, Day 2 was dedicated to the development of three candidate initiatives: plastics, nutrients, and industrial & agricultural pollutants (POPs & heavy metals). For detailed descriptions about the discussions, please refer to the WG I Report.

Knowledge gaps and research priorities[2]
a. Concerted monitoring of temporal, spatial and behavior of pollutants: characterize distribution and effects of pollutants over space and time using standardized monitoring & modelling

[2] vary by pollutant class, among countries, over time

b. Integrated research on fate and effects of microplastics, nutrients, metalloids, Polycyclic Aromatic Hydrocarbons (PAHs) and CO_2: improve comparability and quality of data through partnerships, technology transfer, reference materials, sample exchange, inter-laboratory calibration, training and staff mobility
c. Limited understanding of the consequences of pollution: develop and strengthen Environmental Quality Guidelines so as to protect vulnerable species, ecosystems and indigenous communities at appropriate geographical scales
d. Design and build databases that are open and transparent sharing at national, regional and international scales
e. Evaluate and improve science-based management tools for remediation, waste management and disposal at sea
f. Include or improve socioeconomic analyses for compound-specific pollution
g. Involve social sciences in the study of human behavior in support of positive change

Existing international initiatives/ programmes/ partnerships

(Please refer to the Annex II to the WG 1 Report)

Cross-cutting priorities

Capacity development and technology transfer

a. Design & develop new technologies and software, strengthen harmonization of methods, build and operationalize integrated observing systems
b. Invest in junior and early career professionals to build capacity and to act as key agents of change
c. Strengthen the "UNESCO/IOC Regional Network of Training and Research Centers (RTRCs) on Marine Sciences" to address uneven capacities across the region
d. Create a stronger multilateral ocean science team for a clean ocean: support expert meetings to identify and track ocean pollution priorities

Partnership and financing, communication and awareness

a. A team approach that embraces governments, civil society, industry and the public will help ensure acceptance and success for the Decade
b. Technology will be a key driver for research, citizen science and engagement
c. Cultural and linguistic inclusiveness is vital
d. The Decade will benefit from shifting from a 'bad news' to a 'good news' paradigm, i.e., identifying a problem in support of designing a solution
e. Embrace the cultural mosaic of the ocean communities will strengthen understanding, acceptance, and action among stakeholders
f. A network of Pacific Aquariums can assist in the spectrum of activities within the Decade: research, monitoring, engagement and action.

Recommendations for potential initiatives/programmes/partnerships

I. Design a comprehensive initiative to reduce the pollution of the ocean by plastics through research, monitoring, engagement and action

Pressure (Transport & Fate):

a. Design and operationalize a plastics report card with standardized methods for national and international use
b. Convene a 'Best Practices' working group for plastic pollution research and monitoring
c. Widen and strengthen citizen science participation in data collection and reporting

State (Effects):

a. Establish and fund a high priority research list to address gaps and strengthen 'A Clean Ocean' progress

Response:

a. Establish a Secretariat for the Clean Ocean Initiative with one full time staff member, to be hosted at a supporting organization

b. Establish a consortium of Pacific Rim Aquariums to enhance citizen science, research, monitoring, engagement and action on plastic pollution
c. Grow the innovation sector with an endowed prize for blue design, waste management, recycling and clean-up projects that reduce plastic pollution
d. Host or support incubators designed to reduce plastic pollution
e. Encourage plastic material design in a manner that improves the value and safety of the recycled product
f. Establish a fund to support mobility for students, early career researchers, and professional staff to improve capacity to conduct research, monitoring in support of plastic pollution reduction
g. Create a competitive ocean ambassadors' youth team to extend the awareness of plastic pollution topics and engage the public in solutions and positive action
h. Create high level white papers that translate science to policy and enable informed actions to reduce plastic pollution
i. Build a website for the initiative, and engage the public through social media to report out on the research and monitoring findings, as well as "successful stories"

II. Design a comprehensive initiative to reduce the pollution of the ocean by nutrients through research, monitoring, engagement and action

Drivers and Pressures:
a. Determine the sources, magnitude, transport and fate of nutrients from land, submarine groundwater discharge (SGD), atmosphere, and coastal upwelling

State and Impacts:
a. Assess the links between nutrient inputs, algal blooms, lower oxygen, more acidic waters and other associated environmental impacts
b. Find and use suitable indicators to evaluate the level of eutrophication in the ocean (e.g., satellite derived chlorophyll data)
c. Develop numerical models with improved ability to predict impact of nutrient inputs, eutrophication and oxygen decline and the potential benefits of management options at global, regional and local scales
d. Use and replicate global, regional and site-specific assessment tools to determine nutrient loading in the ocean from land-based sources
e. Assess and quantify the impact of upwelling as source of nutrient-rich but low-in-oxygen waters from the oxygen minimum zones on coastal activities and processes

Response:
a. Capacity development: Instrumentation (e.g. sensors for nutrient monitoring), regular interlaboratory comparison exercises for nutrient analysis, standardized methods and quality assurance protocols, certified reference materials, and data archiving
b. Citizen science: Secchi disk measurements aided by smartphone app for seafarers and students; transparency/turbidity of measurements of coastal waters using smart phones
c. Private sector engagement: encourage (or legislate) detergent manufacturers to produce and market only phosphorus-free detergents, disseminate ways to more efficiently use fertilizers and share best practices in agriculture
d. Research programme development - River basin nutrient estimates to marginal seas

III. Develop a regional research framework to identify, quantify and reduce industrial and agricultural pollutants (POPs & heavy metals) in the ocean and coasts

Drivers: Coastal developments, mining Industries, off-shore oil and gas industries as well as forest fires are the main source of coastal and marine pollutions, such as persistent organic pollutants, heavy metals, and pharmaceutical products.
Impacts: Reduced ecosystem services, Contaminated seafood products, Increased carcinogenic incidences and hormonal disorders

Response:

a. Assessment of industrial pollutants (persistent organic pollutants, heavy metals, and pharmaceutical products) in the regional sea
b. Research and modelling on the distribution, fate and effects of industrial and agricultural pollutants such as POPs, in the region
c. Ecotoxicological studies of metals and other industrial & agricultural pollutants
d. Ecological and human risk assessment of metals and other industrial & agricultural pollutants in the region.
e. Capacity development and communication

IV. Other potential initiatives/programmes/partnerships

- Monitoring and research on ocean noise as an emerging pollutant
- Develop a prioritized and integrated WESTPAC contaminants monitoring framework
- Develop an integrated ocean observation system specifically targeted on marine pollutants and their ecological consequences
- Develop of shared platforms/facilities for the simulation studies of combined effects of multiple stressors (pollutants)
- Develop communication mechanisms (workshops, conferences, training courses, annual reports, and regional joint programmes) on the knowledge of marine pollution status and their consequences
- Establish regional knowledge hubs to develop harmonized systems of data collection & analysis and shared methodologies to understand and address transboundary pollution
- Setting marine debris/plastics as an additional Essential Ocean Variable to measure at a global scale, and developing an International Marine Debris Observation Network (IMDOS)
- Developing a regional microplastic research project with harmonized approaches to fill gaps in data
- Developing a community of experts around science, statistics and governance
- Conduct the 2nd Cooperative Study of the Kuroshio and Adjacent Regions (CSK-2)
- Establish an international technical development project for recycling large amounts of plastic waste
- Develop educational modules to ensure consistency in knowledge

Working Group II: A Healthy and Resilient Ocean *whereby marine ecosystems are mapped and protected, multiple impacts, including climate change, are measured and reduced, and provision of ocean ecosystem services is maintained*

The WG II discussions were built on the major results from the 1st GPM and questionnaire results received from workshop participants. In addition to six GPM identified knowledge gaps (KG 1-6) for "A Healthy and Resilient Ocean", the WG also identified another four knowledge gaps (KG 7-10) which should be addressed in the region to achieve "A Healthy and Resilient Ocean". Major discussion results were provided in the table as follows. For more details about the WG discussions, please refer to the WG II summary.

KG #1	Knowledge gaps		Potential new activities
	Main gaps	Sub-gaps	
Structure and function of the ecosystem in the mesopelagic zone (and other realms) *(From the 1st GPM)*	Lack of quantitative understanding of mesopelagic (and other realms) ecosystem structure and function	• Taxonomy • Capacity building	• Quantitative understanding of the mesopelagic ecosystem structure and function and its connectivity to the epi- and bathypelagic ecosystems • Evaluation of potentially underutilized sustainable resources, such as mesopelagic harvest
	Existing initiatives / programmes / partnerships		
	Ocean Sites Program; WHOI Twilight Initiative; SEAFDEC: surveys on mesopelagic and deep longline; Canadian MPAs; CLIOTOP / IMBeR; KIOST on North Pacific mesopelagic research; PICES: Working on mesopelagic methods, could help with research and has collaborative agreements with RFMOs (under-represented here, e.g. WCPFC); WESTPAC: coordinating organizations, operational framework, networks of observation & research groups; Ocean Health Index: always looking for new areas; North Pacific Fisheries Commission: minimizing impacts & mapping vulnerable ecosystems		
KG #2	**Knowledge gaps**		**Potential new activities**
	Main gaps	Sub-gaps	
Inter-dependency between ecosystems *(from the 1st GPM)*	Interlinkages between ocean – land, ocean – atmosphere, and surface ocean – deep ocean	• Carbon cycles • Oxygen fluxes • Nitrogen runoffs • Ocean circulation (observations and models) • Deep sea ecosystem • Waste streams	• Development of Integrated Coastal Zone Management and Marine Spatial Planning (ICZM/MSP for Asia-Pacific region) • Climate –oceanographic process studies for social-ecological resilience • Coordinate support for expanded deployment of biogeochemical ARGO • Study of linkages between coastal and open ocean ecosystems through drifting and/or migrating organisms, e.g., Sargassum
	Existing initiatives / programmes / partnerships		
	PICES: publications on OA, deoxygenation, carbon cycle, etc.; FUTURE Science Programme provides inter-disciplinary coordination on understanding climate impacts on North Pacific marine ecosystems;		

	WESTPAC: coordinating organizations, operational framework, networks of observation & research groups (ocean acidification regional hub, ocean oxygen network); Future Earth; SOLAS; IMBeR; FUTURE Earth Coast; SIMSEA; Sustainable Ocean Initiative (land-coastal connections); PEMSEA		
KG #3	**Knowledge gaps**		**Potential new activities**
	Main gaps	Sub-gaps	
Ecosystem effects of impacts *(from the 1st GPM)*	Impact of cumulative stressors on the ocean (systematic methods for evaluation)	• Ocean acidification • Deoxygenation • Indicators for a healthy and resilient ocean, including adaptive capacity • Marine heatwaves • Multi- and trans-disciplinary research	• Compare the changes in different marine ecosystems under multiple stressors • Focus on emerging issues, e.g., OA, introduced species, climate change, adaptation of marine organisms • Measurement and/or monitoring for mitigation of or adaptation to climate change • Footprint mapping of impact of cumulative stressors • Create marine heatwave working group • Marine Spatial Planning Initiatives • EEZs / International waters
	Existing initiatives / programmes / partnerships		
	Former GEOHAB Asia; Fisheries and Oceans Canada: MSP programmes; WESTPAC: Several programmes/working groups, respectively on ocean acidification, ocean deoxygenation, coral reef resilience; GO2NE (deoxygenation); GOA-ON; SPC; SPREP; ICES working group		
KG #4	**Knowledge gaps**		**Potential new activities**
	Main gaps	Sub-gaps	
Essential ocean variables and sampling issues *(from the 1st GPM)*	Standardization of EOVs & Data comparison		• Standardize protocol for assessment of marine ecosystem health • Development and use of next generation technologies, including the establishment of protocols • Global coordination of biological observation networks
	Existing initiatives / programmes / partnerships		
	Metadata Best Practices: Ocean Best Practices, Darwin Core, EML; Japanese eDNA standard protocol (eDNA Association); IndiSeas; Ocean Health Index: NCEAS activities; World Ocean Assessment WESTPAC: Several research programmes, such as remote sensing for habitat mapping; Marine biodiversity observing network; GOOS and OceanObs'19		
KG #5	**Knowledge gaps**		**Potential new activities**
	Main gaps	Sub-gaps	
Modelling abrupt changes and phase shifts	Long-term knowledge and monitoring	• Ecosystem mapping • Habitat management & conservation • Holistic approach including	• Understand major driving factors and trends of marine ecosystems • Build capacity for long-term biogeographical observing networks

(*from the 1st GPM)*		traditional/local knowledge • Remote sensing • Development of automatic sensors for biological observation	• Improve remote sensing algorithms for various parameters • Improve understanding of ecosystem resilience and tipping points • Develop model systems to analyze and predict changes of environmental stressors and ecosystem responses • Enhance data sharing and public availability of data
	Existing initiatives / programmes / partnerships		
	Remote sensing – ESA Copernicus; ARGO & Biogeochemical ARGO; Ocean Tipping Points – NCEAS; Coral Atlas (mapping coral reefs around the world); WESTPAC: DRMREEF project; GCRMN; PICES; Future Earth		
KG #6	**Knowledge gaps**		**Potential new activities**
	Main gaps	Sub-gaps	
Modelling the impacts of unknown stressors on ecosystems (*from the 1st GPM)*	Impossible to model the impacts of stressors which are unknown. *Note: This Gap shall be better termed as "Modelling the impacts of **emerging** stressors on ecosystems".*		
KG #7	**Knowledge gaps**		**Potential new activities**
Valuation of marine ecosystem services (mechanism and dynamics) (*Added by the WG II, RPW)*	• Overfishing and overfished stock management, including addressing IUU fishing • Sustainable production and consumption • Capacity building and ocean management & conservation • Restore or recover marine biodiversity • Understanding the value of convergence between science and maritime culture • Knowledge of valuation methods		• Link cultural resources and marine ecosystem services • Science-based ecosystem management training programmes, including valuation and communication among stakeholders • Promote ecosystem-based fisheries management • Encourage the development of EBM decision-making and policy frameworks • Integrated and comprehensive study in the frame of socio-ecological systems • Integrate diverse methods of knowledge generation
	Existing initiatives / programmes / partnerships		
	SIMSEA; PICES: ecosystem services; DFO Canada: MSP initiative; WESTPAC: coordinating organizations, operational framework, networks of observation & research groups, Regional Training and Research Center for Marine Biodiversity and Ecosystem Health (RTRC-MarBEST); Reef Restoration & Conservation; CTI-CFF: Seascapes programme; IPBC: mitigation; UNESCAP: Ocean Accounting; SeaCorps International; Nature Conservancy		
KG #8	**Knowledge gaps**		**Potential new activities**
Transboundary research (sub-regional,	• Connection of MPA networks within, across, and beyond national jurisdictions		• Connecting marine protected areas beyond national boundaries / common heritage ocean parks

regional, and global) *(Added by the WG II, RPW)*	• Evaluation of effectiveness of MPA networks • Connectivity studies • Knowledge of migratory marine species	• Transboundary marine species management • Connectivity study for cooperative management in target large marine ecosystem in Western Pacific • Evaluation of effectiveness of ocean use across national jurisdictions • Connectivity of ecosystem structure within and across MPAs • Management of MPAs for sustainable fisheries
	Existing initiatives / programmes / partnerships	
	WESTPAC; CEC: Baja to Bering; PICES and Joint PICES/ISC Working Groups; UNESCAP; MPAs; NEAPAN; CTI-CFF: Seascapes programme; Convention on Migratory Species	
KG #9	**Knowledge gaps**	**Potential new activities**
Increase communication and awareness *(Added by the WG II, RPW)*	• Holistic approach of citizen science • Function of aquariums & museums • Role of digital media • Increase ocean literacy	• Leadership development programmes for younger generations and early career professionals • Alignment of UN Decade programs to SDG recommendations • Prioritize generated outcomes • Development of apps and games for all ages/demographics • Train scientists for better communication with public and media
	Existing initiatives / programmes / partnerships	
	Zoological Society of London: Field office outreach; NGO Outreach; National Academy of Science & Technology; IOC Ocean Literacy portal; National Geographic; Korea Maritime Museum Network IOCC; Black Sea Summer School: Sirius; ICOM: International Congress of Museums; WESTPAC Floating Summer School, Regional Network of Training and Research Centers on Marine Sciences; Climate Action – Friends of the Ocean	
KG #10	**Knowledge gaps**	**Potential new activities**
Science and policy interface *(Added by the WG II, RPW)*	• Capacity building for better science communication (with public and policy makers) • Propose national, regional, and global policy solutions / recommendations	• Collaboration between academia, researchers, policy-makers, and industrial partners • Collaborative research among local, national, and regional partners • Training on science-policy interface • Development of a partnership between WESTPAC and APEC
	Existing initiatives / programmes / partnerships	
	ASEAN Centre for Biodiversity (ACB);	

	NAST: regular science-policy forums, e.g., plastic pollution; Deep Ocean Stewardship Initiative; CGMT: Technology transfer; NGOs: Ocean Foundation – Capacity Building; WESTPAC: International conferences, Intergovernmental Sessions, UNESCO-ASEAN Cooperation Framework; Ocean Knowledge Action Network; Future Earth; Ocean Foundation: OA Capacity Building; APEC; Sustainable Ocean Initiative – Science Policy interface

Cross-cutting priorities	
Capacity development *and technology transfer* • Define target groups for capacity building (e.g. building capacity of under-represented groups in the ocean science enterprise, or enhancing science infrastructure in Small Islands Developing States) • Involve government, scientific community, private sector and the public • Promote citizen science for public involvement • Mobilize younger generations such as students and early career scientists • Disseminate new findings and technologies • Develop state-of-the-art technologies, e.g., Artificial Intelligence, space-ocean science	Partnership and financing • International collaborative research • Integrating science and art/culture in partnership with maritime museums and aquariums (e.g., maritime culture, history and ocean heritage) • Engagement of private sector and financial institutions, e.g., oil and gas companies, IMF funds for climate change, Asian Development Bank, Schmidt Ocean Institute, etc. • Crowd Funding
Data and information and knowledge sharing • Importance of local knowledge: the need to translate local references to additional languages in order to reach a global audience, and vice versa • Linking regional and global databases	Communication and awareness • Involve two-way communication between scientists, the public, and policy/decision makers, including social media • Incorporate communication as part of all scientists' job • Encourage further engagement, especially of policy-makers and private sectors such as oil and gas companies

Working Group III: A Predicted Ocean *whereby society has the capacity to understand current and future ocean conditions, forecast their change and impact on human wellbeing and livelihoods*

To ensure a focused and fruitful discussion, the WG III initially defined "A Predicted Ocean" as "the development of skillful and user-relevant predictions for the state of the ocean, marine ecosystems, and marine hazards". Given the breadth of the "A Predicted Ocean" discussion, four focus areas were identified: *1) Role of ocean in climate prediction, 2) Ocean predictions, 3) Ecosystem Predictions, and 4) Marine hazards*. Day 1 discussions focused on identifying knowledge gaps and science priorities, while Day 2 focused on existing and potential initiatives, capacity building needs, and research and development activities. For detailed coverage on the discussions, please refer to the WG III summary.

Knowledge gaps and research priorities/questions:

To achieve "a predicated ocean", predictions need to cover the range of temporal scales over which end-users can make decisions. Thus, prediction systems need to be seamless, ranging from short-term forecasts to seasonal to multi-annual predictions. To be useful, predictions also need to be at a high resolution. Following the rapid improvements in computing and modelling capabilities, it was suggested that a 1 km resolution for global ocean predictions and a 10 km resolution for climate (coupled atmosphere-ocean-wave-land-ice system) projections would be appropriate to meet end-user needs and achievable by the end of the Decade. Identified knowledge gaps and region-specific research priorities were classified in three areas: **prediction, process study and ecological predictability.**

Prediction

- Accurate predictions of tropical cyclones, as about 1/3 of global cyclones occur in this region
- Accurate prediction of variability of the Asian Monsoon, which impacts agriculture and marine ecosystem including coral health
- Predictions of sea ice loss including the sea ice loss in the Arctic
- Ecological predictions from physics to fisheries for the coral reef triangle ecosystem, a convergence zone with the richest marine biodiversity in the world
- Biogeochemical forecast capabilities for regions that are home to some of the largest fishing grounds on the globe (e.g., coastal areas, Kuroshio-extension, upwelling regions, Bering Sea, etc.)

Process study: Improved understanding of following processes is essential for advancing skillful ocean predictions during the Decade:

- Western Boundary Currents and low latitude current systems
- The role of the Indonesian Throughflow (ITF) in the transport of water masses, heat, and energy between the Pacific and Indian Oceans
- Air-sea interactions in the region (e.g., tropical areas, Kuroshio and its extension), as these are of the strongest air-sea interaction areas in the world
- The impact of the Indian Ocean Dipole (IOD) on ENSO and its predictability
- The role of the maritime continents to regional climate
- Effects of ventilation changes in the Marginal Seas in ocean predictability over the region

Ecological predictability (e.g., for tropical cyclones and fishing grounds):

- Develop biogeochemical data assimilation capabilities
- Better resolve representation of nutrient inputs and discharge from rivers
- Develop ocean acidification forecasting capabilities to assess multi-stressor impacts on marine ecosystem components
- Improve ocean circulation and ocean temperature forecasts for prediction of phenological changes in marine species (e.g., migration)

- Better understand and represent turbulence in ocean models, especially ocean mixing and air-sea fluxes
- Develop novel ocean coupled models that merge different processes (surface waves, internal waves, Langmuir circulation, eddies, meso/sub mesoscale processes, tides, circulation, etc.) through multi-scale interaction
- Develop novel climate (ocean-atmosphere-land-ice) coupled models based on the new ocean coupled model above
- Initiate an ocean model inter-comparison project
- Investigate the use of non-numerical model schemes including Artificial Intelligence (AI) for both physical and biological predictions.

Existing international initiatives/programmes/ partnerships

Many resources and partnerships could be developed to achieve the research priorities. However, observations are keys to further understanding the processes highlighted in the science gaps, verifying models, and initializing forecast models for predictions. In addition, it was important to further involve the end-user communities (e.g., private firms in the fishery sector, maritime transport, fishery management organizations). Developing partnerships with end-users is needed to ensure maximum societal benefits and widespread adoption of forecasts for the development of climate change adaptation policies. Those initiatives are listed below:

- **Modelling Initiatives***: WESTPAC Ocean Forecasting System; PICES FUTURE science programme; ESSAS; Oceanic and Climate Model Development of China; NOAA Modelling, Analysis, Predictions, and Projections (MAPP) Programme; CLIVAR Ocean Model Development Panel, CMIP6 programs and related MIPs, WMO and national meteorological agencies*

- **Observation Initiatives:** *TPOS2020, SEA-GOOS (WESTPAC), NEARGOOS (WESTPAC), North America-GOOS, Regional IOOS (AOOS), Argo, NPOCE (CLIVAR), AIKEC CSK-II (WESTPAC), YMC, INA-PRIMA, CREAMS 3.0, S2S AAA Monsoon, MOMSEI programme – Monitoring and Predicting Oceanic Heatwaves and its Ecosystem Impacts (WESTPAC), and SMART CABLE*

- **Partnerships with users:** *UN Environment and national environment agencies, regional fisheries management organizations (e.g. IATTC, ISC, WCPFC, NPAFC) and private sector*

Cross-cutting priorities

Capacity building and technology transfer

- Build sustained long-term training courses on model development to build capacity for "A Predicted Ocean" across the region, using the UNESCO/IOC Regional Network of Training and Research Centers (RTRCs) platform especially RTRC on Ocean Dynamics and Climate (ODC Center) which has been successfully providing annual training courses since 2011;
- Expand computational facilities in Small Island Developing States (SIDS) and Least Developed Countries (LDC);
- Promote technology transfer from developed countries to LDC, especially SIDS, and to the younger generation of ocean scientists;
- Develop open source modelling tools to improve knowledge transfer; and

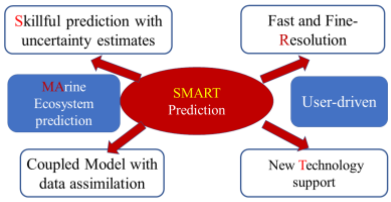
Partnerships and financing

- Facilitate partnerships among regional and trans-national organizations (e.g., WESTPAC, CLIVAR, PICES, ESSAS, NOWPAP, NPRB, Belmont Forum, PACON);
- Develop partnerships with observation networks to allow for real-time information to help ocean forecasting systems and marine ecosystem predictions;
- Partner with national initiatives which encourage international cooperation, such as the China Belt and Road Initiative and others; and
- Develop partnerships with NGOs, foundations, and industry

• Connect traditional knowledge with modern science.	
<u>Access to information, data, and knowledge</u> • Make the tremendous amounts of data that already exist, including archived data, more accessible; • Establish and implement global standards for data quality, data sharing, and assessments of model uncertainty; • Encourage open science, which emphasizes access to information, such as the data and knowledge initiative initiated by the Regional Office for Asia and the Pacific, International Science Council (ISC-ROAP); and • Establish Findable, Accessible, Interoperable, and Reusable (FAIR) data principles throughout the globe.	<u>Communication and awareness</u> • Identify region-specific end-user needs by hosting regional stakeholder meetings; • Co-develop with end-users a platform or demonstration program to link predictions to applications and decisions; • Develop communication materials, briefs, and modules to train end-users on using prediction products; • Improve methods to assess and quantify the values of ecological forecasts given uncertainty and provide uncertainty estimates to end-users; • Better engage decision-makers and politicians to raise the profile of this effort (e.g., have UN send notification letters on the UN Decade to national leaders of each member state)

Recommendations for potential activities/programmes/partnerships

To achieve "A Predicted Ocean", a SMART prediction and information decision support system (see adjacent Figure) based on simulation and prediction should be developed in support of multiple uses, including integrated coastal management and marine spatial planning.



<u>Advance model development</u> • Develop high-resolution oceanic models with coupled surface waves-internal waves-tides-and circulation components; • Further develop coupled (atmosphere-ocean-land-ice) climate models for seamless forecasting from weather to climate scales; • Develop physical-biological forecast systems with biogeochemical data assimilation; • Expand use of mechanistic ecosystem models for ecological predictions; • Develop coupled data assimilation capabilities; • Apply new technologies, including AI, for model parametrizations and to produce forecasts; and • Develop a model inter-comparison project based on the same test bed	<u>Improve data support</u> • Achieve accurate topography from ocean mapping; • Improve accuracy of atmospheric forcing data; • Improve observing capabilities for real-time observation of physics and biogeochemistry from surface to bottom by using ocean satellite data, moorings, Argo, cabled observatories, autonomous platforms, and ship observations; • Develop new technologies for observations of living marine resources; • Develop new technologies for deep-ocean observations in real-time; • Expand monitoring data on marine hazards including tropical cyclones and tsunami source identification; and • Expand telecommunication infrastructure to ensure real-time data transfer
<u>Develop process studies</u> • To better understand ocean mixing processes such as surface and internal waves induced mixing, eddies, sub-mesoscale mixing, bottom boundary layer etc.;	<u>Expand computational support</u> • Expand shared high-performance computer resources for fine resolution simulation, prediction, and storage;

• To better understand air-sea fluxes, including the effects of surface waves; and • To better understand how individual responses are translated to population level demographic responses in marine organisms	• Develop efficient parallel computing schemes; and • Improve technologies to analyze big data

Working Group IV: A Safe Ocean *whereby human communities are protected from ocean hazards and where the safety of operations at sea and on the coast is ensured*

WG IV discussed that ocean hazards could be classified, in a general sense, into following categories: *Tsunami, typhoon/high wave/storm surge, harmful algal blooms (HABs), invasive species, and climate change related hazards (increased storminess, warming temperature, sea level rise, heat wave, ocean acidification)*. Some hazards discussed occur on time scales of generations and are often easily neglected in favor of more pressing needs.

A live poll was conducted, indicating that climate change related hazards ranked above others, with increased storminess as the largest concern. As for concern by region (country), typhoon, tsunami and harmful algal blooms ranked among top three concerns. Due to time constraints and available expertise, it was not possible to discuss in details about all different types of hazards. Thus, discussions on Day 1 focused on the current status and successes, as well as the gaps and opportunities, related to tsunamis, while Day 2 focused on marine heat waves, typhoon/high wave/storm surge and harmful algal blooms (HABs). The WG IV summary can provide you more descriptions about discussions.

The WG categorized knowledge gaps for "A Safe Ocean" as follows: *i. requirements for understanding the risk; ii. requirements for data & science; iii. requirements for new technologies, vi. requirements for emergency management, and v. requirements for building resilient communities.* The working group discussions shifted easily from scientific or data gaps to social science and community issues, and it was recognized that social sciences are required for developing trust in and encouraging the effective use of the science towards a safe ocean. Key discussion results are provided in the tables below.

Knowledge gaps and research priorities/questions	Potential activities
Tsunami	
Understanding risk requirements	
Guidance for communities on conducting risk assessment	Tsunami hazard assessment guidelines
Frequency and magnitude of tsunamis needs to be understood	Study of paleo-tsunamis, and integration of community-based knowledge
Tsunami inundation maps not available for all susceptible areas	Tsunami inundation modelling guidelines
Areas susceptible to volcanic/landslide tsunami to be identified	Identification of areas susceptible to volcanic/landslide tsunamis, and conducting associated risk management
Data & science requirements	
Tsunami source modelling and resonant frequency of specific inlets need refining	Development of a repository of source models
Use of GNSS crustal movement data for tsunami warning	Installation of GPS stations in key subduction zone regions, and alongside existing tsunami warning systems
Bathymetry and topography insufficient for accurate inundation modeling	Pool all datasets together and fund a campaign to "fly the coasts", conducting bathymetric lidar survey
Unknown effects of tsunamis in currents in important ports	Modelling and conduct of hazard assessments for ports
Meteo-tsunami and tele-tsunamis not well-enough constrained	Establishment of a working group on Meteo- and tele-tsunamis
New technology requirements	
Known landslides and submarine landslides to be monitored for warning systems.	Development of inexpensive landslide tsunami monitoring technologies

Tidal gauges for confirmation of tsunami too far apart	Development of inexpensive technology, such as GPS water levels
Tsunami detection instruments expensive to maintain	Use of existing industry telecommunications cables repeaters to report pressure data
Emergency management	
Effective use of scientific knowledge in practical (scientific) applications, particularly in coastal communities	Connect users to user-friendly ocean prediction systems, and promote "Tsunami-Ready" and the "Global Blue Line"
Integration of local and traditional knowledge in emergency protocols/plans	Involvement of social sciences and local communities in emergency preparedness and response
How to convince the public (and regulators) to take the risk seriously, how to mitigate against false alarms, how to evaluate local governments (and public) response	Establishment of an international licensing system for experts in marine disaster mitigation
Undesired consequences of designating tsunami zones to building owners (real estate and insurance)	Make the zones/evacuation routes quasi-regulatory
Partnerships and knowledge exchange need improving	
Sustainability of existing instruments and networks	
Tsunami - Resilience	
Impacts to society not well elaborated	Personalize public campaigns
Limited capacity for disaster mitigation and recovery	Promote ecosystem-based disaster risk reduction, build resilient communities
Development of risk management plan, including risk acceptance	Public campaign (s) that communicate that some level of risk cannot be avoided.
Economic risks not well known in most cases	Conduct risk evaluation
Building resilient infrastructure	Include tsunami-resistant design in national building codes
Existing initiatives/programmes/partnerships	
IOC Tsunami programme, Intergovernmental Coordination Groups (ICGs) for Tsunami Early Warning Systems in Pacific, Caribbean, Indian Ocean and Mediterranean, national programmes in Japan (JMA & JICA technical cooperation), Indonesia, Australia, etc.	
Harmful Algal Blooms	
Species identification and distribution	Capacity and technological development, such as new underwater DNA techniques
Lack of long time series data	Monitoring and data collection
Limited knowledge and skills for HAB monitoring, modelling and prediction	Develop HAB monitoring, prediction and warning system(s)
Limited engagement of stakeholders in scientific discussions	Co-design and co-development of HAB research programmes/priorities.
Lack of standardization of species identification	Some good examples from national protocols
Lack of social and economic valuation on HAB impacts	Engagement of social scientists and economists
Lack of countermeasures to mitigate HAB impacts	Learn and replicate the best practices from others
Existing initiatives/programmes/partnerships	
IOC/Intergovernmental Panel of Harmful Algae Bloom (IP-HAB), Harmful Algal Blooms in the Western Pacific (WESTPAC-HABs), PICES-HABs, SEAFDEC, Northwest Pacific Action Plan (NOWPAP), International Society for the Study of Harmful Algae (ISSHA), EASTHAB.	
Typhoon/high wave/storm surge	
Typhoon intensity and track forecast	Research and model development
Disaster risk reduction in coastal development (refers to all hazards)	Development of guidelines and capacities for DRR in coastal development

Wave setup - offshore/nearshore models better coupled.	Coupled model development
Storm surge setup - Interactions between coastal and open oceans- e.g., eddies when combined with storm surge or tsunamis	Storm surge model development
Impacts of storm surge on coastal drinking/farm water	To be further discussed due to time constraints
Capacify for hazard mitigation	Follow on the tools established by WESTPAC and others, and examples set for tsunami capacity listed above
Climate change related hazards	
Role of ocean in carbon cycle / greenhouse gases	Support “Belt & Road” countries to build up GHG monitoring stations, promote ecosystem based DRR
Sea level rise	Understand and reduce the projection uncertainty
Increased storminess and coastal erosion	Understand and reduce the projection uncertainty
Ocean heat wave and its impacts on ocean ecosystems	Develop seamless observations from local scale to basin scale, and conduct multidisciplinary studies
Ocean acidification and its impacts on ocean ecosystem and seafood security	Address the global issue at the regional/local scales
Existing initiatives/programmes/partnerships	
World Meteorological Organization and national organizations	
Other hazard gaps mentioned	
Turbidity currents and international cable/pipeline protection	To be further discussed due to time constraints
Invasive species	To be further discussed due to time constraints

Other potential initiatives/programmes/partnerships

- *Development of seamless observations from basin scale to local scale through the partnerships, e.g. TPOS 2020-IOC/WESTPAC partnership*
- *Conduct of multidisciplinary (physical-biological interaction) study on marine hazards*
- *Joint research and development on tools and technology for non-seismic induced tsunamis*
- *Strengthening science-policy interface for disaster risk reduction*

Cross-cutting priorities

Capacity and technology development

In a number of cases, the most effective solution is to produce guidelines on how a community or coastal developer might utilize scientific knowledge towards improved decision-making related to community planning, preparedness, response, and mitigation/risk reduction. Examples include:

- *Guidelines for assessing tsunami risk for coastal communities*
- *Guidelines for ecosystem-based disaster risk reduction*
- *Guidelines for building resilient infrastructure and community*
- *Standardization of algae species identification*

Technological development can provide efficient solutions. Examples of suggested “cost effective” technological advances include:

- *Working with telecommunications companies to instrument their already existing cables*
- *Deploying inexpensive water level sensors more frequently along coastlines, to validate both earthquake generated tsunamis and volcanic/landslide generated tsunamis*
- *Deploying GPS (GNSS) antennas in areas where crustal flexures can increase tsunami prediction accuracy; and*

Examples of suggested “expensive” technological advances include:

- *Use of tsunami radar or ocean observing systems for better tsunami validation*
- *Underwater DNA sampling devices for identification of algae species*

Access to information, data, and knowledge • Legislation and standardization: sharing and utilization of data • Transfer knowledge to the community • Developing sustainable observation systems with easy and timely access to data and information • Information transfer should be interactive (two way), and multidisciplinary.	Partnership and financing Partner with industry partners • *International licensing system for experts in marine disaster mitigation* • *Modelling of the effect of toxic algae on aquaculture* With policy and regulatory communities • *Build resilient communities and coastal infrastructure* • *Include tsunami resistant design in national building codes*
Communication and awareness • Connect users to the development and utilization of ocean prediction systems • Require licensing of hazard professionals to promote trust in the science (communications and regulatory) • Personalize risk information and strengthen the links between the science and society through education and outreach campaigns that incorporate science and traditional knowledge • Public campaign that indicates that some level of risk (1/1000 year event) cannot be avoided • Campaign to implement “Tsunami Ready” in all countries	

Working Group V: A Sustainably Harvested and Productive Ocean *ensuring the provision of food supply and alternative livelihoods*

The WG highlighted the unique characteristics of this region in both the oceanographic environment and global social-economic development. Achieving "a sustainably harvested and productive ocean" in this region is vital to humans' survival and prosperity not only for the region, but, more importantly, for the whole world.

To better reflect regional priorities, the WG therefore grouped GPM knowledge gaps and identified research priorities as presented in the tables below. WG also discussed ways to categorize/prioritize decadal activities, with two criteria: *Importance* (such as ecological, economic, food security, cultural, etc.), and *Feasibility* (such as scientific capability, scale, available data, political will, etc.). For more details about the WG discussions, please refer to the WG V Summary.

Knowledge gaps	Research priorities
Sustainable fishery	A primary goal is to reduce overfishing and realize sustainable use of marine ecosystem services. • Improve identification of ecosystem thresholds (maximum sustainable yield, tipping points, etc.); • Build capacity in ecosystem-based management; • Improve stock assessments, especially for data-limited species, shared across the region; • Improve monitoring of fishery removals, including on-vessel and remote monitoring; • Develop indicators of sustainability;
	Existing initiatives/programmes/partnerships
	WESTPAC, PICES-FUTURE, SEAFDEC, NPAFC, NPFC, WCPFC, CTICFF, etc. SPC, IMBeR, IUCN, WWF, Ocean Mega-science Center (CAS), ASEAN, APEC, Ecolabel (for traceability & sustainability)
Ecologically-friendly aquaculture	A primary goal is to provide food security through ecologically-friendly and sustainable aquaculture. • Define chemical & biological impacts, including introduced species • Establish guidelines: waste treatment, chemical substances, GMO & endemic species, monitoring and evaluation, food safety • Improve regional and biogeochemical modelling to assist aquaculture siting
	Existing initiatives/programmes/partnerships
	PICES, SEAFDEC, IUCN, SCOR-HABs, FAO, Ecolabel (for traceability & sustainability)
Climate change impact	Sustainability requires understanding impacts on fishery production, distribution, community structure, and catch, as well as on human societies. • Improved observations and data dissemination; • Improved coupled physical-biological modelling, including forecasts and projections; • Ecosystem impacts of extreme events; • Process studies on impacts of OA, deoxygenation
	Existing initiatives/programmes/partnerships
	IPCC, WESTPAC, SEAFDEC, PICES-FUTURE, S-CCME, FUTURE EARTH, NPAFC, FAO Friends of the Ocean, LMEs

Ecosystem structure and function	Effective management and maintenance of a sustainable ecosystem require improved understanding of trophic linkages and impacts of climate variability and change • Develop and share advanced technologies with standard methodologies to improve ecosystem monitoring; • Define ecotypes and monitor biodiversity & ecosystem structure; • Improve modelling to understand species interactions and food web structure, population dynamics of target fishery and keystone species
	Existing initiatives/programmes/partnerships
	PICES, IPBES, WESTPAC, IMBeR, NPAFC, NCEAS, OBIS, CTI-CFF, WWF, NGOs
Understanding the future of food production from the ocean	• Western Pacific: coastal/small scale, high per capita fish consumption and high dependence on fisheries for livelihoods, diet, nutrition, survival, food security cultural/subsistence/food security in SIDS; • Indigenous communities, subsistence fisheries, among others • North Pacific: important as an economic driver (e.g., Bering Sea)
	Existing initiatives/programmes/partnerships
	PICES special activities with RFMOs (e.g. IYS), MSEAS, SEAFDEC, GEF/UNEP on Refugia
Understanding social structures to enhance resilience of coastal communities and reduce vulnerabilities	Research priorities include resilience/vulnerability of communities, artisanal and/or industrial fisheries, gender, governance/political will, etc. • Social justice and equity issues to identify effective policies in light of future climate change (or other, e.g., increase multiuse of ocean resources). Understand relationship between people and resources. • Feasibility varies by community. Small scale diversity in social structure and social vulnerability. • Importance varies with social vulnerably of community: important to understand social structure for artisanal fishery/first nation communities but different for industrial fishing.
	Existing initiatives/programmes/partnerships
	PICES special projects, GEF/LMEs projects, PEMSEA, MSEAS(ICES/PICES), SEAFDEC
Understanding trade-offs between different uses of the ocean and its resources.	• Impacts of blue economy sector activities on fisheries, and vice-versa
	Existing initiatives/programmes/partnerships
	ORSP (WESTPAC), PEMSEA
Links between ocean health and human health	Existing and emerging issues affecting physical health (red tides, mercury, etc.), as well as psychological health (loss of way of life, loss of culture). Importance and feasibility are scale- and location-dependent. Refer to WG 1 and WG II results.
	Existing initiatives/programmes/partnerships
	SEAFDEC, WESTPAC, Minamata Convention on Mercury

Cross-cutting priorities	
<u>Capacity building and technology transfer</u> • To create citizen scientists, increase awareness of environmental change, participate in decision-making process, etc. • Using social media to reach more people	<u>Partnership and Financing</u> • Engage foundations, support multidisciplinary projects on social structures and trade-offs • Engage private industry to support work on

(provide internet access) • Increase science communicators (build scientists' capacity to communicate to the public) • Expand use of emerging technologies (low cost, low power, easy to maintain – to be used in remote areas) • Standardizing methods for technology transfer and interoperability, e.g., coastal habitat mapping and others • Training to empower women in the conduct and delivery of ocean science research and ocean science governance and diplomacy scientists (e.g. WMU partnership with Canada and Sasakawa Global Ocean Institute) • Training on regional and global models and use of climate forecasting products	trade-offs • Partnerships between developed and SIDS or LDCs and new financing mechanisms from private sector will be the key to realize sustainable blue-green growth. • Global/regional collaboration involving academia, researchers, policy makers and development partners
<u>Access to information, data, and knowledge</u> • Large amounts of freely available data already exist, e.g., Sentinel-2 and LANDSAT. Make the data findable and accessible. Understanding what the key barriers are to making data findable and accessible and what can be done to lower those barriers, would be useful • Statistical data on ocean related industries should become more readily accessible in the Decade to evaluate the status of blue growth. • Developing and using more social media and apps as tools for data access and raising awareness	<u>Communication and awareness</u> • Development and increased use of social media and apps, e.g., Eye on the Reef, International Coastal Clean-up Campaign • Advance citizen science programmes • Engagement with NGOs • Provide for communication amongst stakeholders

Recommendations for potential initiatives/programmes/partnerships

- New programmes must merge natural and social sciences to be useful (e.g., PICES-FUTURE)
- New initiatives should be community based, bottom-up, and locally focused (e.g., Sea Grant)
- Develop a Western Pacific initiative for ecologically-friendly aquaculture
- Develop an "XPRIZE" to address science needs of the region and to leverage private and public funding
- Enforcement initiative/collaboration between countries, particular on the high-seas
- Mechanisms for considering genetically modified species
- Tools and methods for biodiversity observation & data sharing
- Develop tools and methods for ecosystem structure observation/monitoring for marine ranching technology
- Marine ranching technology and its impact on marine ecosystems

In plenary, the concept of "Satoumi" was suggested as a way to promote the sustainable use of marine ecosystems, and complement the concurrent (top-down) development of legal and management systems. The concept of "Satoumi" is a coastal ecosystem management practice led by local communities including fishermen, the general public, teachers, and other stakeholders, to help develop the rule of best-use and conservation of marine ecosystems and seascape.

Working Group VI: A Transparent and Accessible Ocean *whereby all nations, stakeholders and citizens have access to ocean data and information, technologies and have the capacities to inform their decisions*

Over the course of the discussions, the group gradually broadened the scope of a transparent and accessible ocean, from an implied data focus, to the development of data products for stakeholders, and later to encompass an entire value chain from the translation of societal needs into ocean observing requirements, to the acquisition and archiving of ocean data, the scientific interpretation of data, and the delivery of ocean information and knowledge to societal stakeholders (See figure at left: *proposed ocean knowledge value chain for sustainable development*). For details about the WG discussions, please refer to the WG VI Summary.

Data – in addition to expanding the scope of data discussions to include open data and data products, the conveners invited participants to consider data system priorities for the region. Participants also considered opportunities to advance ocean knowledge for sustainability, in view of strengths within North Pacific organizations and the unique societal and oceanographic features of the region.

Capacity Building – the full ocean knowledge value chain concept emerged during the capacity building discussions, as participants concluded that capacity development for ocean sustainability requires investments and commitments across the spectrum from the translation of societal needs into ocean observing requirements through to the delivery of knowledge and information products to decision makers and other societal stakeholders.

Knowledge gaps/priorities
• The growing ocean data volume is a barrier to information transfer and there is a need to improve access to relevant ocean data • How to integrate data/information and convert it to useful data products, combine the data from existing ocean data portals, use the extensive satellite data, and utilize the large scale & local level ocean data. It is proposed to develop regional data centers, and build national & regional capacity for data processing, data analysis, and data & information management • Lack of ocean observations and monitoring in developing countries, particular in LDCs and SIDS, key regions, and on high seas, and • a need for standardized ocean health monitoring and reporting.
Scientific Opportunities
Unique regional features identified included an abundance of marginal seas, the ENSO cycle, the Indo-Pacific convergence[3], and the rapid industrialization of Asian coastal regions and resulting impacts on the marine environment

Existing initiatives/programmes/partnerships
UN Agencies
• **Intergovernmental Oceanographic Commission (IOC)** – *The IOC Oceanographic Data Exchange Policy adopted in 2003 (Resolution IOC-XXII-6) recognized the importance of the "timely, free and unrestricted international exchange of oceanographic data" for operational purposes and to advance scientific understanding, and the importance of enhancing the "capacity of developing countries to obtain and manage oceanographic data and information*".

[3] The Indo-Pacific convergence zone north of the Equator in the western Pacific is an area of convergence of atmospheric circulation, ocean circulation, tectonic convergence of three crustal plates that creates geographic complexity, and high marine biodiversity.

- **United Nations Environment (UNEP**) *–UN Environment works in three areas related to the production and collection of data needed for monitoring indicators and policy development: methodological development and data services, data use and visualization, and capacity building.*
- **UN Global Partnership for Oceans** – *This initiative under the SDG Partnerships Platform aims to "bring together and mobilize all oceans stakeholders around shared goals [and] tackle documented problems of overfishing, pollution, and habitat loss". A presentation on the Global Ocean Accounts Partnership highlighted an integration framework that can combine coastal habitat information with national data on income, waste generation and energy use related to tourism to support sustainable development of this sector of the blue economy.*
- **Biodiversity Beyond National Jurisdiction (BBNJ)** – *On-going negotiations at the UN related to the conservation and sustainable use of biodiversity in areas beyond national jurisdictions are aimed at adding an agreement to the United Nations Convention and the Law of the Sea. One of the goals of the current draft agreement is the establishment of a "clearing house" that would serve as an "open-access web-based platform" [Article 51] for data related to the collection and use of marine genetic resources in areas beyond national jurisdiction. Since a large portion of the North Pacific lies beyond national jurisdiction, this clearing house could become an important tool for benefit sharing from the sustainable use of the marine genetic resources of the region.*

International Cooperative Research Programmes in the North Pacific

- **Cooperative Study of the Kuroshio and Adjacent Regions (CSK)** – *This long-time cooperative study of the Kuroshio Current and East Marginal Seas operates under the auspices of the IOC Sub-Commission for the Western Pacific. A proposed extension of this programme (CSK-2) would provide basic ocean data and support the study of the influence of the Kuroshio current on climate and pollution.*
- **North Pacific Ocean Circulation of Climate Experiment (NPOCE)**– *This cooperative research programme, endorsed by CLIVAR, coordinates research "designed to observe, simulate, and understand the dynamics of the NWP (Northwestern Pacific) ocean circulation and its role in low-frequency modulations of regional and global climate." A second decade of activity is currently being considered.*
- **Partnership in Environmental Management of the Seas of East Asia (PEMSEA)** – *This programme, which has been operating for over two decades, aims to "foster and sustain healthy and resilient coasts and oceans, communities and economies across the Seas of East Asia through integrated management solutions and partnerships." Recent activities include a 2015 report that offered a practical Blue Economy framework for business.*

Operational data

Several programmes in the region generate and freely share operationally oceanographic data and data products including forecasts. These include:

- **WESTPAC/SEA-GOOS** (South East Asian GOOS) - *generates data products such as its ocean forecasting system*
- **WESTPAC/NEARGOOS** (North East Asian Regional GOOS)-*real time and delayed mode databases*
- **Japan Coast Guard** - *a maritime domain awareness initiative for the Japanese area, data products available*
- **ODIN-WESTPAC** Ocean Data Information Network
- **Chinese Academy of Sciences, Center of Ocean Megascience** – *releasing compilations of available global oceanographic data. Recent*

Access to ocean biological data

There is a need for increasingly complex ocean biological data to support the sustainable use of ocean resources. This present tremendous challenges for data archiving and timely dissemination. Discussions identified several international collaborative programs that are addressing this challenge:

- **Marine Biodiversity Observation Network (MBON)** – *a growing global initiative brings together regional networks of scientists, resource managers, and end-users working. MBON aims to "integrate data from existing long-term programs to improve our understanding of changes and connections between marine biodiversity and ecosystem functions".*
- **Ocean Biogeographic Information System (OBIS)** – *a global collaboration that provides free and open access to information on the geographic distribution of marine life. OBIS is evolving to accept new forms of biological data such as* imagery.

releases include global ocean temperature and salinity gridded products dating back to the mid of the 20th century • **JAMSTEC 4D Earth Simulator** - working to develop more comprehensive data products	• **Global Omics Observatory Network (GLOMICON)** – *This ocean-focused initiative's mission statement is to federate omically enabled observatories and create an integrated, global system of multi-omic monitoring to enhance our capacity to understand, investigate, and monitor the biosphere.*

Capacity Building

Capacity building is required across the entire spectrum of ocean information activities. Many agencies were involved in capacity building at different points, thus it was difficult to determine which agencies were contributing to which level(s) of capacity development, and in which countries.

Important capacity building activities identified were the Ocean Teacher Global Academy programme that is delivered in the North Pacific by Malaysia, and the WESTPAC initiated Regional Network of Training and Research Centers (RTRCs) on Marine Sciences. Future investments in capacity building would benefit from an overall assessment of current activities in the region.

Recommendations for potential initiatives/programmes/partnerships

Based on discussions of data system and knowledge gaps and capacity building needs, WG VI recommends that the IOC and regional actors in the region:

- *Begin exploring pragmatic ways to implement the IOC Oceanographic Data Exchange Policy that will lead toward greater data sharing*
- *Develop some powerful examples of the benefits of open data sharing (and perhaps negative consequences of not making data open) that can be used to convince governments and other data holders to share more ocean data.*
- *Work with partners to accelerate efforts to bring the complete spectrum of biological data into ocean data systems*
- *Consider mechanisms for aggregating data from BBNJ areas.*
- *Aid large Decade projects by providing internationally supported data technicians that can foster easy submission processes*
- *Begin working with other UN bodies to determine how to connect ocean science data with other types of data necessary for these studies and assessments*
- *Develop mechanisms and outreach to use ODIS to enhance participation and use of data systems*
- *Develop capacity-building activities to accelerate the development of national ocean data systems*
- *Begin ocean science capacity building for the Decade by undertaking national capacity assessments (people and technology) across the full spectrum of ocean information and ocean knowledge activities*
- *Undertake a national capacity assessment demonstration project in a single nation*
- *Develop a clearing house for capacity building activities to help match capacity building with specific needs, and identify gaps.*

6. Way Forward

The Regional Planning Workshop in Tokyo reached agreement among ocean stakeholders in the North Pacific and Western Pacific Marginal Seas about what should be collectively achieved through the UN Decade of the Ocean. The overwhelming interests in this regional planning workshop and heated discussions throughout the event reflected a high level of enthusiasm of ocean stakeholders for the Decade and a high expectation on advancing ocean knowledge for sustainable development. Commitments were made by several

institutions, countries and international organizations to contributing to the identified initiatives and programmes.

The three-day workshop culminated in a catalog of knowledge gaps and scientific priorities/questions that need to be addressed in the region, as well as a list of concrete recommendations for actions, potential activities, programmes and partnerships in support of the Decade. The generated outputs will inform the preparation phase of the Decade and the development of the implementation plan. To follow up on the recommendations, identified activities, programmes, and topic workshops need further development with lead institutions and ocean stakeholders at the appropriate stage.

Engagement at the national level, and even the local level, is critical to the success of the Decade. Currently the awareness about the Decade remains limited at the national level. Enhanced efforts will be made at the United Nations level to raise the awareness of national leaders and/or high-level governmental officials about the Decade. Meanwhile, participants, their institutions and organizations are encouraged to engage their ocean stakeholders at the national level in the Decade, identifying and assessing their national needs, potential commitments, financing and partnerships.

Annex I: Acronyms and Abbreviations

AIKEC	Air-Sea Interaction in the Kuroshio Extension and its Climate Impact
ASEAN	Association of Southeast Asian Nations
APEC	Asia-Pacific Economic Cooperation
BBNJ	Biological Diversity beyond National Jurisdiction
CAS	Chinese Academy of Sciences
CBD	Convention on Biological Diversity
CEC	Commission for Environmental Cooperation
CGMT	Criteria and Guidelines on the Transfer of Marine Technology
CLIOTOP	Climate Impacts on Oceanic TOp Predators (IMBeR)
CLIVAR	Climate Variability and Predictability
CMIP6	Coupled Model Intercomparison Project Phase 6
COP	Conference of the Parties of the UN Framework Convention on Climate Change
CSK	Cooperative Study of the Kuroshio and Adjacent Regions
CTI-CFF	Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security
DFO	Fisheries and Oceans Canada
DRMREEF	DNA Taxonomy and Recruitment Monitoring of the Coral Reef Marine Organisms (WESTPAC)
EASTHAB	Harmful Algal Bloom Research Group for East Asia
EC	European Commission
EEZ	Exclusive Economic Zone
EML	Ecological Metadata Language
ENSO	El Niño-Southern Oscillation
EOVs	Essential Ocean Variables
EPG	Executive Planning Group
ESA	European Space Agency
ESSAS	Ecosystem Studies of Subarctic and Arctic Seas Search
FAO	Food and Agriculture Organization of the United Nations
GCRMN	Global Coral Reef Monitoring Network
GEF	Global Environment Facility
GEOHAB Asia	Global Ecology and Oceanography of Harmful Algal Blooms in Asia
GHG	Greenhouse Gas
GLOMICON	Global Omics Observatory Network
GMO	Genetically Modified Organism
GNSS	Global Navigation Satellite System
GO2NE	Global Ocean Oxygen Network
GOA-ON	Global Ocean Acidification Observing Network
GOBI	Global Ocean Biodiversity Initiative
GOOS	Global Ocean Observing System
GPM	Global Planning Meeting of the UN Decade of Ocean Science for Sustainable Development
GPS	Global Positioning System
HAB	Harmful Algal Bloom
ICES	International Council for the Exploration of the Sea
ICGs	Intergovernmental Coordination Groups
ICOM	International Council of Museums

ICP	UN Informal Consultative Process (ICP) on Ocean Affairs and Law of the Sea
ICZM	Integrated Coastal Zone Management
IGO	Intergovernmental Organization
IMBeR	Integrated Marine Biosphere Research project
IMDOS	International Marine Debris Observation Network
Ina PRIMA	Indonesia Program Initiative on Maritime Observation and Analysis
IndiSeas	Indicators for the Seas
IOC	Intergovernmental Oceanographic Commission
IODE	International Oceanographic Data and Information Exchange
IATTC	Inter-American Tropical Tuna Commission
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IPCC	Intergovernmental Panel on Climate Change
ISA	International Seabed Authority
ISC	International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean
ISSHA	International Society for the Study of Harmful Algae
IUCN	International Union for Conservation of Nature
JAMSTEC	Japan Agency for Marine-Earth Science and Technology
JICA	Japan International Cooperation Agency
JMA	Japan Meteorological Agency
KIOST	Korea Institute of Ocean Science and Technology
LDCs	Least Developed Countries
LMEs	Large Marine Ecosystems
MBON	Marine Biodiversity Observation Network
MEXT	Ministry of Education, Culture, Sports, Science and Technology of Japan
MHEWS	Multi-Hazard Early Warning Systems
MPAs	Marine Protected Areas
MSEAS	Marine Social-Ecological Systems (ICES)
MSP	Marine Spatial Planning
NCEAS	U.S. National Center for Ecological Analysis and Synthesis
NGOs	Non-Governmental Organizations
NMHS	National Meteorological and Hydrological Services
NOAA	U.S. National Oceanic and Atmospheric Administration
NOWPAP	Northwest Pacific Action Plan
NPAFC	North Pacific Anadromous Fish Commission
NPFC	North Pacific Fisheries Commission
NPOCE	North Pacific Ocean Circulation of Climate Experiment
NPRB	North Pacific Research Board
OBIS	Ocean Biogeographic Information System
ODIS	Ocean Data and Information System
ORSP	Ocean Remote Sensing Programme
PACON	Pacific Congress on Marine Science and Technology
PAHs	Polycyclic Aromatic Hydrocarbons
PEMSEA	Partnerships in Environmental Management for the Seas of East Asia
PICES	North Pacific Marine Science Organization
POGO	Partnership for Observations of the Global Ocean

POPs	Persistent Organic Pollutants
RFMOs	Regional Fisheries Management Organizations
RPW	Regional Planning Workshop
RTRC	Regional Network of Training and Research Centers on Marine Sciences
SCOR	Scientific Committee on Oceanic Research
SDGs	Sustainable Development Goals
SEAFDEC	The Southeast Asian Fisheries Development Center
SGD	Submarine Groundwater Discharge
SIDS	Small Island Developing States
SIMSEA	Sustainability Initiative in the Marginal Seas of South and East Asia
SOLAS	International Convention for the Safety of Life at Sea
SPC	The Pacific Community
SPREP	Secretariat of the Pacific Regional Environment Programme
TPOS	Tropical Pacific Observing System
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific, and Cultural Organization
UNGA	The United Nations General Assembly
WCPFC	The Western and Central Pacific Fisheries Commission
WESTPAC	IOC Sub-Commission for the Western Pacific
WHOI	Woods Hole Oceanographic Institution
WMO	World Meteorological Organization
WWF	World Wildlife Fund

The Decade Regional Planning Workshop for the North Pacific and Western Pacific Marginal Seas is organized by

Supported by

In partnership with

IOC Sub-Commission for the Western Pacific (WESTPAC)
Intergovernmental Oceanographic Commission (IOC) of UNESCO
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