



Biodiversity Conservation, Ecosystem and Human Health and Blue Economy

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Vice Chair, IOC Westpac; Universiti Sains Malaysia



Fourteenth Intergovernmental Session of the IOC Sub-Commission for the Western Pacific
4-7 April 2023, Jakarta, Indonesia



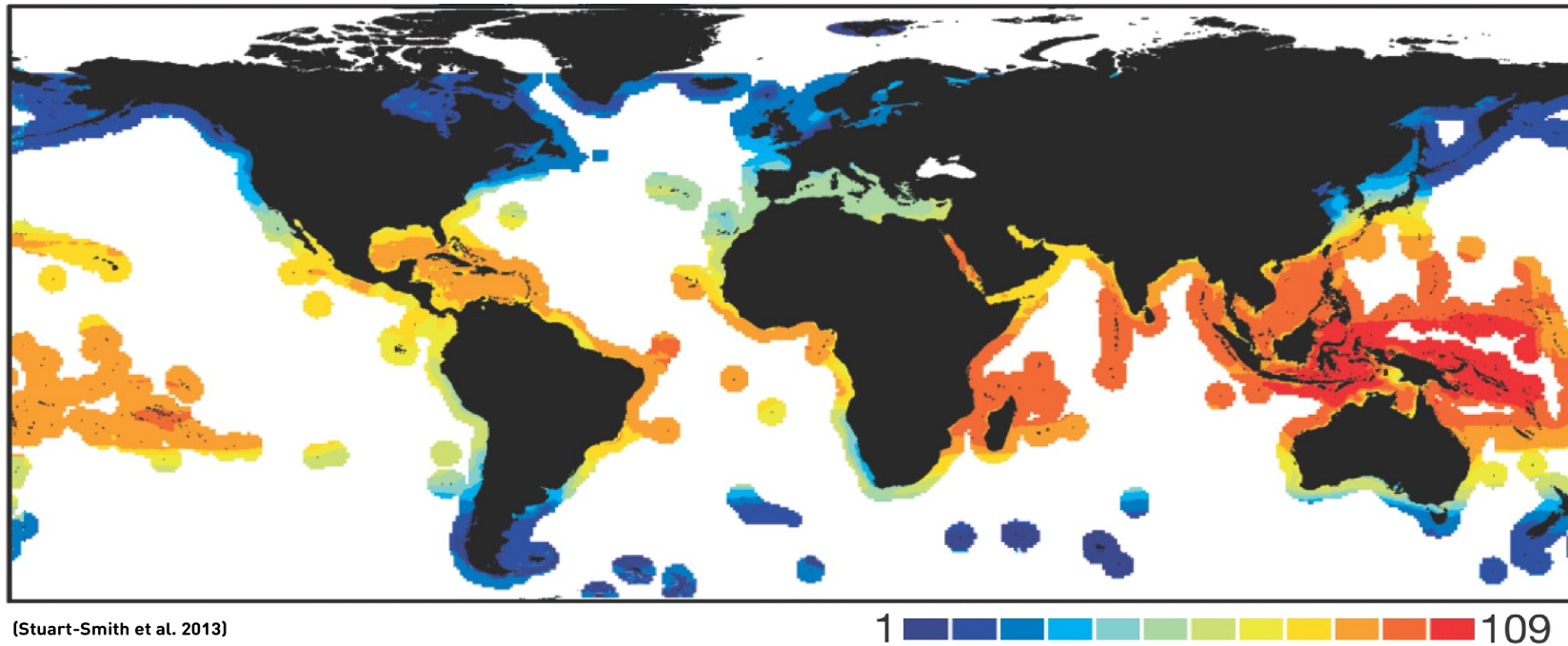
Presentation outline



- **Biodiversity conservation, ecosystem and human health, and Blue Economy**
- Why is biodiversity conservation **important?**
- **Our effort** in addressing marine biodiversity conservation, ecosystem, human health and blue economy
- A summary of **key achievements**
- **Key activities** since the last Session (April 2021)
- **Problems encountered and recommendation** for future development
- **Planned activities** for May 2023- April 2025

Richness of Species Diversity for Fishes

a Species density



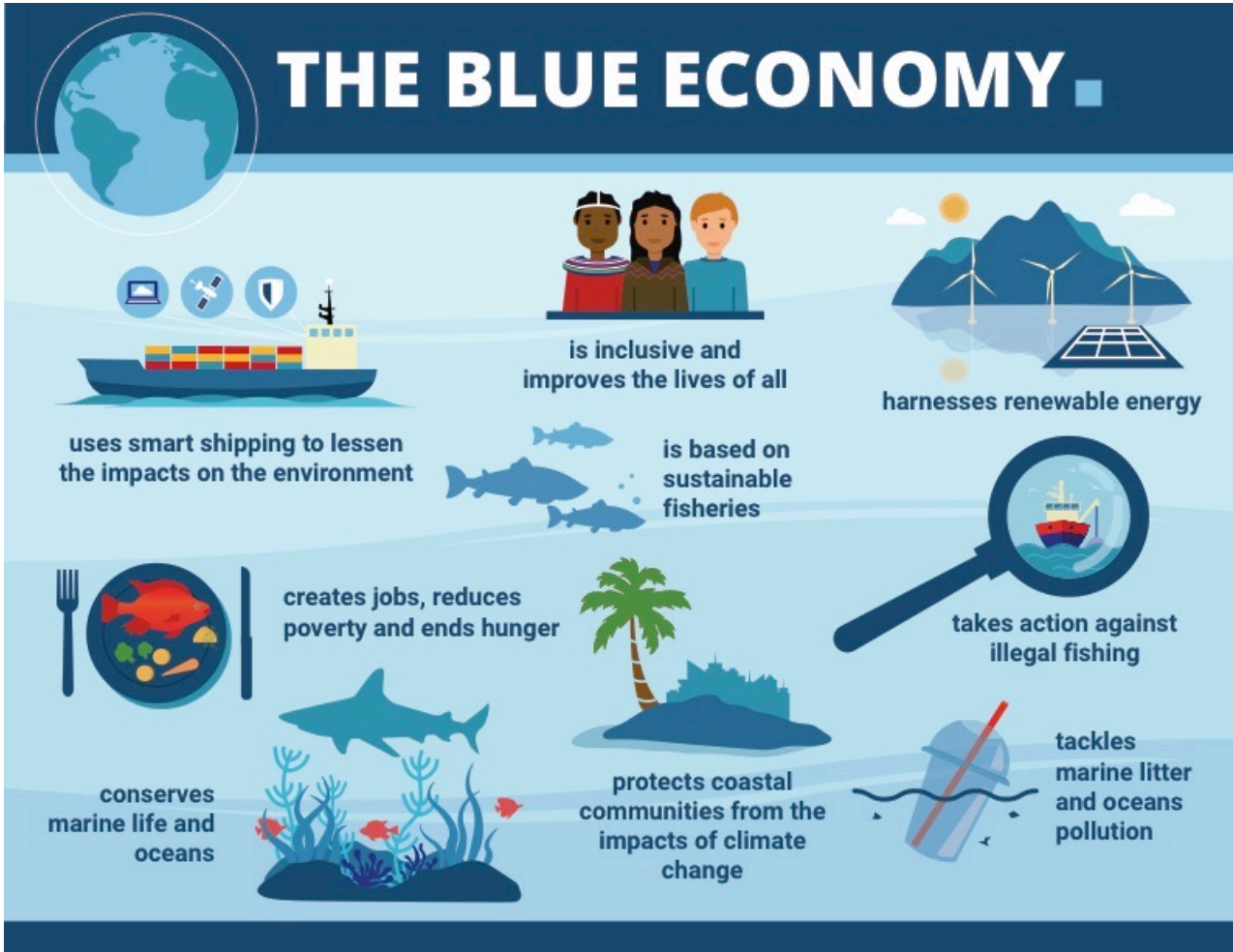
Protein Source, Food security



Cultural Value & Heritage

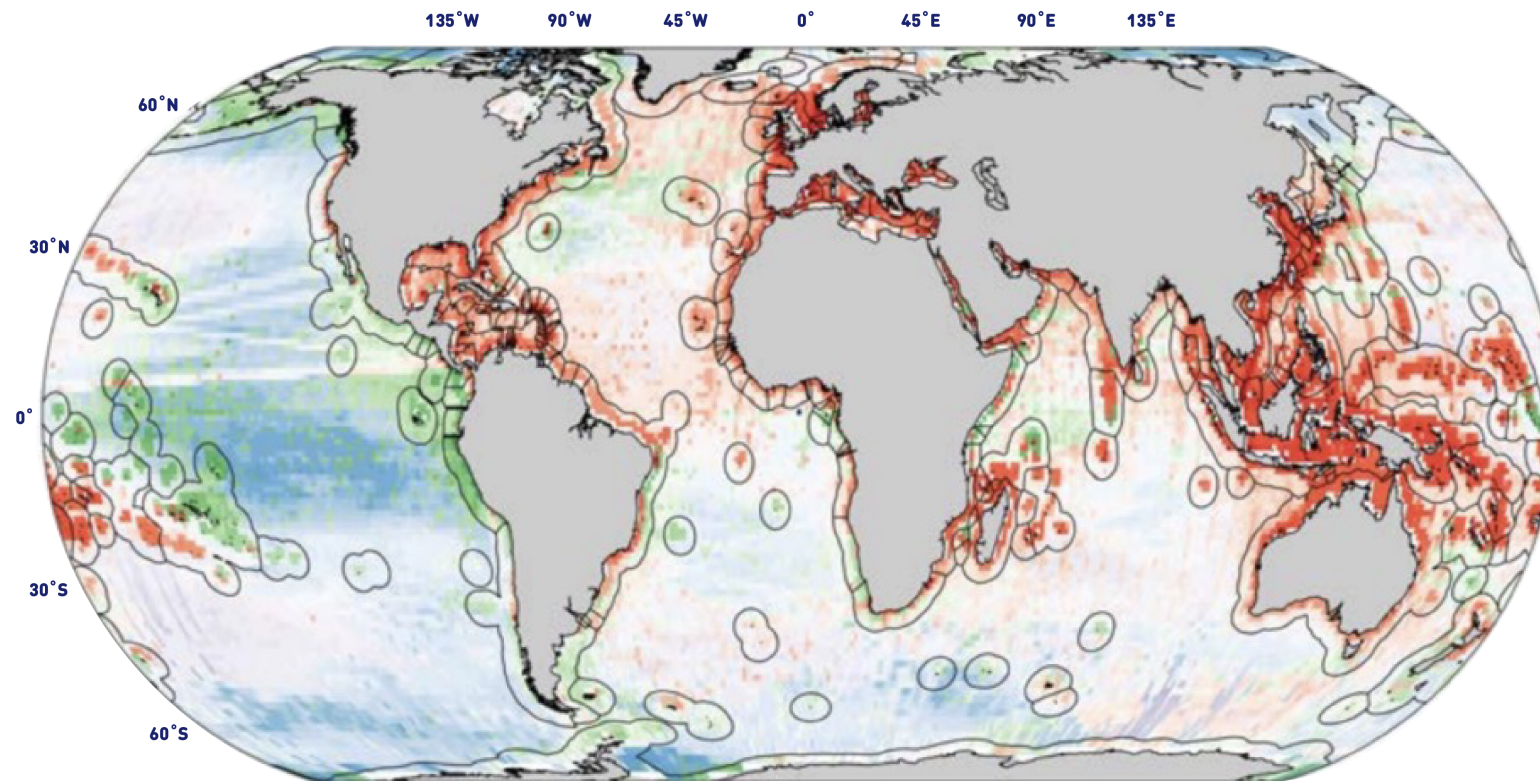
- Our forebears are great seafarers with life neatly intertwined with the sea
- Lost of biodiversity constitute lost of cultural heritage & our historical diversity





Lee et al., 2020
(Environment International)

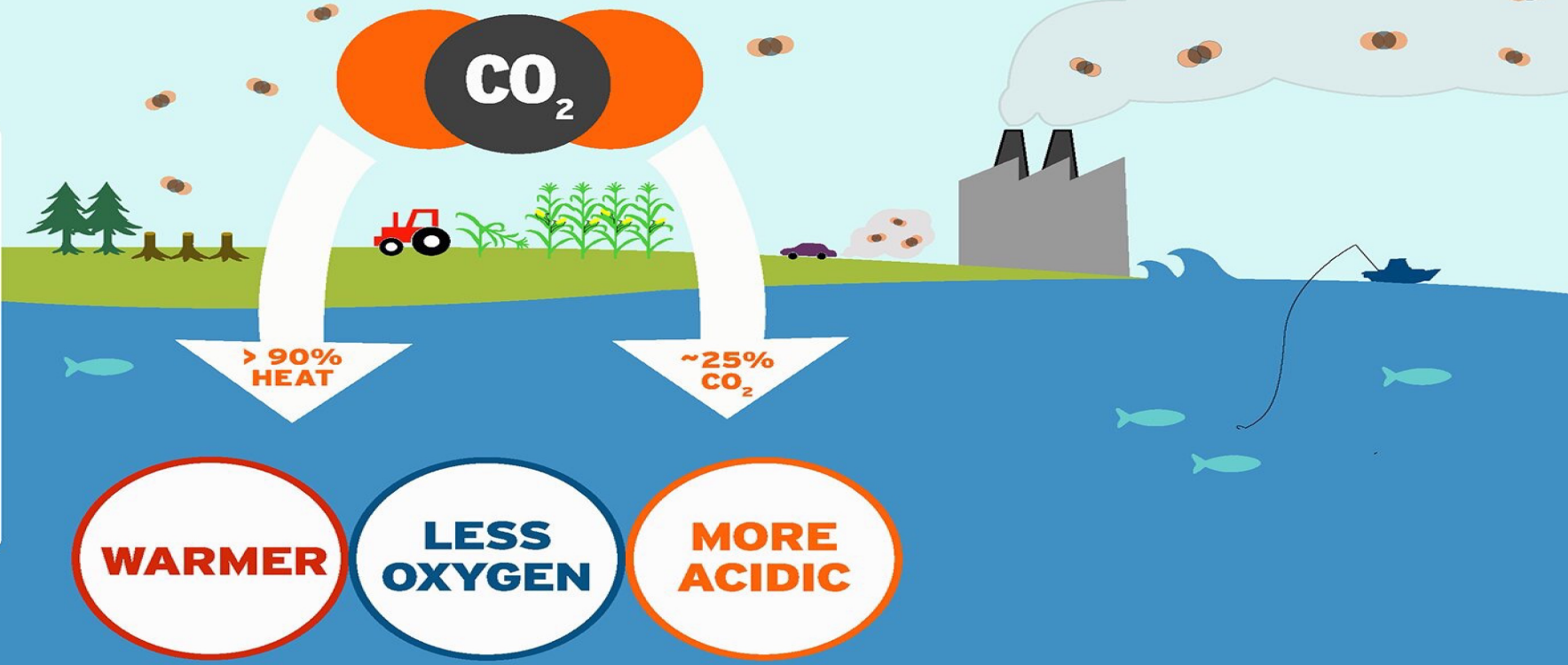
Marine Biodiversity in Relation to Human Impacts





Rogers et al., 2020

~~Future threats:~~ Warmer, Breathless, and Acidic


Burning fossil fuels, deforestation and industrial agriculture release carbon dioxide (CO₂) and other heat-trapping gases into our atmosphere, causing our planet to warm. The ocean has buffered us from the worst impacts of climate change by absorbing more than 90 percent of this excess heat and about 25 percent of the CO₂, but at the cost of causing significant harm to marine ecosystems.





SEA LEVEL
Sea level rise is accelerating, flooding coastal communities and drowning wetland habitats.


BLEACHING
Warm-water coral reefs (marine biodiversity hotspots) could be lost if the planet warms by 2°C (3.6°F).


TOXIC ALGAE
Larger and more frequent blooms are making fish, birds, marine mammals and people sick.

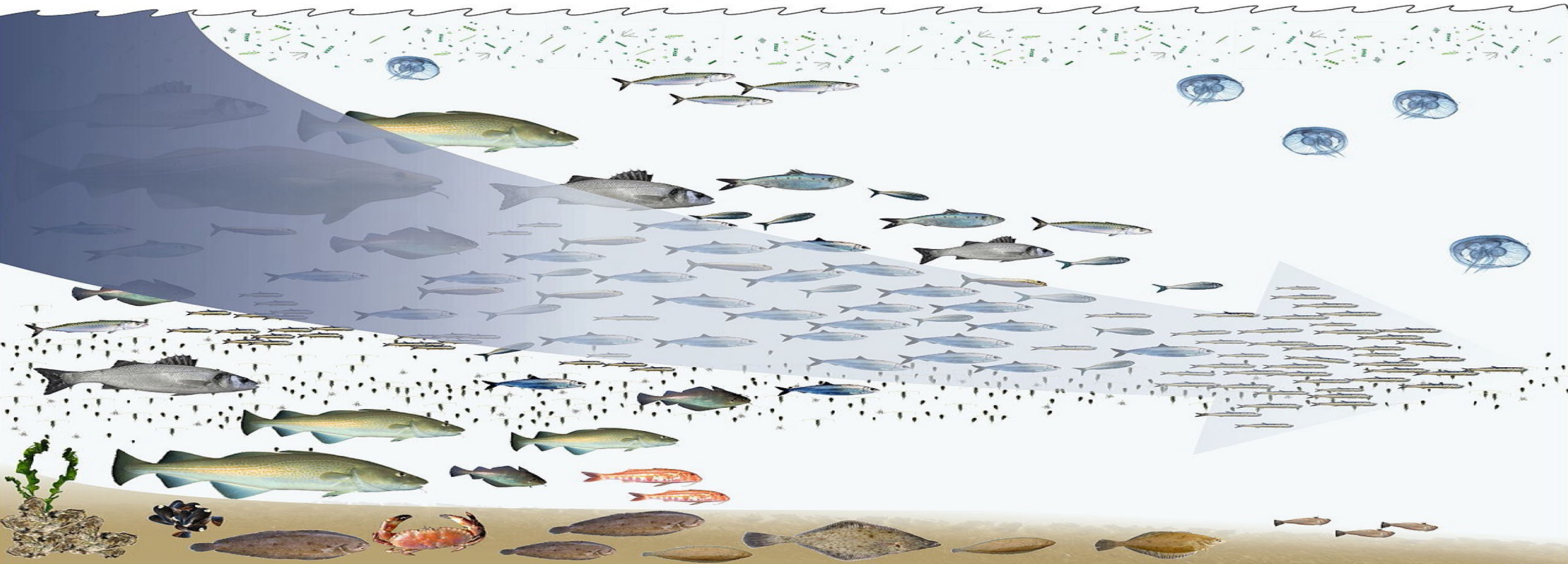

HABITATS
Lower oxygen levels are suffocating some marine animals and shrinking their habitats.


ACIDIFICATION
More acidic water harms animals that build shells, such as corals, clams, and oysters.


FISHERIES
Disruptions in fisheries affect the marine food web, local livelihoods, and global food security.



Future threats: Emptying of our Ocean



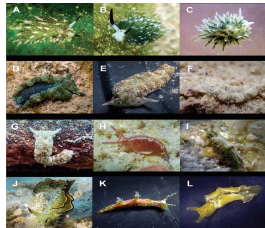
Projects supported by IOC-WESTPAC

Issue-based Solution-Oriented Projects



Coral Reef Resilience to Climate Change and Human Impacts

Thamasak Yeemin
Marine Biodiversity Research Group,
Ramkhamhaeng University, Bangkok, Thailand



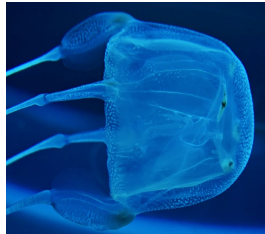
Coral Reef Restoration

Suchana Chavanich
Department of Marine and Coastal Resources
(Thailand) and Chulalongkorn University



Harmful Algal Blooms

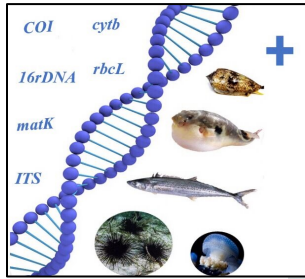
Kazumi Wakita & Po Teen Lim
Centre For Marine & Coastal Studies,
Universiti Sains Malaysia, Malaysia



Harmful Jellyfish Research in the Western Pacific and Adjacent Seas

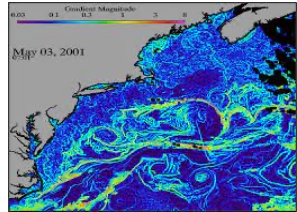
Aileen Tan Shau Hwai
Centre For Marine & Coastal Studies,
Universiti Sains Malaysia, Malaysia

Projects



Enhance the Capacity for Species Identification and Genetic Analysis on Marine Organisms in the Coral Reef Ecosystems in the Western Pacific -3rd Phase (DRMREEF-III)

Youn-Ho LEE
Korea Institute of Ocean Science and Technology(KIOST)



WESTPAC Ocean Remote Sensing Project for Coastal Habitat Mapping

Teruhisa KOMTSU
Japan Fisheries Resource Conservation Association



Distribution, Source, Fate and Impacts of Marine Microplastics in the WESTPAC (Asia Pacific Region)

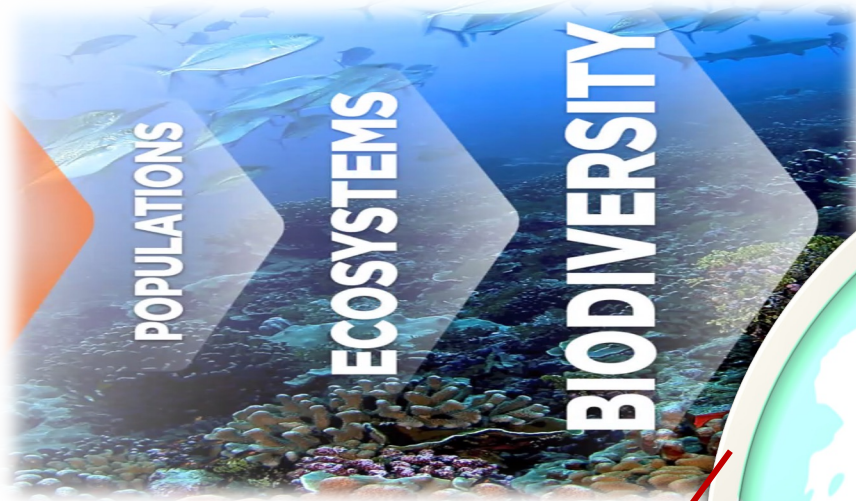
Daoji LI
East China Normal University

SEAFOOD SAFETY



Marine Toxins and Seafood Safety (IOC-WESTPAC-TMSS)

Dao Viet Ha
Institute of Oceanography, Vietnam



Distribution, Source, Fate and Impacts of Marine Microplastics in the WESTPAC (Asia Pacific Region)

Coral Reef Resilience to Climate Change and Human Impacts

Coral Reef Restoration

Enhance the Capacity for Species Identification and Genetic Analysis on Marine Organisms in the Coral Reef Ecosystems in the Western Pacific - 3rd Phase (DRMREEF-III)

Harmful Algal Blooms

Marine Toxins and Seafood Safety (IOC-WESTPAC-TMSS)

Harmful Jellyfish Research in the Western Pacific and Adjacent Seas

WESTPAC Ocean Remote Sensing Project for Coastal Habitat Mapping

WESTPAC-XIV, 4-7 April 2023, Jakarta, Indonesia

KEY ACHIEVEMENTS



Establishment & Strengthening of the WESTPAC Network

Capacity Development especially for young scientists

Standardization of research methodology

Trans-boundary research & Collaboration





KEY ACHIEVEMENTS – Joint Publications

BOOKS



BRIN
BADAN RISET
DAN INOVASI NASIONAL

WESTPAC-XIV, 4-7 April 2023, Jakarta, Indonesia

KEY ACHIEVEMENTS – *Multi-disciplinary involvement*

By Marine Biologists

FIELD GUIDE to the JELLYFISH of WESTERN PACIFIC

EDITORS: Aileen Tan Shau Hweil, Sim Yee Kwang, Hiroshi Mijake
 AUTHORS: B. A. Venkatesh Meran, Chandra Aungmye, Chuan Chee Hee, Hiroshi Mijake, Ifrah Ishaq, Isara Arinratt, Kritikan D. Karunaratne, Libertine Aquila F. Denzing, M. D. S. T. de Cruz, Muhammad Rizman-kid, Nithyasa Nilamara, Prutint Rungsang, Sim Yee Kwang, S.M. Ghaffaruzaman, Widiastuti, Yean Das

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Physiogeographical Characteristics	
Essentials (04)	
Shape	Bell-shaped but with a flat apex
Colour	Transparent
Surface texture	Smooth but subumbrella surface with 2 circular yellow protuberances
Pattern mark	Down to black spots forming a band near bell edge, scattered on other areas of the bell
Bell top	Flat
Bell edge	With 16 sharply oval marginal lobes and 8 rhopalia
Presence of bell edge marginal tentacles	With 16 very short tentacles
Bell section	Oral Arms & Tentacles
Number of tentacles	8
Layer of tentacles	Single layer projecting on bell edge in between oral-auricular lappet
Shape of tentacles	Very short and simple
Colour of tentacles (stalk) (lipet)	White
Presence of appendages on tentacles	No appendages on tentacles

General Management Guide for Harmful Jellyfish Stings in the Western Pacific and Adjacent Areas

EDITORS: Aileen Tan Shau Hweil, Hiroshi Mijake, Kritikan D. Karunaratne, Muhammad Rizman-kid, Nithyasa Nilamara, Prutint Rungsang, Sim Yee Kwang, S.M. Ghaffaruzaman, Widiastuti, Yean Das

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GENERAL MANAGEMENT GUIDE FOR HARMFUL JELLYFISH STINGS IN THE WESTERN PACIFIC AND ADJACENT AREAS

Case D-3

An 8-year-old boy was stung by a jellyfish at Pantai Bersih, Kepala Batas, Penang. The patient had swelling and redness over the right forearm associated with local pain with a pain score of 2/10. He also had abdominal pain 30 minutes post sting, bilateral lower limb weakness but was able to walk with a normal gait. There were superficial lesions and erythematous, non-circumferential marks on the forearm with mild tenderness and swelling. He was discharged 2 days later.

Image courtesy of RECS ASEAN.



By Medical Scientists, with Marine Biologists

CO-DESIGN AND CO-PRODUCE SOLUTIONS

Stop the sting

Box jellyfish stings can cause cardiac and respiratory arrest, aside from excruciating pain. There will be many large red welts on the body where the tentacles struck.

Here are steps a victim should take after a jellyfish attack.

- 1 Get out of the water immediately.
- 2 Don't scrape the tentacles off with hands or wet sand as this can cause the stinging cells to release more venom into the body.
- 3 Pour vinegar on the affected area for 30 seconds to stop the stinging cells from releasing the venom.
- 4 Remove the tentacles from your body using a towel or a tweezer.
- 5 Get medical help as soon as possible.

@The Star Graphics

WESTPAC-XIV, 4-7 April 2023, Jakarta, Indonesia

OUTREACH PROGRAMS

Science to Policy makers Science to the Public

Involvement of policy makers and industry partners

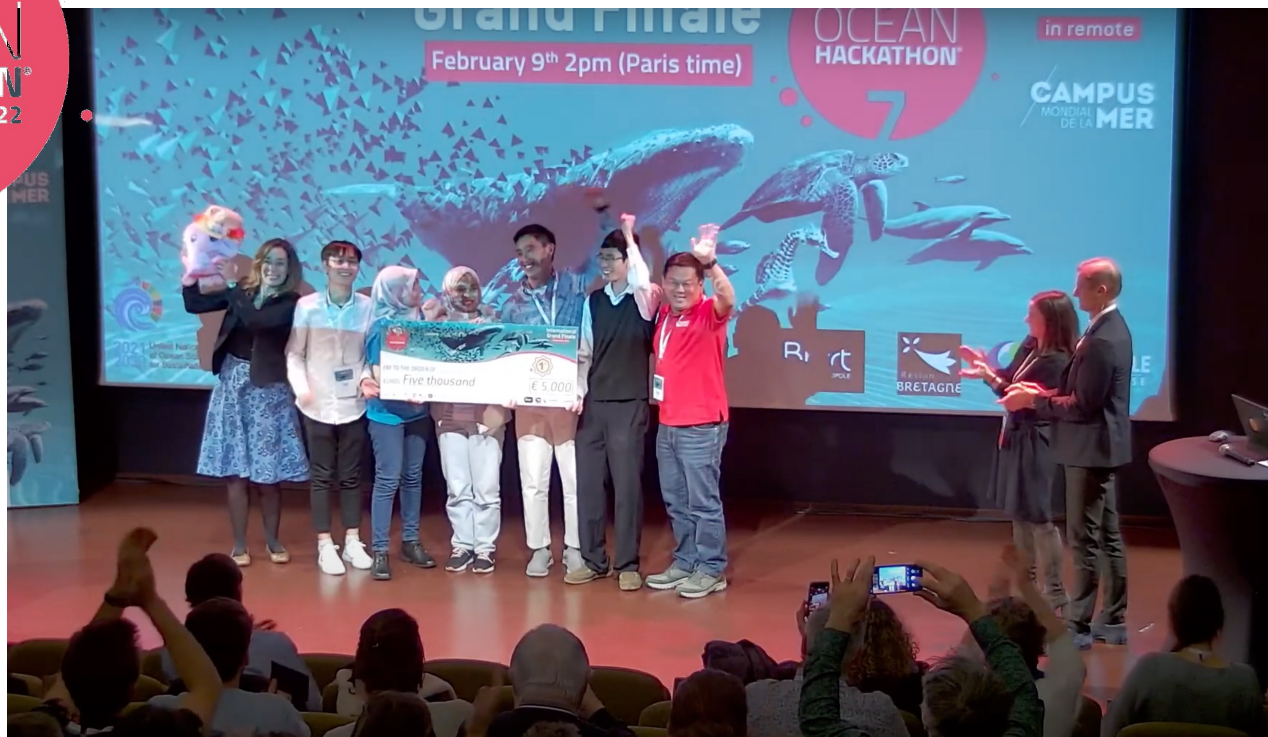


KEY ACHIEVEMENTS

*Solution-Oriented Science and
Science into Action*



*Winning the OCEAN HACKATHON® 2022
using data generated from long term monitoring*



Winner of **Ocean Hackathon® 2022** at Kuala Lumpur, Malaysia (National Level) and Brest, France (International level). It is a 48-hour non-stop event during which teams develop a prototype to tackle a challenge. This event was organized by the Embassy of France. The jellyfish team proposed a challenge to develop the first prediction model for the jellyfish distribution and appearance in Penang Island, Malaysia, a mobile application called **Jelly Go.**



JELLY GO!



SCAN ME

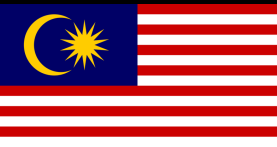


Main Features of Our JELLY GO!

- **Prediction for Monthly Jellyfish Abundance**
(Ind./m³ → No. of Jellyfish in 1 Olympic-sized Swimming Pool)
- **Emergency Action Plan for Medical Teams, Front Liner & Public**
- **Citizen Science & Information**

Remarks:

2.000 x10⁻³ Ind./m³ = 20 jellyfish/10 million liters
or 20 jellyfish in 10ML sea water (ML = million liter or Megaliter)
or 20 jellyfish in 4 Olympic-sized swimming pool
or 5 jellyfish in 1 Olympic-sized swimming pool
(Olympic-sized swimming pool measuring 50m long & 25 m wide contains 2.5ML or 2.5 million liters of water)



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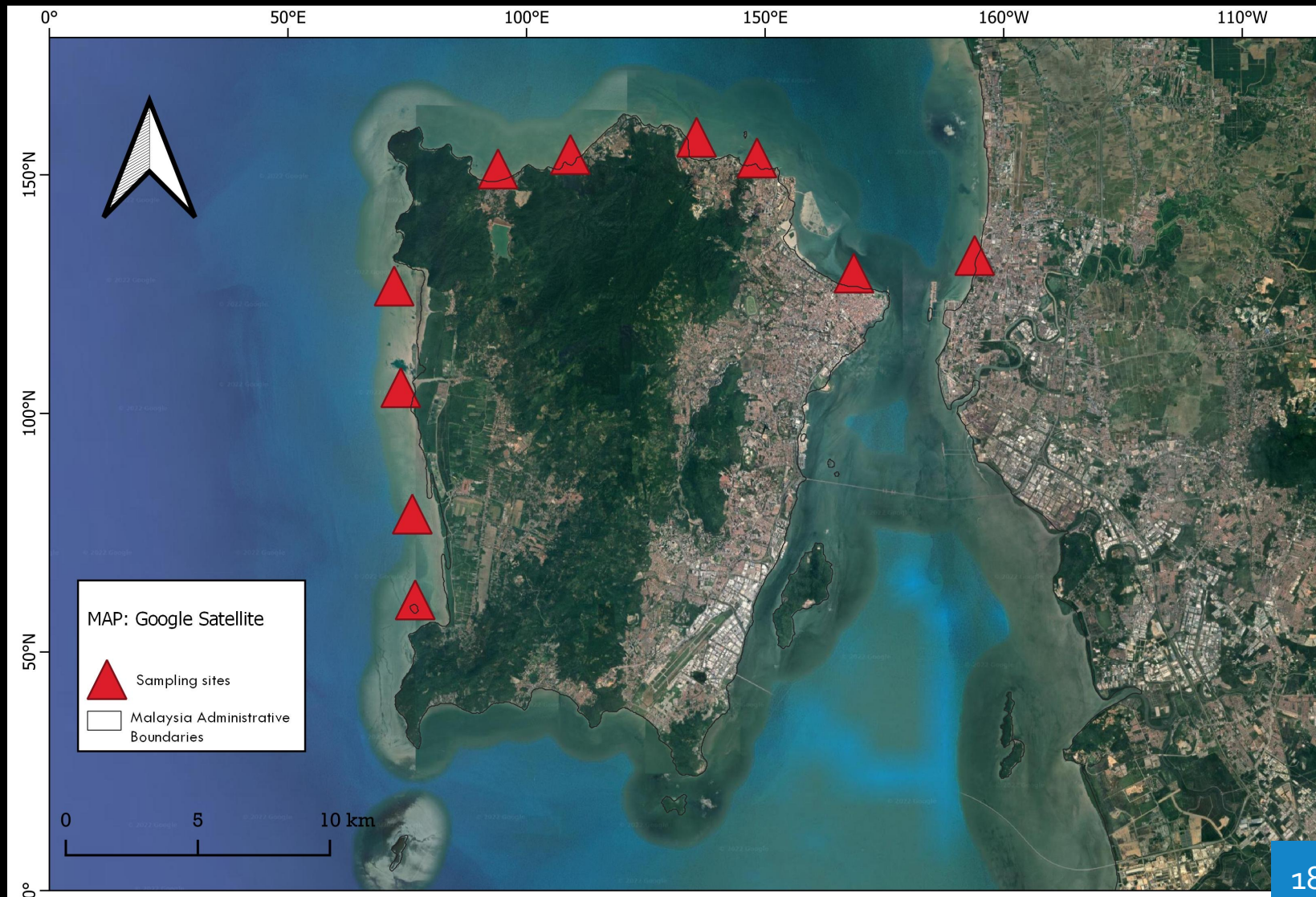
JELLY GO!



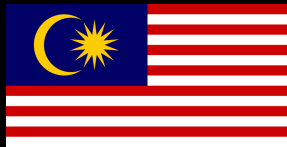
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Prediction for Monthly Jellyfish Abundance



Data Source: Monthly Sampling for Environmental Parameters (*in-situ*) and Jellyfish Abundance (Ind. $\times 10^{-3}/m^3$)



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JELLY GO!

Prediction for Monthly Jellyfish Abundance (2)

```

57 #combine with new actual data---
58 newForecast <- tibble( #create new dataframe for 4 new months
59   Month = seq(from = as.Date("2022-08-01"), to = as.Date("2022-11-01"), by = "month")) %>%
60   cbind(newAbundance) #combine with Forecast values
61
62 #read actual data and average by month
63 actual <- read_csv("extra4Months.csv", col_types = cols(Month = col_date(format = "%d/%m/%y"))) %>%
64   dplyr::select(Month, Abundance) %>%
65   group_by(Month) %>%
66   summarise(across(everything(), mean), .groups = "drop") #find mean for each variable by month
67
68 #merge actual and forecast
69 comparison <- actual %>%
70   left_join(newForecast) %>%
71   rename(actualAbundance = Abundance,
72          predictedAbundance = newAbundance)
73
74 #plotting actual and predicted
75 ggplot() +
76   geom_line(df, mapping = aes(x = Month, y = Abundance, color = "gray", size = 2)) +
77   geom_point(df, mapping = aes(x = Month, y = Abundance, color = "gray", size = 5)) +
78   # aesthetic performance of model
79
80 Console Terminal Jobs
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```

● Vector Autoregression Model on R

```

35 VARselect(dfTime,
36           lag.max = 1,
37           season = 12 #monthly
38           )
39
40 #create a VAR model---
41 var.a <- VAR(dfTime,
42             season = 12,
43             lag.max = 1,
44             ic = "AIC"
45             )
46 #summary(var.a)
47
48 #forecast, plot and extract forecasted values---
49 fcast <- predict(var.a, n.ahead = 4) #forecast 4 months in the future
50 par(mar = c(2.5, 2.5, 2.5, 2.5)) #multiple graphs in a single plot
51 plot(fcast) #plot forecast for all variables
52
53 #extract forecast values
54 new <- fcast[["Fcast"]][["Abundance"]]
55 newAbundance <- new[,1]
56

```

● Multivariate Time Series Forecasting

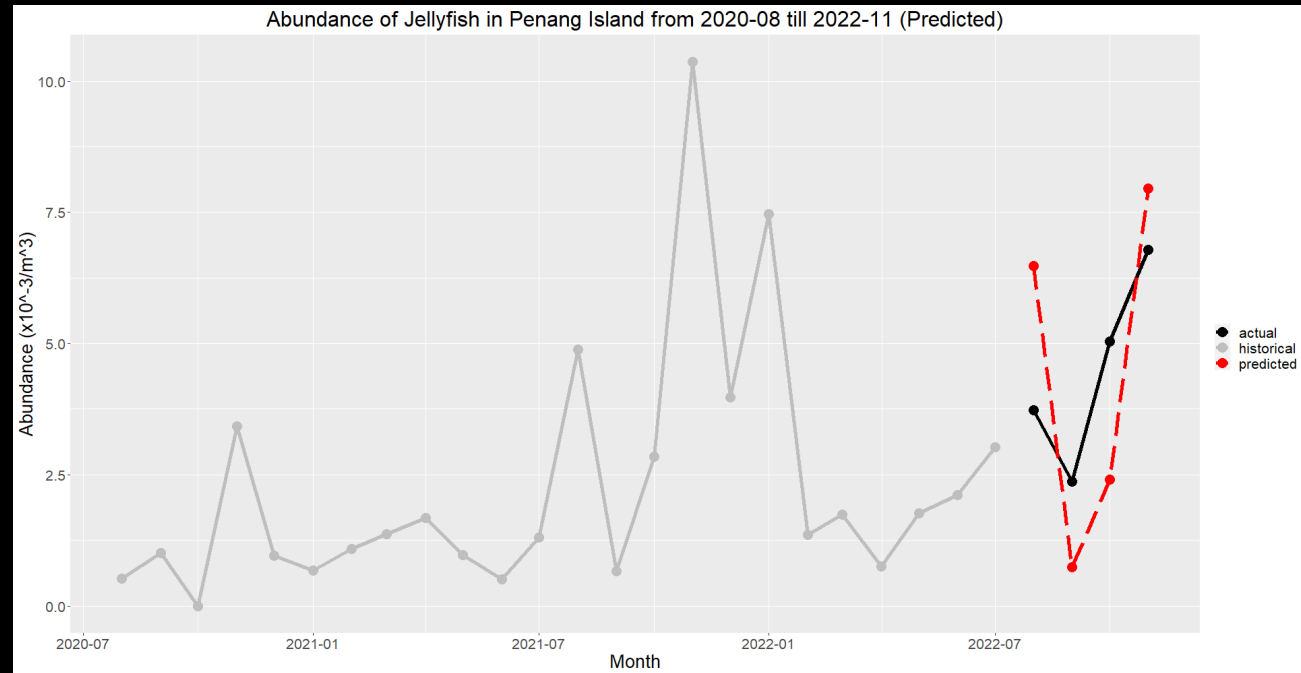
9:41 Dec 4 2022

Prediction

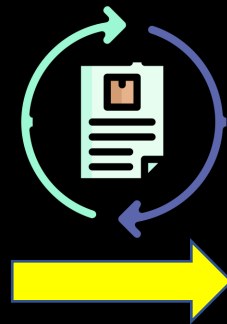
pH Abundance SST

Abundance of Jellyfish in Penang Island from 2020-08 till 2022-11 (Predicted)

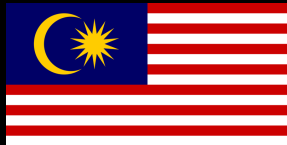
Month	Abundance (x10 ⁻³ /m ³)
Dec 2022	7.30
Jan 2023	5.01
Feb 2023	4.10
Mar 2023	3.75



Mean (comparison S.D.) + 1.45



SCAN ME



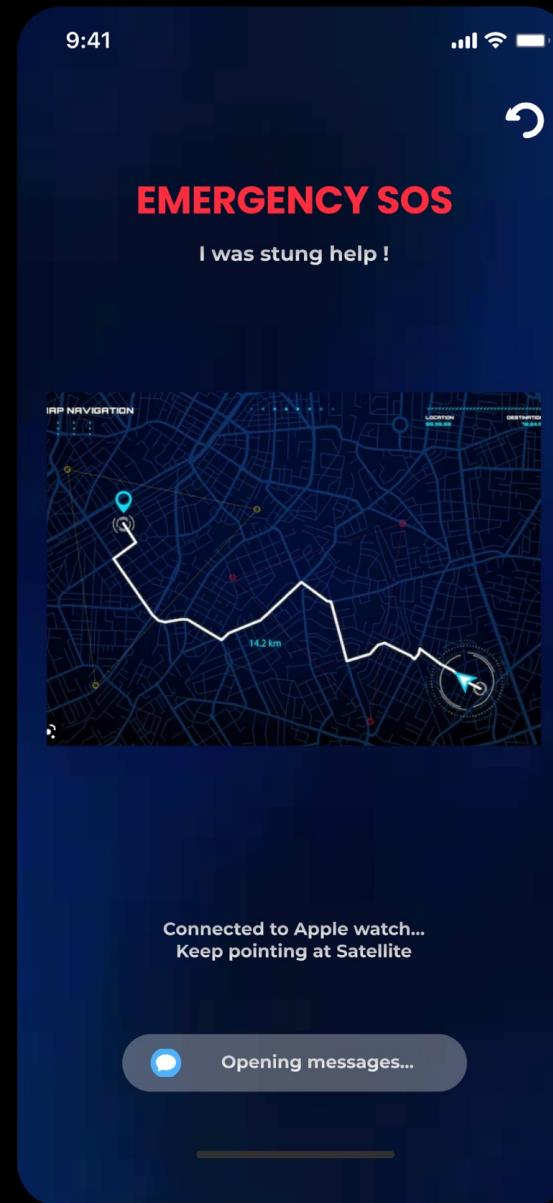
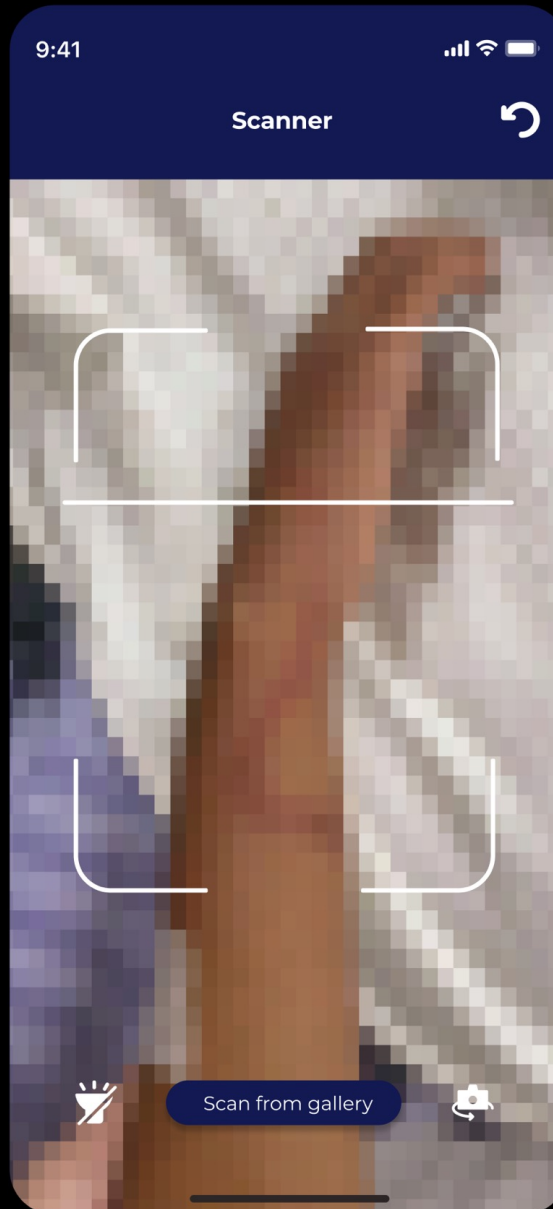
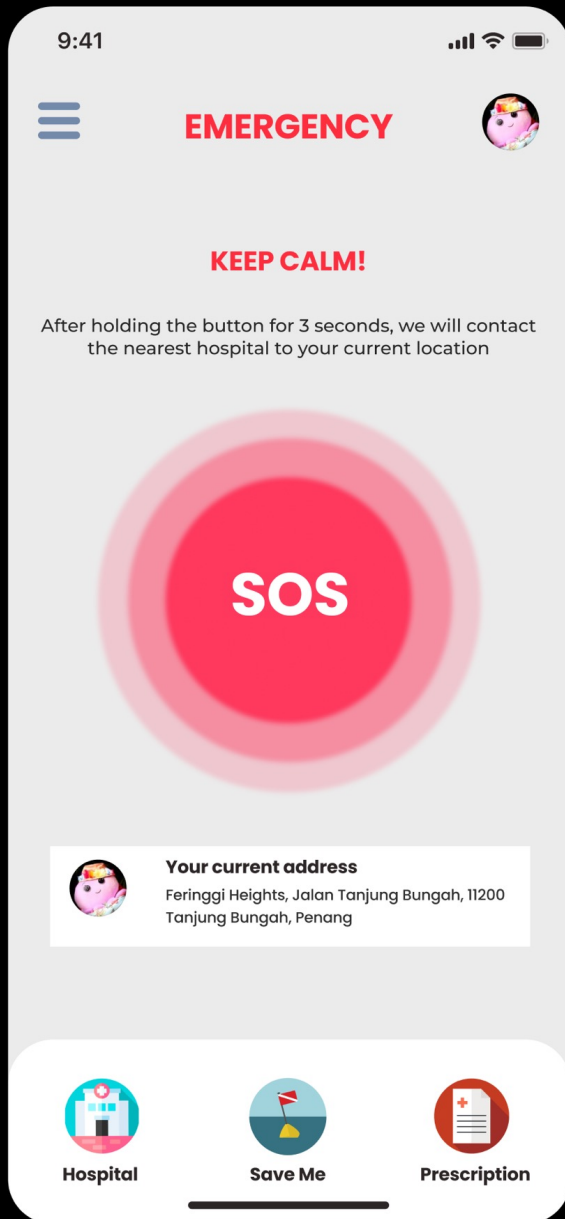


JELLY GO!



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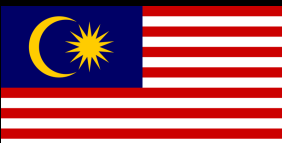
Emergency Action Plan



Our Response Teams



Our Reference Partner



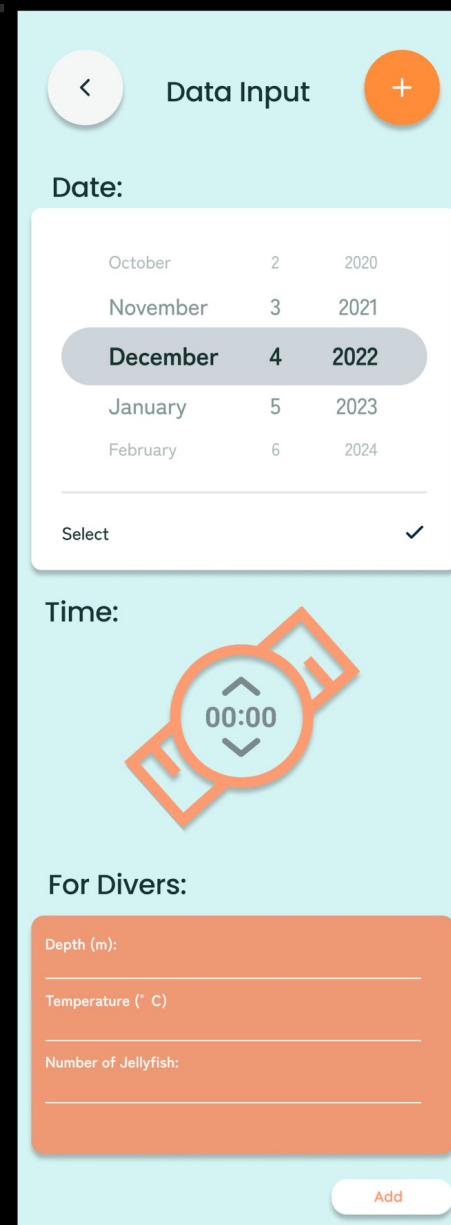


JELLY GO!

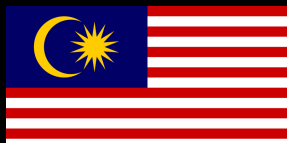


SCAN ME

Citizen Science



Our Partner



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KEY ACHIEVEMENTS



Establishment of the WESTPAC Marine Biodiversity Portal



KEY ACHIEVEMENTS – Joint Publications



PUBLICATION in JOURNALS

Science of The Total Environment
Volume 690, 10 November 2019, Pages 821-830

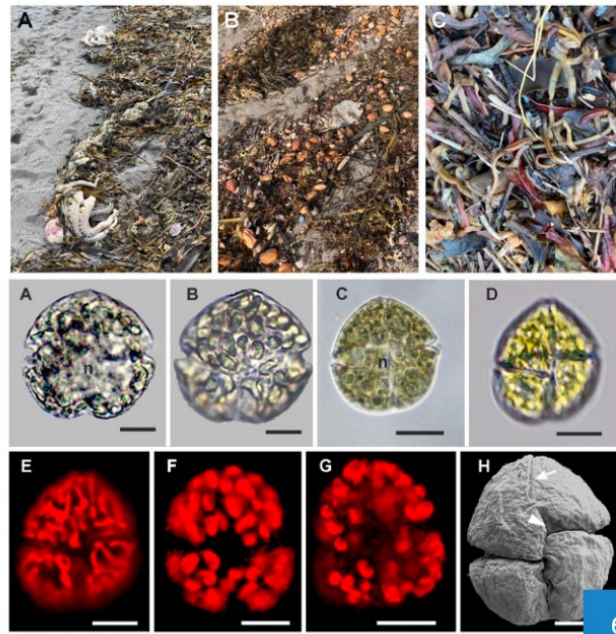
Microplastics in fishes from the Northern Bay of Bengal

M. Shahadat Hossain^a, Faisal Sobhan^b, Mohammad Nasir Uddin^c, S.M. Sharifuzzaman^a, Sayedur Rahman Chowdhury^b, Subrata Sarker^d, M. Shah Nawaz Chowdhury^a

Harmful Algae
journal homepage: www.elsevier.com/locate/hal

A massive bloom of *Karenia* species (Dinophyceae) off the Kamchatka coast, Russia, in the fall of 2020

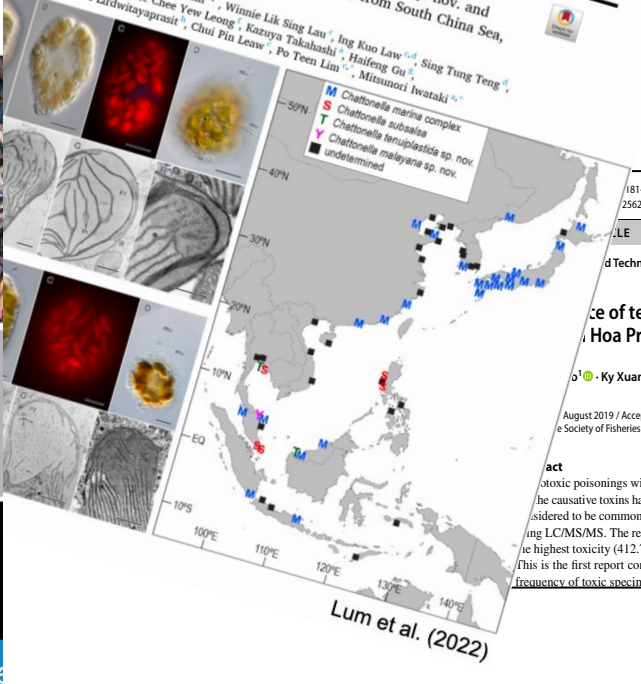
Tatiana Y. Orlova^{a,*}, Anatoly I. Aleksanin^{b,c}, Ekaterina V. Lepskaya^a, Kseniya V. Efimova^a, Marina S. Selina^a, Tatiana V. Morozova^a, Inna V. Stonik^a, Vasily A. Kachur^{a,c}, Alexander A. Karpenko^a, Kirill A. Vinnikov^a, Andrey V. Adrianov^a, Mitsunori Iwataki^{d,e}



Harmful Algae
journal homepage: www.elsevier.com/locate/hal

Description of two new species *Chattonella tenuiplastida* sp. nov. and *Chattonella malayana* sp. nov. (Raphidophyceae) from South China Sea, with a report of wild fish mortality

Wai Mun Lum^a, Hong Chang Lim^{b,c}, Winnie Lik Sing Lau^d, Ing Kuo Law^{e,f}, Sing Tung Teng^g, Garry Benico^h, Sandic Chee Yew Leongⁱ, Kazuya Takahashi^j, Haifeng Gu^k, Thaithaworn Lirdwitsayaprasit^l, Chui Pin Leaw^m, Po Teen Limⁿ, Mitsunori Iwataki^o



Fisheries Science
<https://doi.org/10.1007/s12562-022-01638-6>

ORIGINAL ARTICLE

Food science and Technology

Ciguatera in moray eels raising the risk for seafood safety in Viet Nam

Ha Viet Dao^{1,2}, Hy Ho Khanh¹, Thao Thi Thu¹, Ky Xuan Pham¹, Minh Quang Bui¹, Leo Lai Chan⁴

Received: 31 May 2022 / Accepted: 31 August 2022
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Abstract

...suspected ciguatera fish poisoning (CFP) cases caused by the consumption of moray eels, popular seafood for locals ... been reported in Viet Nam. However, little is known about ciguaterins (CTXs) in these marine fish. In ... six moray eel species were collected for CTX detection from Ly Son Island (site 1), Ninh Hai ... and Spratly Islands (site 4), where suspected CFP from moray eel consumption have ... aid chromatography–mass spectrometry (LC/MS) analysis in 12 specimens belong- ... *G. flavimarginatus*, *G. javanicus*, and *G. undulatus*, accounting for about ... ably, CTX-1B levels detected in all toxic specimens were beyond the safety threshold ... highest occurrence was observed at site 4 (15.6%) (n=45), followed by site 1 (10.0%) ... whereas no CTX-1B was detected in any specimens (n=18) from site 3. These results

ZooKeys 1042:73–188 (2021)
doi: 10.3897/zookeys.1042.64474
<https://zookeys.pensoft.net>

RESEARCH ARTICLE

An updated inventory of sea slugs from Koh Tao, Thailand, with notes on their ecology and a dramatic biodiversity increase for Thai waters

Rahul Mehrotra^{1,2}, Manuel A. Caballer Gutiérrez^{3,4}, Chad M. Spencer Arnold⁵, Coline Monchanin^{2,6}, Voranop Viyakarn^{2,4}, Yoranop Viyakarn^{2,4}

frontiers | Frontiers in Marine Science

Variation of Carbon-Nitrogen Contents and Allelopathic D of Renieramycin M-Producing Sponge *Xestospongia* sp. i of Thailand

Udomsak Darumas^{1*}, Gad Elsayed Mohamed Salem^{2*}, Khamit Voranop Viyakarn^{2,4} and Suchana Chavanich^{2,4,5*}

OPEN ACCESS

Edited by: ...

181–186
2562-019-01375-3

Food Technology

... of tetrodotoxin in three *Nassarius* gastropod species ... Hoa Province, Vietnam

... Ky Xuan Pham¹, Ben Xuan Hoang¹, Masato Tanioka², Ryuichi Watanabe³, Toshiyuki Suzuki³

August 2019 / Accepted: 10 October 2019 / Published online: 12 November 2019
© Society of Fisheries Science 2019

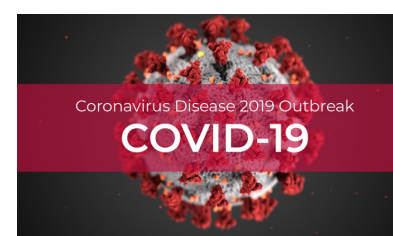
Abstract

...otoxic poisonings with fatal symptoms caused by consumption of *Nassarius* gastropods have been reported in Vietnam ... the causative toxins have not been confirmed. In the present study, *Nassarius conoidalis*, *N. glans* and *N. pullus*, which are ... considered to be common causative species, were collected in Khanh Hoa province, Vietnam in May 2016 for toxin analysis ... using LC/MS/MS. The results confirmed that TTX is a dominant toxin in these gastropods. Among them, *N. glans* exhibited ... the highest toxicity (412.7 ± 107.3 MU/g), followed by *N. conoidalis* (144.8 ± 82.0 MU/g) and *N. pullus* (19.6 ± 9.8 MU/g). ... This is the first report confirming TTX in these species. All specimens in this study were highly toxic, indicating that the ... frequency of toxic specimens of the three *Nassarius* species is extremely high. Further, their toxicities were all beyond the



Orlova et al. (2022)
WESTPAC 4 / April 2023, Jakarta, Indonesia

KEY ACTIVITIES *(since April 2021)*



WEBINARS

Seminar
Science for Sustainable Use of the Ocean: SDG 14 Life Below Water

Speakers:

- Mr. Shigeru Aoyagi** (UNESCO Bangkok, Director)
- Dr. Vladimir Ryabinin** (UNESCO-IOC, Executive Secretary)
- Mr. Takahiro Morita** (JICA Thailand, Chief Representative)
- Dr. Pornsri Suthanaruk** (Department of Marine and Coastal Resources, Deputy Director-General)
- Dr. Wiparat De-ong** (National Research Council of Thailand, Executive Director)
- Prof. Dr. Suchana Chavanich** (Chulalongkorn University, Moderator)
- Prof. Dr. Bundhit Eua-ara** (Chulalongkorn University, President)
- Mr. Wenxi Zhu** (UNESCO-IOC/ WESTPAC, Head)
- Prof. Dr. Hiroaki Saito** (University of Tokyo)
- Prof. Dr. Atsuhiko Ise** (Kyushu University)
- Mr. Alex Rendell** (UN Environmental Program, Goodwill Ambassador for Thailand)

Tuesday 28 September 2021
13.00 -14.30 pm (Thailand time GMT+7)
Join Zoom Meeting
Meeting ID : 915 8272 9364
Password : ChulaSDG14

SYMPOSIUM
CONSERVATION AND RESTORATION IN A CHANGING WORLD

Under 47th International Congress on Science, Technology and Technology-Based Innovation

*How can we reimagine conservation in our rapidly changing world?
What are the key knowledge gaps that must be urgently addressed for a better conservation ?*

Through **zoom**
October 6, 2021 8.30-10.00 am (Thailand Time UTC +07:00)

Invited Speakers

- Dr. Kentaro Ando** (UNESCO-IOC/WESTPAC)
- Dr. Dominic Thomson** (Environmental Justice Foundation)
- Dr. Siriporn Sriaram** (IUCN)
- Dr. Suchana Apple Chavanich** (Chair)
- Dr. Nontivich Tandavanitj** (Co-Chair)

FREE Register NOW

Topic:
Current coral reef restoration in a changing world

Dr. Tali Vardi (ECS for NOAA)

Thursday 23 September 2021
9.00 -10.00 am (Thailand time GMT+7)

Moderator:
Dr. Suchana Chavanich (Chulalongkorn University)

Meeting ID : 952 8071 0586
Password : ChulaSDG14

HARMFUL JELLYFISH WEBINAR

**Future Friend or Foe:
Handling Our Relationship with Jellyfish in SEA**

Speakers:



Dr. Mohammed Rizman Idid
Senior Lecturer, University of Malaya, Malaysia
Diversity, Distribution and Ecology of Jellyfish: Insights from Coastal Surveys in Malaysia



Dr. Tri Maharani, Msi, SpEM
Head Emergency Daha Husada Jospital Kediri East Java Indonesia & President Indonesia Toxinology, Indonesia
Jellyfish Cases in Indonesia: Data and Problems



Dr. Patrick Joseph Tiglao, MD, FPCEM
Emergency Medicine Consultant/ Specialist, Corazon Locsin Montelibano Memorial Regional Hospital & Eastern Visayas Regional and Medical Center , Philippines
Jellyfish Impact to Health: The Philippines Experience



Prof. Dr. Lakkana Thaikruea
Professor, Chiang Mai University, Thailand
"How to Turn the Lethal Jellyfish Controversial Health Threat with Conflicts of Interest into International Solution"

15th Sept 2020

2:00 pm - 4:00 pm
(UTC/GMT +08:00)

Moderator:



Iffah Iesa
Scientific Officer, Curator
Lee Kong Chian Natural History Museum, Singapore

Scan & Join us



<https://forms.gle/minmCQwVqhPZRgd9a>



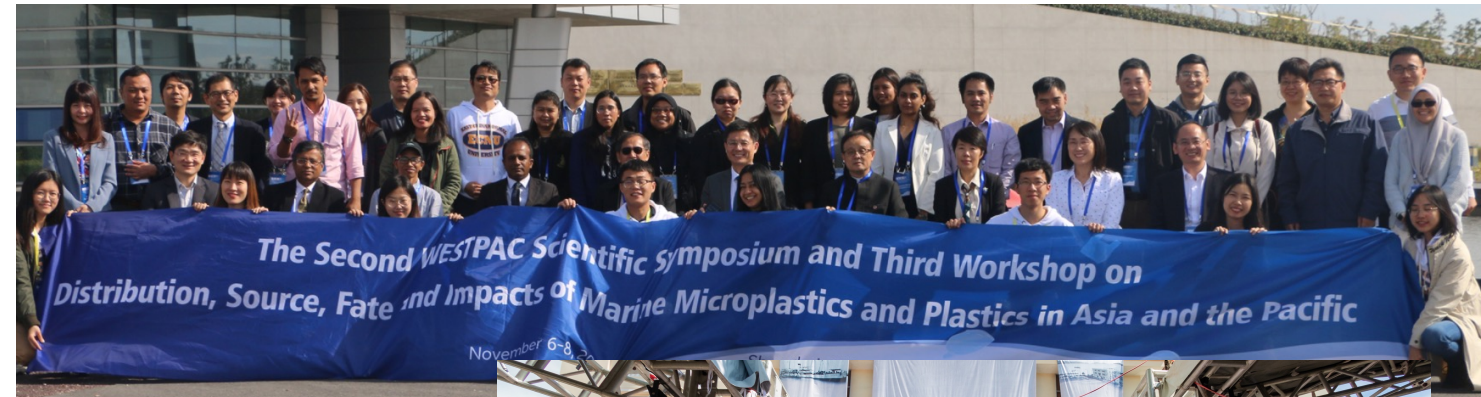
BRIN
BADAN RISET
DAN INOVASI NASIONAL

WESTPAC-XIV, 4-7 April 2023, Jakarta, Indonesia

KEY ACTIVITIES *(since April 2021)*



WORKSHOPS *(International)*



WESTPAC-XIV, 4-7 April 2023, Jakarta, Indonesia

KEY ACTIVITIES *(since April 2021)*

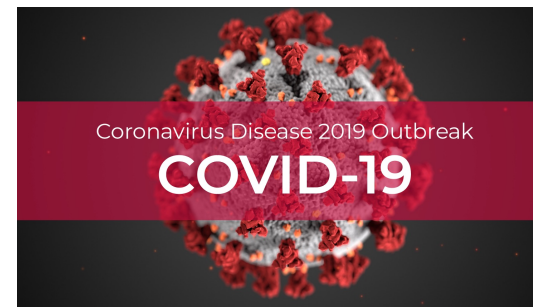


WORKSHOPS *(National)*



WESTPAC-XIV, 4-7 April 2023, Jakarta, Indonesia

PROBLEMS ENCOUNTERED



- The long-term impacts of the COVID-19 pandemic in terms of socio-economic and logistic problems
 - Face-to-face and on-site workshops and training courses could not take place due to international or domestic travel restrictions imposed by Covid 19 pandemic.
- **Lack of recognition of the work and activities by countries outside of the region in the subject related to the research in the Western Pacific region**
- **Continuous fundings to support continuous research in own country. Recommendations to explore more opportunities from other related international parties/NGOs/organisation for funding opportunity**



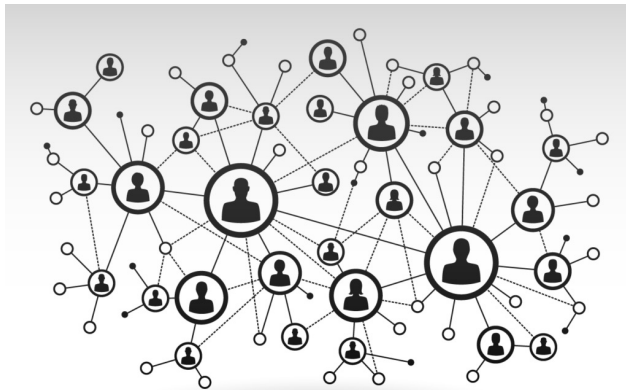
PROBLEMS ENCOUNTERED

- **Lack of data in database, hampering the effort to understand long term changes in the ocean in all member states (especially due to climate change)**
- **Data sharing are restricted due to data ownership issue by different member states**
- **Transboundary issue concerning the export of toxin contaminated seafood to neighbouring countries**
- **Inequal resources, knowledge and capacity on research and long-term monitoring among member states.**

RECOMMENDATIONS

- **INCREASE NETWORKING / ENGAGEMENT WITH MEMBER STATES**
 - *To conduct physical or hybrid events; and if necessary continue with online meetings*
 - *To conduct regular seminars/ workshops & Joint Publications with member states*
- **DATA SHARING**
 - *Promote Data Submission to recognized platforms by member states ie OBIS & Promote Data Sharing among member states*
- **CONTINUOUS FUNDINGS**
 - *Need to explore funding opportunities from other related international parties / organizations*
- **CAPACITY DEVELOPMENT**
 - *Involvement & Commitment of ECOP*

PLANNED ACTIVITIES *(May 2023 – April 2025)*



NETWORKING



- **Strengthening Networking**
 - *Joint field activities*
 - *Symposium / Series of seminars*
- **Capacity development training**
 - *Workshops*
 - *Summer schools*
- **Science to Action**
 - *Communicating science to a broader audience ie policy makers, stakeholders & public*

Translating Science into Action

WHAT CAN WE DO?

- **Continue Engaging** with scientists, policy makers & public
- **Continue Supporting** Marine Science & Technology
- **Continue developing healthy STIE** (*Science Technology Innovation & Economy*) in Marine Biodiversity, Conservation, Ecosystem, Human Health & Blue Economy





Thank You

Aileen TAN



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