

## SCIENTIFIC PROGRESS REPORT FOR YEAR 1 (ENDING MARCH 31, 2021)

### 1. BACKGROUND

PICES member countries have significant resources for monitoring environmental conditions and fisheries in coastal waters. At the same time developing nations are far more limited in their capacity for collecting data needed to advance their management practices. Citizen-based monitoring is an approach designed to improve the efficiency and effectiveness of monitoring efforts when technical and financial resources are not sufficient. There are many successful examples of citizen-based monitoring in developed countries. However, this approach has not been widely applied yet to the collection of environmental and fisheries data in developing nations.

The overall goal of the PICES/MAFF project, entitled “*Building Local Warning Networks for the Detection and Human Dimension of Ciguatera Fish Poisoning in Indonesian Communities*” (acronym: Ciguatera; <https://meetings.pices.int/projects/Ciguatera>), is to build the capacity of local small-scale fishers and community members to monitor their coastal ecosystems and coastal fisheries. Creating community empowerment will benefit human health in Pacific Rim developing countries. As well, the project will create transferable knowledge for ocean communities with similar climate or environmental stresses. This 3-year (April 2020–March 2023) project is funded by the Ministry of Agriculture, Forestry and Fisheries (MAFF) of Japan, through the Fisheries Agency of Japan (JFA), from the Official Development Assistance (ODA) Fund.

The project’s focus is to detect and monitor *Ciguatera Fish Poisoning* (CFP) in tropical reef fisheries, which globally has the most significant human health and economic impacts of any algal-based poisoning syndromes. CFP stems from the human consumption of fish containing toxins produced by benthic microalgae of the genus *Gambierdiscus* and *Fukuyoa*, dinoflagellates which are the initial sources of ciguatoxin. Ciguatoxin affects sodium transport channels in an organism by lowering the voltage-gated opening in their cells, thereby altering the nervous system in ways that negatively affect numerous aspects of fish and animal physiology. Ciguatoxin is lipophilic, meaning that it accumulates in fatty tissues and becomes concentrated up the food web. When present at sufficiently high concentrations in raw or cooked fish, ciguatoxin consumption leads to the onset of major CFP symptoms – vomiting, diarrhea, numbness of extremities, mouth and lips, reversal of the sensations of hot and cold, muscle and joint aches – within 1 to 3 hours of ingestion and may last for days, weeks or even months.

The impact of CFP on the human dimension extends far beyond the proximate health and economic outcomes. Chronically impacted communities tend to become fearful of local and other fish sources, and they transition from these traditional ways of life to one where all protein is imported from foreign sources.

Although CFP is recognized to occur in pristine environments, its emergence in new regions, and intensification in others, often is associated with anthropogenic pressures. There also is evidence that climate drivers may be expanding the geographic distribution of CFP. The primary concerns for local communities are first to identify reef regions where the causative organism is abundant and second, to manage their anthropogenic stressors to minimize increases in its presence.

The 2017–2020 PICES/MAFF project on “*Building Capacity for Coastal Monitoring by Local Small-scale Fishers*” (acronym FishGIS; <https://meetings.pices.int/projects/FishGIS>) has led to the development and implementation of smartphone-based tools for fisheries and environmental observations, such as water quality, phytoplankton, fish catch, floating garbage (plastics) and Illegal Unregulated and Unreported (IUU) fishing, by local small-scale fishers and community members in Indonesia. The new project aims to adapt and further refine these smartphone-based capabilities for measurement and automated reporting, with the addition of

benthic toxic algae measurements, to empower Indonesian coastal communities to minimize their CFP exposure in community-scale fisheries. The project strategy will comprise an “*Assess. Detect. Avoid!*” convention to protect communities against this emerging health concern.

- To *Assess* the state of the local coral reefs, a common ecosystem for ciguatoxic fish, community members will monitor some aspects of water quality (turbidity and water color) of the reef, and document the outbreaks of eel-grass or the expansion of the dead coral (all factors associated with increased CFP presence) using the smartphone-based tools and approach developed during the FishGIS project.
- To *Detect* the presence of the toxin-containing dinoflagellates in the reef environment, two approaches will be used: one that is developed within the project and is based on specialized smartphone-driven microscopes (Foldscopes) and community-appropriate protocols, and the other that employs a detection kit recently created by an international CFP working group (International Atomic Energy Agency (IAEA); <https://www.iaea.org/>; see also FAO and WHO (2020)) to determine the presence of *Gambierdiscus* and *Fukuyoa* in the water column and measure their abundance. These two technologies will meld well to help develop predictive indices for reef regions susceptible to CFP.
- To *Avoid* the transfer of contaminated fish from the damaged environment to the tables of families, the community will be trained to reduce risk – avoid eating fish from regions where *Gambierdiscus* and *Fukuyoa* numbers are high. This simple message will require an investment in socio-ecological scientists – a specialty of the MAFF mandate.

Consistent with the directives of the United Nations Decade of Ocean Sciences for Sustainable Development (UNDOS; <https://www.oceandecade.org/>), the project will focus on three major initiatives:

1. Coastal ecosystem monitoring activities by local small-scale fishers and other community members to detect ecosystem changes (*e.g.*, changes in water quality and the presence and changes in the spatial distribution of dead coral and eel-grass benthic environments).
2. Detection of CFP toxin-containing dinoflagellates in the reef environment using smartphone-based observation tools developed during the FishGIS project, and new international standardized sampling protocols for toxic benthic algae.
3. Training of community members to employ these tools for generating citizen-science data streams to be used in local decision-making on coastal fisheries regions to avoid a health risk associated with fishing until the presence of CFP toxin-containing dinoflagellates is minimized.

These three initiatives will be supported by a series of capacity building workshops led by scientists from PICES member countries. The purpose of the workshops is to work with local communities to increase the sustainability of their fishing resources by providing them with CFP information. It is expected that the combination of training and citizen-science contributions in the project will: (1) generate the needed capacity for monitoring CFP hotspots in Indonesian waters, (2) provide valuable datasets for the study of *Gambierdiscus* and *Fukuyoa* and the factors controlling their abundance in reef systems, and (3) increase human wellness by identifying fishing regions where the health of community members is at risk.

In addition to the primary initiatives, early steps will be taken to explore two secondary initiatives: modifying the FishGIS application to incorporate (1) artificial intelligence-based assessment of fish stocks from the collective catch data reported by the local fishers, and (2) a tsunami early warning notification for remote fishing communities, with the goal of laying the foundation for future full development of these capabilities.

Indonesia was chosen as a developing Pacific Rim country to implement the project. The importance of having more effective fisheries management practices is widely recognized in Indonesia, and this leads to support by the federal government and the willingness of stakeholders to consider new approaches such as the development and implementation of a citizen/fisher-based observation system linked with fisheries scientists and managers. The project foundation would be the strong collaboration PICES scientists have with the Indonesian Agency for the Assessment and Application of Technology (BPPT) and the Indonesian Institute of Sciences (LIPI) developed over previous PICES/MAFF projects – “*Development of the prevention systems for harmful organisms’ expansion in the Pacific Rim*” (2007–2012), “*Marine ecosystem health and human well-being*” (2012–2017), and “*Building capacity for coastal monitoring by local small-scale fishers* (2017–2020).

The longer-term intent of this work is to transfer the knowledge gained and technology developed to other developing regions. In conjunction with the UNDOS, there is substantial interest within PICES in sharing knowledge with other southern hemisphere locations, particularly in under-represented nations.

## 2. PROJECT ORGANIZATION AND MANAGEMENT

PICES Governing Council approved the request to undertake the project in February 2020. The project principles agreed to by MAFF/JFA and PICES are listed in Appendix 1.

The project has strong connections and interactions with, and supports the relevant activities of, the PICES Scientific Committees on Human Dimensions – HD, Marine Environmental Quality – MEQ (through the Section on *Ecology of Harmful Algal Blooms in the North Pacific* – S-HAB) and Fishery Science – FIS, PICES Technical Committees on Data Exchange – TCODE and on Monitoring – MONITOR, and the PICES FUTURE (Forecasting and Understanding Trends, Uncertainty and Responses of North Pacific Marine Ecosystems) Science Program (specifically, Research Theme 3 on “How do human activities affect coastal ecosystems and how are societies affected by changes in these ecosystems?”) (Fig. 1). The HD Committee is the parent committee for the project.

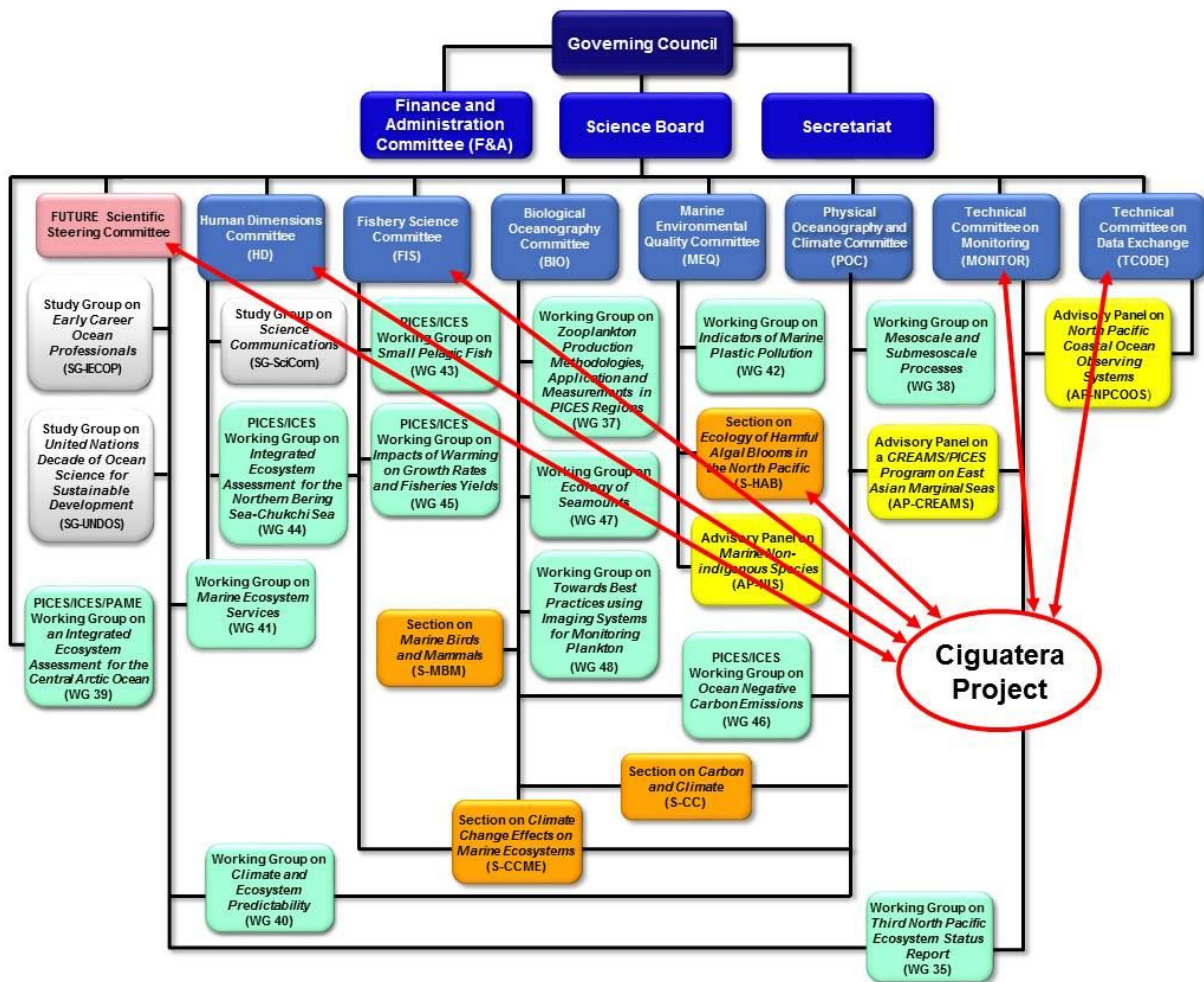


Fig. 1 PICES (North Pacific Marine Science Organization) structure for 2020–2021 showing links between the Ciguatera project and PICES expert groups and committees.

To direct the project, a Project Science Team (PST) was established by Science Board based on principles and procedures detailed in the *PICES Policy for approval and management of special projects* (Decision 2017/A/7; <https://meetings.pices.int/publications/annual-reports/2017/2017-GC-Decisions-Vladivostok.pdf>). All PICES member countries and all the above-mentioned Committees are represented on the PST. The majority of PST members were also involved in the FishGIS project. As the Indonesian collaborators at BPPT and LIPI are also those who participated in the previous PICES/MAFF projects, retaining a core group of former PST members will facilitate efficient implementation of the project. PST membership is shown in Table 1 and contact information for PST members is provided in Appendix 2.

The PST is co-chaired by Drs. Mitsutaku Makino (Atmosphere and Ocean Research Institute, The University of Tokyo, Japan; [mmakino@aori.u-tokyo.ac.jp](mailto:mmakino@aori.u-tokyo.ac.jp)) and Mark Wells (School of Marine Sciences, University of Maine, USA; [mlwells@marine.edu](mailto:mlwells@marine.edu)), who are responsible for the detailed planning and execution of the project, and for the annual reporting on scientific progress to MAFF/JFA (within 90 days after the close of each project year ending March 31) and to PICES Science Board through the HD Committee.

According to the projects principles, Dr. Alexander Bychkov was appointed by the PICES Executive Secretary to serve as the Project Coordinator and is responsible for the management of the fund, and for the annual reporting on its disposition to MAFF/JFA (within 90 days after the close of each project year ending March 31) and to the PICES Finance and Administration Committee.

Table 1 Membership of the Project Science Team

Name	Affiliation	Country/Group
Daisuke Ambe	Japan Fisheries Research and Education Agency	Japan/TCODE
Seung Ho Baek	South Sea Research Institute, KIOST	Korea/S-HAB
Vladimir Kulik	Pacific Branch of VNIRO (“TINRO”)	Russia/MONITOR
Mitsutaku Makino*	Atmosphere and Ocean Research Institute, The University of Tokyo	Japan/HD
Shion Takemura	Japan Fisheries Research and Education Agency	Japan/HD
Naoki Tojo	Hokkaido University	Japan/FIS
Vera Trainer	Northwest Fisheries Science Center, NOAA	USA/SB
Charles Trick	University of Toronto	Canada/S-HAB
Pengbin Wang	Second Institute of Oceanography, Ministry of Natural Resources	China/S-HAB
Mark Wells*	University of Maine	USA/S-HAB

\* Project Co-Chairs

Within PICES, Science Board takes the responsibility for informing Governing Council on the progress and achievements of the project, and the Finance and Administration Committee takes the responsibility for reporting to Governing Council on the financial and management aspects of the project.

### 3. PROGRESS IN YEAR 1

#### 3.1 Project Science Team meeting

Progress on the project in Indonesia was essentially brought to a standstill during the first year due to the COVID-19 pandemic. Even travel to the anticipated case study sites by BPPT or LIPI staff was not permitted. Under these circumstances, the first PST meeting, initially scheduled for May 2020, in conjunction with the MSEAS-2020 Symposium (Yokohama, Japan), was delayed to January 2021 in hopes that pandemic

improvement would allow in-person consultations. When that remained impossible, the meeting was held virtually on March 9, 2021 (Fig. 2). PST members gathered to review the overall strategy and general directions for the project, to consider and develop timelines for project activities and deliverables, and to determine the main elements of the Year 2 workplan.

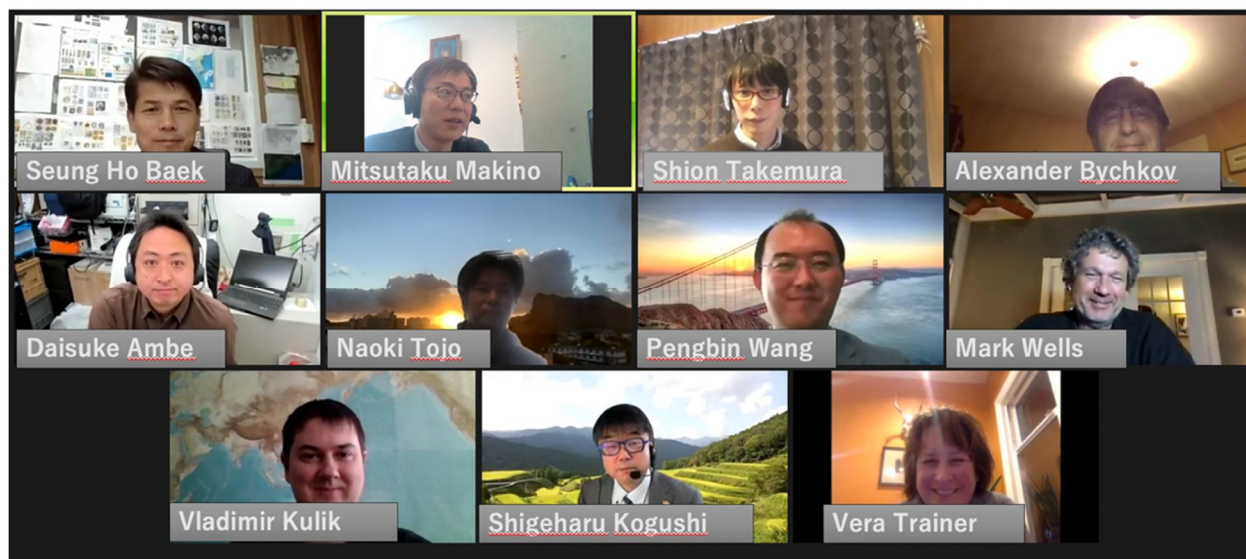


Fig. 2 Participants of the first PST meeting held virtually March 9, 2021.

The central points from this virtual meeting were:

- Review of the smartphone-based technologies developed during the preceding FishGIS project;
- Discuss the general framework, objectives and deliverables of the project;
- Review the guiding principles of the project;
- Build the capacity of local small-scale fishers and communities to monitor their coastal ecosystems and coastal fisheries to benefit human health in Pacific Rim developing countries;
- Gain knowledge about CFP as climate drivers extend its range into PICES member countries;
- Discuss the abbreviated progress on the project during Year 1;
- Review and plan how to adapt the original Year 1 workplan for use in Year 2;
- Discuss and initiate the development of a Project Design Matrix (see below).

### 3.2 Case study site selection and preparation of capacity building plan

During the implementation of the FishGIS project, special relationships were already developed with local communities at several case study sites (Muara Gembong, Indramayu District, Serang and Pelabuhan Ratu). Based on recommendations from the Indonesian government agencies (BPPT, LIPI, *etc.*), work will be continued at some of these locations. In addition, three new possible case study sites were identified in consultation with our Indonesian partners – Lombok and Gili islands (West Nusa Tenggara Province), Bali, and Lembah Strait (Bitung) – but investigation during the first year of the project showed that only the Lombok and Gili islands site was suitable at this time. The two main criteria for selecting this site were the existence of a well-established local fishing community and an active LIPI research station, facilitating project implementation. This site also benefits from close contacts between BPPT and the Provincial Government as well as the existence of a program by the Ministry of Marine Affairs and Fisheries in the development of marine tourism that can support the implementation and sustainability of the project.

### 3.3 Other progress in Year 1

The COVID-19 pandemic prevented efforts to initiate on-site activities, a frustrating, though unavoidable situation, but progress nevertheless was made on other aspects during Year 1. In addition to the groundwork done by our Indonesian colleagues that led to selecting the first implementation site, advances were made on modifying the smartphone application and creating a Project Design Matrix (PDM) to assist in establishing a framework for guiding the project beyond the intended Year 1 activities.

#### *FishGIS smartphone application*

Work continued during Year 1 to add improvements to the smartphone application. Steps were taken to make the user interface more intuitive and user friendly, and the version was updated to be supported by iOS12 or later and Android 5.1 or later. The data storage, originally based on a server in Japan, was migrated over to a server in Indonesia (provided by Google). The Indonesian government allows access to these data. (In a minor step, acknowledging supporting agencies with the placement of their logos was discussed during the PST meeting.)

Further development of the application is needed in terms of CFP-related data reporting, which in part depends on how the field program will be conducted and overseen. These questions cannot be answered adequately until the site visit and community consultations are able to begin. With significant progress anticipated on COVID-19 vaccinations by fall 2021, we expect the field portion of the project will start in January 2022.

#### *Project Design Matrix*

Once an assessment of the underlying situation is in hand, a common organizational approach for complex projects is to define a PDM to comprehensively describe the project. The PDM describes the logical structure of the project (the links between activities and objectives under given assumptions) as well as the major quantitative data that will be obtained. This framework assists in the planning process, facilitates communication of the “why” and “how” of the project, and provides a basis for common understanding of the project progression. It is structured to list the *Project Goals* (to codify the overriding objectives), the *Project Purpose* (the intended impacts and anticipated benefits), the *Results/Outputs* (the objectives the project management must achieve and sustain), and the *Activities* (steps taken to achieve the desired results/outputs).

The core information and perspectives of the project presented and reviewed at the first PST meeting were discussed in the context of creating a formal PDM, and work is ongoing to complete this framework very early in Year 2. It is anticipated that this PDM will (1) refine the project structure based on wider opinions and problem recognition by the PST, Indonesian officials and researchers, and community members (people in the Lombok and Gili islands region), (2) help to focus project efforts and to better communicate key aspects of the project to community members, and thereby (3) instill a sense of ownership of this project by the participants.

#### *Workshop planning*

General workshop planning steps will follow the successful plan developed during the previous PICES/MAFF FishGIS project although some modifications may be implemented based on the PDM. Our Indonesian colleagues have established connections with the local government agency and research staff who will be the key individuals participating in the project. The cost analysis for the initial site visit, workshop and training, equipment needs, and fabrication of sampling devices was completed this year. The necessary funds have been transferred to BPPT so that production of sampling devices and other preparations can begin as soon as it is safe to proceed.

## 4. WORKPLAN FOR YEAR 2

### 4.1 Project Science Team meetings

The first Year 2 PST meeting will be held virtually in late May or early June in order to (1) review and adopt the PDM, and (2) reassess, and modify if needed, the workshop and implementation planning. Our Indonesian colleagues, Dr. Suhendar Sachoemar (BPPT) and Dr. Arief Rachman (LIPI) will be invited to join this meeting to add assessments and suggestions for adapting the PDM to better address the goals of their respective agencies, and to bring a realistic perspective for the case study communities. Based on the knowledge and experience gained in the previous MAFF projects, and the input to date from our Indonesian colleagues, we are confident that the current project implementation plan is reasonable, but the PDM will help to refine these goals and better focus the effort on specific outcomes.

The second virtual PST meeting will occur after the first case study site visit (see below) to report on the initial communication with the communities and infrastructure availability. Using this information, the PST will finalize the community workshop plans for implementation.

The third PST meeting, hopefully in person, is scheduled for March 2022, to review the community workshop outcomes, assess progress of the project within the PDM, and to plan the Year 3 activities.

### 4.2 Case study site visits and community and training workshops

We continue to optimistically plan for a visit of PICES experts to Indonesia in January 2022 to conduct our initial assessment of the case study sites on Lombok and Gili islands, review the capacity building needs and opportunities, and optimize the capacity building plan and the training logistics as guided by the PDM. The training workshop design will be finalized based on this site visit assessment and the first community workshops initiated in late February or early March 2022.

During the preparation of this PICES/MAFF project proposal, the intention was to conduct training exercises at two case study sites in Indonesia. The purpose was to increase the capacity building footprint and provide a more extensive database and *in-situ* experience to guide the development of observational and mitigation efforts. Given the pandemic-related delays, this goal will need to be reassessed based on how the current situation progresses. At the moment, we continue to plan for this expansion by including the necessary site visit late in Year 2 to implement workshop training in Year 3.

### 4.3 Observation tools

The 2017–2020 PICES/MAFF FishGIS project has led to the development of smartphone applications and protocols for citizen-based monitoring in Indonesian fishing communities. These smartphone capabilities – measurement and automated reporting of water quality, fish catch, IUU fishing, floating garbage (plastics), and pelagic toxic phytoplankton (red tides) – are the foundation for this project, where measurement of benthic toxic algae (*i.e.*, ciguatoxin-producing phytoplankton) will be added. Work on modifying and refining the FishGIS application design, initiated in Year 1, will continue in Year 2, guided by consultations with local agencies and communities in Lombok and Gili islands.

### 4.4 Sampling programs

Based on the outcomes of the site visit(s), PST meetings and consultations with our Indonesian partners, two sampling programs are expected to be initiated in Year 2:

1. Data collection using observation tools developed in the FishGIS project and new international standardized sampling protocols for toxic benthic algae (including deployment and retrieval of CFP sampling devices) to be carried out by one or more professionals.

2. Data collection to develop the algorithm to convert the optical measurements from the smartphone-based water quality assessment application HydroColor to chlorophyll, to be conducted by graduate students from a local university. This algorithm will enable rapid assessment of the general reef conditions (nutrient-impacted *vs.* pristine) for comparison with enumerations of toxic benthic algae.

#### 4.5 Database

It is expected that data gathered from the project will be managed by the Indonesian National Ocean Data Center (NODC) to guard against loss and to ensure responsible continued accessibility by interested Indonesian government agencies, private sectors and their corresponding collaborators. The transitioning of the combined FishGIS, HydroColor and CFP database from Japan to Indonesia (BPPT and NODC), completed in Year 1, will provide the foundation for designing data outputs and reports in consultation with BPPT, LIPI, and community leaders.

**Note:** The uncertainties surrounding the global COVID-19 outbreak are a major consideration in the project plan. The Year 2 workplan depends critically on international travel and in-person meetings, which continues to be a problem. Although we are hopeful that conditions will improve by the end of 2021, public health recommendations of PICES member countries and Indonesia may require further modifications or delays in the planned activities.

## 5. REFERENCES

FAO and WHO. 2020. *Report of the Expert Meeting on Ciguatera Poisoning. Rome, 19–23 November 2018.* Food Safety and Quality No. 9. Rome. <https://doi.org/10.4060/ca8817en>.



## APPENDIX 1

### PROJECT PRINCIPLES

1. The overall goal of the project entitled “*Building Local Warning Networks for the Detection and Human Dimension of Ciguatera Fish Poisoning in Indonesian Communities*”, funded by the Ministry of Agriculture, Forestry and Fisheries of Japan (MAFF), through the Fisheries Agency of Japan (JFA), is to build the capacity of local small-scale fishers and community members to monitor their coastal ecosystems and coastal fisheries to benefit human health in Pacific Rim developing countries. The focus of this project is to detect and monitor *Ciguatera Fish Poisoning* (CFP) in tropical reef fisheries, which globally has the greatest human health and economic impacts of any algal-based poisoning syndromes. The aim of the project is to adapt smartphone-based observation tools developed in the 2017–2020 PICES/MAFF project on “*Building Capacity for Coastal Monitoring by Local Small-scale Fishers*” (acronym FishGIS; <https://meetings.pices.int/projects/FishGIS>) to empower Indonesian coastal communities to assess, detect, and minimize their exposure to CFP in community-scale fisheries. The project also is intended to foster partnerships with non-PICES member countries and related international programs and organizations. The MAFF contribution is from the Official Development Assistance (ODA) Fund and therefore, involvement of developing countries in project activities is required.
2. The duration of the project is 3 years, with the ending date set as March 31, 2023.
3. The following organizational principles agreed to by MAFF/JFA and PICES apply to the project:
  - The project will have strong connections and interactions with, and support relevant activities of, the PICES Scientific Committees on Human Dimensions – HD, Marine Environmental Quality – MEQ (through the Section on *Ecology of Harmful Algal Blooms in the North Pacific* – S-HAB) and Fishery Science – FIS, PICES Technical Committees on Data Exchange – TCODE and on Monitoring – MONITOR, and the PICES FUTURE (Forecasting and Understanding Trends, Uncertainty and Responses of North Pacific Marine Ecosystems) Science Program (specifically, Research Theme 3 on “*How do human activities affect coastal ecosystems and how are societies affected by changes in these ecosystems?*”). The HD Committee will serve as the parent committee for the project.
  - The project will be directed by a Project Science Team (PST) formed based on principles and procedures detailed in the *PICES Policy for approval and management of special projects* (Decision 2017/A/7). All the above-mentioned groups and all PICES member countries are expected to be represented on PST.
  - The PST will be co-chaired by PICES members, with one Co-Chairman from Japan, representing the Human Dimensions Committee, and the other from the USA, representing the Section on *Ecology of Harmful Algal Blooms in the North Pacific*. These Co-Chairmen will provide the geographical balance and the balance of expertise between the human dimension and harmful algal bloom components of the project. The PST Co-Chairmen are responsible for the scientific implementation of the project and for the annual reporting to MAFF/JFA and to PICES Science Board through the HD Committee. This report should be submitted to JFA within 90 days after the close of each project year ending March 31, and include a summary of the activities carried out for the year, with an evaluation on the progress made, and a workplan for the following year.
4. The following financial principles agreed to by MAFF/JFA and PICES apply to the project:
  - A separate bank account shall be established to deposit the remitted funds.
  - The PICES Executive Secretary or a Project Coordinator designated by the Executive Secretary is responsible for the management of the fund and for the annual reporting on its disposition to MAFF/JFA and PICES Governing Council, through the Finance and Administration Committee, within 90 days after the close of each project year ending March 31.

- Travel and meetings – this category covers travel costs associated with project activities such as field studies, organizational trips, project meetings, workshops, scientific sessions and public events.
      - Contracts – this category covers grants/fees to be paid to consultants and experts employed to implement the project. Tasks and deliverables for contractors are to be determined by the PST Co-Chairmen. To support the objectives of the project and to ensure that its activities have minimal impact on the workload of the existing staff of the PICES Secretariat, the Project Coordinator can employ additional staff as required.
      - Publications – this category covers costs associated with publishing findings of the project in special issues of peer-reviewed journals, reports and brochures, and dissemination of these materials.
      - Equipment – this category covers purchases and shipment of equipment for laboratory/field data/sampling processing/analysis, computer hardware/software for the development of database(s) and the project website.
      - Miscellaneous – this category covers expenses associated with the project (mail and phone charges, bank charges, *etc.*) and includes contingencies such as fluctuations in currency exchange rates.
    - Transfers of up to 10% of allocations between the budget categories are allowed based solely on the decision by the PICES Executive Secretary or the Projects Coordinator. In special cases, transfers up to 20% between the budget categories can be authorized by JFA. All transfers shall be reported at the end of the fiscal year.
    - A 13% overhead on the annual budget shall be retained by PICES to offset expenses related to the Secretariat's involvement in the project.
    - The interest earned by the fund shall be credited to the project and used in consultation with JFA.
    - Any funds remaining after the completion of every fiscal year of the project shall be reported and disposed of in consultation with JFA.
5. Ownership of the outcomes of the project, including materials, data, copyright and intellectual property rights, will be vested to PICES and the Government of Japan. Either Party may use those outcomes, but will give full credit to their source.

## APPENDIX 2

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