SCIENTIFIC PROGRESS REPORT FOR YEAR 1 (ENDING MARCH 31, 2024)

1. PROJECT BACKGROUND, OBJECTIVES AND INITIATIVES

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 to collect data needed to advance their management practices in these waters. Citizen-based monitoring is an approach designed to improve the efficiency and effectiveness of monitoring efforts when technical and financial resources are insufficient. There are many successful examples of citizen-based monitoring in developed countries. However, this approach has not yet been widely applied to collecting environmental and fisheries data in developing nations. Based on such recognition, PICES has conducted two citizen-based monitoring projects funded by the Ministry of Agriculture, Forestry and Fisheries (MAFF) of Japan: "*Building capacity for coastal monitoring by local small-scale fishers* (FishGIS: November 2017 – March 2020) and "*Building local warning networks for the detection and human dimension of Ciguatera Fish Poisoning in Indonesian communities*" (Ciguatera: April 2020 – March 2023).

The overall goal of the project, entitled "*Creating a phytoplankton-fishery observing program for sustaining local communities in Indonesian coastal waters*" (FishPhytO) is to establish, in collaboration with local fishers, research institutes and universities, the capacity to develop and operate a phytoplankton-fishery observing program in the Lombok Island region (West Nusa Tenggara Province, Indonesia). This project is expected to use tools developed and refined during the previous two PICES/MAFF projects (2017–2023) that enable the detection of toxic benthic Harmful Algal Bloom (HAB) species that can threaten tropical reefs and other coastal fisheries and record images of the fishery catches for enumeration of fish species and sizes. The long-term objectives are to (1) provide local communities with the operational capacity and knowledge to manage their fisheries resources and ensure sustainable seafood safety, and (2) identify research needs for deploying these tools in PICES member countries.

Benthic HAB species, such as the causative organism underlying Ciguatera Fish Poisoning (CFP), arguably have the greatest human health and economic impacts of algal-based poisoning syndrome. CFP occurs when humans consume fish that contain toxins created by benthic microalgae of the dinoflagellate genera *Gambierdiscus* and *Fukuyoa*, which are the initial sources of ciguatoxin and are endemic in many tropical Pacific regions. The impact of CFP on the human dimension extends far beyond the proximate health and economic outcomes – chronically impacted communities in the Pacific Region and elsewhere can become fearful of local and other fish sources and transition from these traditional ways of life to one where all protein is imported from foreign sources, altering their cultural heritage. In addition to threats of benthic HABs and CFP in Indonesia, there also are pelagic blooms of toxic algae species (*e.g*., *Alexandrium* spp.) that produce potent neurotoxins, which bioaccumulate in both aquaculture and subsistence fisheries, yet there is no comprehensive monitoring of seafood safety for the majority of the Indonesian coastline. With only a handful of plankton experts available to identify when coastal conditions become toxic, Indonesia lacks the capacity to effectively mount the type of HAB monitoring that is common in developed countries.

The problem of toxic algal blooms appears to be increasing globally. Although Ciguatera and other toxin-producing benthic HABs appear in pristine environments, anthropogenic pressures and climate change are leading to its emergence in new regions and intensification in others. There is evidence of range extension of some of these species into the waters of PICES member countries, which is raising significant concerns. The expansion of dead corals and eel-grass habitats that replace healthy corals facilitates intrusion and establishment of exotic populations of toxin-producing benthic algae. Despite the widespread impacts of benthic and other HABs, the resultant health and socioeconomic effects remain poorly understood.

Indonesia is part of the Coral Triangle, the most biodiverse marine area on Earth, and these extensive reefs are vital to maintaining the ecological products that contribute to fisheries in this region. However, presently only about 7% of these coral reefs are in excellent condition, while anthropogenic stressors have left more than 35% in poor condition. Decreasing coral health in Indonesia is a relatively new phenomenon compared to other areas of the world, and the human populations living adjacent to the deteriorating corals are not yet fully aware of the consequences of this change. Current reports of benthic and pelagic HABs occurrences are low in Indonesia, almost certainly because diagnosis is difficult without proper training and experience.

Knowledge transfer is essential. Maintaining a healthy environment is critical to a sustainable relationship between the country and the marine environment. Communities must understand the risks of exposure to keep the impact of benthic HABs to a minimum. The highest risk is when the reefs, that communities depend on for fish, have large patches of dead coral or large seagrass mats, as these surfaces are ideal for the growth of benthic algal cells. Pelagic HABs, on the other hand, are much less predictable, so vigilance with the proper tools is essential. The project will offer technology-assisted, community-based training that drives community awareness of emerging problems and will foster surveillance and management skills that can reduce the incidence of HAB-related illnesses. Communities should engage in three levels of surveillance: the health of the corals and coastal waters, the biology of the benthic and pelagic HAB species, and the harvesting of potentially contaminated fish or bivalves to the communities.

The foundation of this project is the robust collaborations developed over the previous four PICES/MAFF projects (conducted in the period from 2007 to 2023) with two Indonesian research institutions, the Indonesian Agency for the Assessment and Application of Technology (BPPT) and the Indonesian Institute of Sciences (LIPI), now integrated into the Indonesian National Research and Innovation Agency (BRIN). In addition, in March 2022, PICES has signed a Memorandum of Understanding with the Indonesian Institute of Technology (ITI) with the goal of integrating both faculty expertise and student involvement into the project to enhance its longer-term sustainability. Project activities are expected to be supported by the Provincial Government of West Nusa Tenggara, which already provided invaluable assistance in organizing a Ciguatera project's community training and knowledge dissemination workshop in January 2023 in Lombok, and expressed strong interest and political will to assist in implementation of future projects.

Four long-term goals guide the project. First, consumers will come to rely on information from local communities and researchers about HABs when purchasing marine goods or services. Secondly, the socioeconomic basis of local communities will gain resilience by not depending on products with neurotoxic risks. Thirdly, coral reef health and signals of declining health are better understood by developing nations. Through these capacity-building goals, coastal Indonesian communities can be sustainably improved, with fewer uncertainties and risks from CFP and degradation of coral ecosystems, and the emerging threats of pelagic HABs. The fourth long-term goal, and most directly relevant to PICES, is that lessons learned in this project inform and benefit PICES member countries facing the emergence of climate-driven benthic range extension of HAB species into their marine systems.

The project is proposed to focus on the following major initiatives:

1. Provide a scientific basis to inform local communities about the influence of benthic HABs on their sustainable use of marine resources. This will be underpinned by developing a database from coastal ecosystem monitoring activities by local fishers and community members to detect ecosystems changes.
2. Develop automated image analysis strategies for quantifying fisheries-relevant information from image analysis of the smartphone application data collections. These data will be combined with known benthic HAB toxin vectors to inform risk assessments.
3. Detect the presence of toxin-containing dinoflagellates in the reef environment using two approaches: (a) implementation of smartphone and internet-capable automated microscope and species identification tools developed during the previous PICES/MAFF projects, and (b) employing internationally-standardized sampling protocols for toxic benthic algae.

4. Training of "local trainers" and community members to utilize these tools and collected data in local decision-making on coastal fisheries regions to avoid the potential transfer of contaminated fish and shellfish from the damaged environment to the tables of families.

To support these primary initiatives, a series of training/capacity building workshops, led by scientists from PICES member countries, is planned to be held in Indonesia. The workshops aim to work with local communities to increase the sustainability of their fishing resources by providing them with HAB information. The combination of training and citizen-science contributions in the project is expected to (1) generate the needed capacity for monitoring HAB hotspots in Indonesian waters, (2) provide valuable datasets for the study of *Gambierdiscus, Fukuyoa, Alexandrium,* and other toxic algae, along with the factors controlling their abundance in reef and coastal systems, and (3) increase human wellness by identifying fishing regions where the health of community members is at risk.

It is anticipated that besides the primary initiatives, three secondary initiatives will be explored during the project: (1) deploying several new low-cost compact, internet-capable flow-through microscope systems for rapid detection and quantification of pelagic and benthic phytoplankton, (2) developing image analysis libraries for rapid automated identification of toxic species within the generated datasets, and (3) modifying the FishGIS smartphone application with preliminary steps towards artificial intelligence-based assessment of fish stock from the collective fish catch data reported by community members.

2. PROJECT ORGANIZATIONAL AND MANAGEMENT

The request to undertake the project was approved at the inter-sessional PICES Governing Council meeting on May 30, 2023. The first year of the project (June 1, 2023 – March 31, 2024) was funded by MAFF, through the Fisheries Agency of Japan (JFA), from the Official Development Assistance (ODA) Fund. Following the project principles agreed to by MAFF/JFA and PICES (*Appendix 1*):

- The project had strong connections with the PICES Scientific Committees on Human Dimensions (HD), Fishery Science (FIS), and Marine Environmental Quality (MEQ) (through the Section on *Ecology of Harmful Algal Blooms in the North Pacific* — S-HAB), PICES Technical Committees on Data Exchange (TCODE) and on Monitoring (MONITOR), and PICES FUTURE (Forecasting and Understanding Trends, Uncertainty and Responses of North Pacific 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 was the parent committee for the project.
- A Project Science Team (PST), co-chaired by Dr. Mitsutaku Makino (HD Chair; University of Tokyo, Japan) and Dr. Mark Wells (S-HAB Co-Chair; University of Maine, USA;), was established by PICES Science Board to direct the project. The PST Co-Chairs were responsible for the detailed planning and execution of the project, and reporting on its scientific progress to MAFF/JFA and to Science Board through the HD Committee.
- Dr. Alexander Bychkov was appointed by the PICES Executive Secretary to serve as the Project Coordinator and was responsible for the management of the fund and reporting on its disposition to MAFF/JFA and to PICES Governing Council through the Finance and Administration Committee.
- Within PICES, Science Board took the responsibility for informing Governing Council on the progress and achievements of the project, and the Finance and Administration Committee took the responsibility for reporting to Governing Council on the financial and management aspects of the project.

3. ACTIVITIES AND PROGRESS DURING PROJECT YEAR 1

3.1 Project Science Team meetings

The FishPhytO PST was formed based on principles and procedures detailed in the PICES Policy for approval and management of special projects (Decision 2017/A/7). All PICES member countries and all groups mentioned

in the project principles, but MONITOR, were represented on the team. Considering the focus of this project, HD and MEQ have decided to nominate several PST members. There are strong links between the FishPhytO project and the previous two PICES/MAFF projects – FishGIS (2017–2020) and Ciguatera (2020–2023), and the majority of FishPhytO PST members were involved in one or in both of these projects. As the leading Indonesian collaborators are also those who participated in the previous PICES/MAFF projects, retaining this core group was important to facilitate efficient implementation of the project. Selection of Dr. Mitsutaku Makino and Dr. Mark Wells as PST Co-Chairs warranted continuation in the leadership and provided the desirable geographical balance and the balance of expertise between the human dimension and HAB components of the project. The PST membership is shown in Table 1, and contact information for PST members is provided in *Appendix 2*.

Table 1 Membership of the Project Science Team.

Name	**Affiliation**	**Country/Group**
Daisuke Ambe	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
Mitsutaku Makino*	Atmosphere and Ocean Research Institute, Univ. of Tokyo	Japan/HD
Moonho Son	National Institute of Fisheries Science	Korea/S-HAB
Shion Takemura	Fisheries Research and Education Agency	Japan/HD
Naoki Tojo	Faculty of Fisheries Sciences, Hokkaido University	Japan/FIS
Vera Trainer	Olympic Natural Resources Center, Univ. of Washington	USA/SB
Charles Trick	Institute for Inclusive Health and Well-Being, Univ. of Toronto	Canada/S-HAB
Pengbin Wang	Second Institute of Oceanography, Ministry of Natural Resources	China/S-HAB
Mark Wells*	School of Marine Sciences, Univ. of Maine	USA/S-HAB

* Project Co-Chairs

Three PST meetings were conducted during Year 1:

- The first meeting was held July 8, 2023, immediately after the community training workshop (July 5–7, 2023), in Lombok, Indonesia. The main objectives of the meeting were to (1) review the outcomes of the July 2023 training workshop in Lombok, and (2) discuss a workplan for Year 1 of the project in order to set up a logistically feasible sampling program for benthic phytoplankton and fisheries in the Lombok/Gili Matra region so that data collection can begin early in the project (*Appendix 3*).
- The second meeting took place on October 20, 2023, in conjunction with PICES-2023 in Seattle, USA. The main objectives of the meeting were to (1) analyze the outcomes of the July 2023 activities in Indonesia, (2) assess the current state of data collection in the Lombok/Gili Matra region and the development of a feasible sampling program in Indonesia, (3) review the updates in the FishGIS smartphone application, and (4) discuss a workplan for the rest of Year 1 and for Year 2 of the project (*Appendix 4*).
- The third meeting was convened via Zoom videoconference from 10:00–12:00 JST (Japan Standard Time) on February 2, 2024 (February 1 in the Western Pacific). Considering information from JFA that MAFF's funding for the project will be ceased after completion of Year 1, the sole objective of the meeting was to consider options for supporting FishPhytO-related activities after March 31, 2024 (*Appendix 5*).

The next PST meeting is planned to be held in a hybrid format in late October 2024, in conjunction with the 2024 PICES Annual Meeting (PICES-2024) in Honolulu, USA, with the following main objectives: (1) to review potential funding sources for continuing FishPhytO-related activities, (2) to discuss research needs and options for deploying observation tools refined during the project in PICES member countries, (3) to assess the state of data collection in the Lombok/Gili Matra region and the perspectives of the field sampling program in Indonesia, and (4) to develop a workplan for 2024–2025, if feasible.

3.2 Observation tools

FishGIS – smartphone-based monitoring service

FishGIS is a service provided to PICES by Green Front Laboratory, Inc. (GFL, Japan). This service consists of three components: (1) a smartphone application (FishGIS application) that allows users to report accurate location information and photos or videos, even when there is no cell phone signal, (2) a secure GIS-based cloud database (FishGIS database) where data reported from the smartphone application are stored, and (3) a web application for a desktop PC (FishGIS dashboard) that allows data managers, who have permission from a reporter, to access the collected data set from the cloud database and use it for analysis.

The development of FishGIS was initiated in 2018 within the FishGIS project (2017–2020). Through this project, GFL released an initial version of FishGIS, a customized version of the Furusato Photo Memory System®, into a smartphone application. The Furusato Photo Memory® System, an integrated field survey data reporting and sharing service for supporting citizen-science-based surveys and research (Reg. No. 5738785), was created by GFL and issued as a trademark by the Japan Patent Office in 2015. The project developed and implemented smartphone-based tools (applications, sampling methods and reporting protocols) that enabled local fishers and community members to collect and electronically share fisheries and environmental data (water quality, fish catch, toxic phytoplankton, Illegal Unregulated and Unreported (IUU) fishing, and floating garbage (plastics)) with relevant Indonesian government authorities and university researchers. Details can be found in Section 3.2 of the FishGIS Scientific Report (PICES Sci. Rep. No. 58).

The major upgrades to the FishGIS application during the Ciguatera project (2020–2023) included: (1) an improved user interface, (2) a reporting scheme that is consistent with ABS (Access to genetic resource and Benefit Sharing) rules of the UN Convention of Biological Diversity, (3) a function allowing the direct launch of the HydroColor water quality application, (4) a function allowing the direct launch of the Info BMKG application (provided by BMKG – Indonesian government agency for Meteorology, Climatology and Geophysics) to better incorporate a tsunami early warning notification for remote fishing communities, and (5) a function to map Ciguatera field survey data and to accumulate fisheries-related data (from photos of fish species in local fish markets). Besides, a data search and view function and a data download function of the FishGIS dashboard were developed. Details of all changes can be found in Chapter 4 of the Ciguatera Scientific Report.

FishGIS was further improved in Year 1 (2023–2024) of the FishPhytO project. The completed modifications to the FishGIS application comprise: (1) an option to choose the language among English, Indonesian-Bahasa, Chinese, Japanese, Korean, and Russian, (2) a reporting function enabling users to select image size from high- to medium- to low-resolution, and (3) a reporting function allowing users to add comments to the image file. Since May 18, 2024, the newest version of the application is available on Apple Store and Google Play for installation on iOS 11 and Android 8 or later smartphone devices. In addition, an account authorization function for PC management page was modified, and FishGIS dashboard's user interface was completely redesigned. Details of all changes can be found in *Appendix 6*.

Similar to the FishGIS and Ciguatera projects, all work on FishGIS during the first year of the FishPhytO project, including: (1) refinement of the FishGIS application, (2) support of minor updates to mobile operating systems, and (3) maintenance of cloud database servers in Indonesia and Japan, was conducted by GFL based on a contract with PICES and in consultation with the PST members. Dr. Shion Takemura led this activity within the PST for this and the previous two PICES/MAFF projects. As funding from MAFF for the FishPhytO project has ended, available financial resources are not sufficient to continue FishGIS modifications through GFL. Nevertheless, with support from PICES, GFL will maintain the FishGIS cloud server for Indonesia in 2024–2025.

Multilingualization of the FishGIS application, that also incorporates customized fish groups, is essential for deploying this observation tool in PICES member countries Going forward, an attempt will be made to use the application for citizen-based monitoring projects in some of these countries. It should be indicated here that the Government of Japan has given PICES a permit "to modify the FishGIS application, developed under the PICES

special projects funded by MAFF, and to provide this application to other projects or businesses, including for a fee". The Government of Japan has also confirmed that "it will not claim ownership of any data collected from the use of the FishGIS application by PICES or any such projects or businesses that use the application".

Foldscope and Planktoscope – community appropriate microscope platforms

Identifying toxic phytoplankton species through microscopic examinations has been the mainstay of seafood safety programs in many developed nations, but these programs have depended on expensive microscopic tools which are beyond the practicalities of small-scale fisheries in developing nations. The situation has changed with the development of Foldscope, a portable, durable, and ultra-affordable ($3 US) folded paper (origami) microscope that performs on par with conventional research microscopes and can be interfaced with any smartphone camera to provide images with quality suitable for a taxonomic diagnostic. Foldscope was introduced as one of observation tools in the FishGIS project (see Section 3.3 in PICES Sci. Rep. No. 58). It empowers non-science-trained community members to collect photos of phytoplankton in their local waters, and send these images to the specialists competent in phytoplankton identification. Though it works well, it is a slow process and requires some dexterity to operate efficiently.

The developers of this remarkable product (Stanford University, USA) have then launched Planktoscope, a more sophisticated, but still low-cost (<$800 US) microscope platform that allows automated image collection of phytoplankton cells in a simple flow-through system. These images then can be uploaded to a dedicated server where AI (artificial intelligence) software can be trained to identify and quantify the composition of the phytoplankton assemblage. Planktoscope, a tool that is expected to revolutionize low-cost plankton monitoring, was found particularly suited to the Ciguatera project. Technical, hands-on training on the detailed operation of Planktoscope, using locally collected plankton samples, was provided to a subset of participants with science background at the community training and knowledge dissemination workshop held January 25–27, 2023, in Lombok, Indonesia (for details see Chapter 6 of the Ciguatera Scientific Report). Then, two Planktoscopes were donated by the project to the Plankton Laboratory at BRIN's Research Center for Oceanography and to the Faculty of Science at the Mataram University. A trial for a new method for analyzing phytoplankton samples with Planktoscope was conducted during the February 2023 survey in the Gili Matra region (for details see Chapter 5 of the Ciguatera Scientific Report).

Left: Symbolic delivery of Planktoscopes to ITI and BRIN at the General Lecture (July 4, 2023, ITI campus, Serpong, South Tangerang, Indonesia); right: Participants learn the operation of Planktoscope at the community training workshop (July 6, 2023, Lombok, Indonesia).

Planktoscope was further promoted in the first year of the FishPhytO project. Two presentations on the use of this tool for quantifying benthic and pelagic phytoplankton were given by Dr. Mark Wells in Indonesia – during the General Lecture on "Creating a phytoplankton-fishery observing program for sustaining local communities in Indonesian coastal waters" on July 4, 2023 (ITI Campus, Serpong, South Tangerang) and at the

community training and knowledge dissemination workshop on July 5, 2023, in Lombok. A symbolic delivery of two Plantonscopes from the project to ITI and BRIN took place at the General Lecture. Technical, hands-on training on the use of Planktoscope was also a special component of the July 2023 workshop. Details on the General Lecture and the community training workshop can be found in section 3.3 of this report (below).

3.3 July 2023 activities in Indonesia

General Lecture

The General Lecture on "Creating a phytoplankton-fishery observing program for sustaining local communities in Indonesian coastal waters" was organized at the ITI campus on July 4, 2023. The objective was, through a series of presentations by FishPhytO PST members and Indonesian scientists, to disseminate information about fisheries management and the hazards of benthic HABs in Indonesian coastal waters, and to communicate the background, principles and goals of the FishPhytO project to the broad audience that included students, scientists and engineers from academia, research institutions and industry, and government officials from Tangerang Region and Banten Province. Approximately 100 people were in attendance.

The Lecture was opened with a report of the Organizing Committee by Dr. Shinta Leonita (ITI), welcome addresses by Dr. Marzan Azis Iskandar (ITI Chancellor) and Dr. Sasa Sofyan Munawar (Head of the BRIN's Research Center for Environment and Clean Technology) and a brief introduction to the FishPhytO project by Dr. Mark Wells (PST Co-Chair). This was followed by a delivery of two Plantonscopes from the project to ITI and BRIN and a signing ceremony of Implementation Arrangements (IA) between PICES and the Department of Agroindustry Technology and the Department of Chemical Engineering at ITI. These documents are expected to strengthen support from the government and various institutions in Indonesia for collaborative research with PICES and the sustainability of the observation network after the project is completed.

Signing of Implementation Arrangements between PICES and ITI's Department of Agroindustry Technology (left) and ITI's Department of Chemical Engineering (right) at the General Lecture (July 4, 2023, ITI campus, Serpong, South Tangerang, Indonesia).

After an introduction of the topics and speakers by Dr. Suhendar I Sachoemar (ITI, BRIN), the event continued with presentations by FishPhytO PST members – Dr. Mark Wells (*Introduction to Planktoscope*), Dr. Shion Takemura (*Smartphone applications: FishGIS, HydroColor*), Dr. Naoki Tojo (*Practical approaches for research and assessment in data-poor/limited situation with fisheries communities*), and Dr. Charles Trick (*Public health and social aspects*), and by Mr. Arief Rachman (BRIN) on behalf of the Indonesian Ciguatera Science Team (*Harmful Algal Blooms and Ciguatera Indonesia Studies in Lombok*). These presentations (now posted on the FishPhytO website) were followed by a prolonged in-depth question period with the attendees. Closing remarks were given by Dr. Dwita Suastiyanti (ITI Vice-Chancellor for Academic, Research and Student Affairs).

Opening of the Presentation Session of the General Lecture by Dr. Suhendar I Sachoemar (top row, left) and presentations at this session by FishPhytO PST members – Dr. Mark Wells (top row, right), Dr. Shion Takemura (middle row, left), Dr. Naoki Tojo (middle row, right) and Dr. Charles Trick (bottom row, left) and by Mr. Arief Rachman (BRIN) on behalf of the Indonesian Ciguatera Science Team (bottom row, right).

After the Lecture, the PST members had an extended conversation with ITI Chancellor. This interaction included a more in-depth discussion about the goals and methods of the FishPhytO project, and considerations about incorporating ITI faculty and students into this activity. There was also the exchange of opinions on potential funding sources for expanding the project towards this capacity-building aspect. It was agreed to consider a possibility to devote a day of the next PST visit to Indonesia to working with students on the ITI campus.

Community training and knowledge dissemination workshop

It was expected that the primary initiatives of the FishPhytO project will be supported by a series of capacity building workshops, aiming to work with local communities to increase the sustainability of their fishing resources. Due to the limited funding, only one community training and knowledge dissemination workshop was conducted in the first year of the project. The main objectives of this workshop were to (1) disseminate information to the broad spectrum of participants about fisheries management and the hazards of benthic HABs in Indonesian coastal areas, (2) provide technical, hands-on training on the use of smartphone-based tools for monitoring of fisheries resources (FishGIS) and environmental health conditions (HydroColor), and on the use of Planktoscope for quantifying benthic and pelagic phytoplankton, and (3) communicate the consequence of changes to the marine resources on the community fishers.

The 2.5-day workshop, held from July 5–7, 2023, was organized in collaboration with ITI, BRIN, WNT-BRIDA (West Nusa Tenggara Regional Research and Innovation Agency) and the University of Mataram (UNRAM). The workshop was also supported by a generous contribution of $9,244 from the Atmosphere and Ocean Research Institute of the University of Tokyo.

In order to align this training with a local-based sampling program for both benthic phytoplankton and fisheries that could continue on a regular basis, the workshop focus was on local University students, along with local community members, who are willing to implement sample collections and analysis. The participants included members of coastal communities from Gili Matra and the surrounding Lombok area, officials and researchers from BRIN, ITI, UNRAM, UNPAD (University of Padjadjaran) and regional institutions and agencies, representatives of the WNT Provincial Government and their Regional Work Units, local NGOs and coastal community groups, and members of the tourism industry.

The workshop began at the Garden Hotel Lombok in the afternoon of July 5 with a report by the Chair of the Organizing Committee, Dr. Suhendar I Sachoemar (ITI, BRIN), a welcome address by Dr. Amry Rakhman (Head of WNT-BRIDA) and an overview of the FishPhytO project by Dr. Mitsutaku Makino (PST Co-Chair). Following the Opening Session, participants were provided with presentations on Planktoscope (Dr. Mark Wells), smartphone applications – FishGIS and HydroColor (Dr. Shion Takemura), the methodologies for fisheries resource assessment (Dr. Naoki Tojo), and the social aspects of this project (Dr. Charles Trick).

Group photo of workshop participants and instructors taken at the end of the Opening Session on July 5, 2023 (Lombok, Indonesia).

On the second day (July 6), workshop participants were split into two groups for hands-on training. The first group of ~15 persons worked on the FishGIS and HydroColor applications in the morning and fisheries resource management in the afternoon. Trainees successfully installed the applications and were guided through the methods of their operations by Drs. Shion Takemura and Daisuke Ambe. The fisheries resource training, led by Drs. Naoki Tojo and Charles Trick, used a simulated case study game, where participants "fished" for slips of paper, some marked to indicate high ciguatoxin levels. The exercise aimed to illustrate the consequences of overfishing and ciguatera-toxin composition on the fishery's financial outcome.

The second group of ~10 persons spent the day on the setup and detailed operation of Planktoscope. This activity was led by Adam Larson (Stanford University), who has been closely involved in developing and using Planktoscope in his Ph.D. dissertation. He was aided by Dr. Mark Wells, Mr. Drajad Seto (Ph.D. student from the University of Maine) and Mr. Arief Rachman, who are also familiar with this tool. All participants had earlier studied Planktoscope operations at the January 2023 workshop, conducted within the Ciguatera project, so they were well prepared for this more intensive training and showed operational competence with the instrument. It is important to note that the participants included faculty members of the University of Mataram (where one of Planktoscopes donated by the project will reside). The goal here is to have these individuals oversee the use of Planktoscope in the analyses of project samples.

Overall, the leaders of both groups were impressed with enthusiasm and engagement of the participants, and the opinion was that the training methods were successful and that now, with several workshops under our belts, the strategy and techniques have evolved to generate more effective outcomes.

Prior to a July 6 training session, the PICES delegation and several Indonesian colleagues took an early morning field trip to the fish market in Mataram to learn about the local fisheries and evaluate the effectiveness of using fish markets as the core method for collecting fisheries data using the FishGIS application. Conversations with local fishmongers confirmed that they are aware of changes that have been happening in the local fisheries (including decreasing sizes of fish). It seems that FishGIS data collection from markets could be a valuable tool to quantify changes in fisheries. A benefit of this approach is that it would significantly reduce the difficulty of recruiting students to obtain fisheries data.

Field survey at the fish market in Mataram on July 6, 2023, to evaluate the effectiveness of using fish markets as the core method for collecting fisheries data using the FishGIS application in Lombok and surrounding areas.

On July 7, PICES representatives together with the Organizing Committee members and a subset of workshop participants travelled by boat to Gili Air (the most populated of the Gili Islands). In the morning, a training field survey was conducted to collect plankton samples (under supervision of Dr. Mark Wells and Mr. Afief Rachman) and environmental data using the HydroColor application (under supervision of Drs. Shion Takemura, Daisuke Ambe and Suhendar I Sachoemar) in marine coastal area surrounding Gili Matra.

Collecting plankton samples (left) and environmental data using the HydroColor application (right) during a training field survey in coastal area surrounding Gili Matra (July 7, 2023).

In the afternoon, PICES scientists met with community leaders and ~15 students from the University of Mataram doing community service during the summer semester as part of Indonesia's "kaka en program" (community service period required of all University students). After a brief introduction to the FishPhytO project and the goals of the training program, participants were provided with condensed versions of presentations on HABs (including CFP), the rationale for fisheries resource management, the social implications of overfishing, and smartphone applications – FishGIS and HydroColor. This was followed by hands-on training on the use of the applications and the work of Planktoscope. As in the main workshop, participants were enthusiastically engaged in operating the applications and asked questions throughout.

Participants and instructors of the training session at Gili Air (Indonesia) on July 7, 2023.

A consensus at the conclusion of the July 2023 workshop was that the training sessions effectively reached the capacity-building goals. It was also agreed that though more extensive workshops are better for knowledge dissemination, small-group workshops are more efficient for technology training. The primary concern was to ensure that participants quickly begin using the knowledge so that the activity remains fresh in their minds. This will require frequent contact to generate and sustain momentum in obtaining and analyzing samples over the next few months.

Should funding be identified for the spring 2025 community training and knowledge dissemination workshop, it will focus on University of Mataram faculty and students and community representatives from Gili Matra and around Lombok, the National Marine Protected Area Center, and local government and NGOs. The objectives of this workshop are expected to include: (1) disseminating, through lectures and training, technology for monitoring the environmental condition and health using the FishGIS and HydroColor applications and Planktoscope to the universities and surrounding communities of the Lombok region, as well as to policy makers to increase their knowledge, and (2) reconnecting with trainees from the July 2023 workshop to review the logistical strengths and weaknesses of the sampling program, and to expand the sampling program to other Lombok regions represented at the workshop.

3.4 Field sampling program in Indonesia

During the Ciguatera project (2020–2023), the Gili Matra/Lombok region (WNT Province) was selected as a case study site based on recommendations from our Indonesian colleagues. The central factors underlying this selection were the existence of a well established local fishing community, an active BRIN research station in the area, the capabilities and interest of individuals at UNRAM, and the strong support for the project by the WNT government. The initial plan was to have local small-scale fishers and community members in the region carry out field observations and sample collections. However, the COVID-19 pandemic-related delays to the intended on-site training workshops led to shifting the focus to a substantial augmentation of existing BRIN-planned surveys of waters surrounding Gili Matra to expand data collection opportunities. A portion of Ciguatera project funds were re-directed to support a total of five extended surveys conducted in different seasons: Survey I from May 23–28, 2022 (Wet to Dry Season/Transition I), Survey II from August 1– 5, 2022 (Dry Season), Survey III from October 10–16, 2022 (Dry to Wet Season/Transition II), Survey IV from December 12–18, 2022 (Wet Season), and Survey V from February 20–25, 2023 (end of the Wet Season). The FishGIS and HydroColor smartphone tools were actively used in these surveys. A trial for a new method for analyzing phytoplankton samples with Planktoscope was conducted during the February 2023 survey. In addition to water column and benthic samples, fish caught around Gilli Matra or Lombok were purchased for ciguatoxin analysis. Researchers from BRIN and UNRAM also collected fundamental socioeconomic data in the area using the same methodology as in the previous PICES/MAFF projects (on-site surveys, questionnaires, and focus group discussions). As a consequence, a valuable initial assessment of water quality, benthic HAB, fisheries data, and socioeconomic status was completed in the Gili Matra region (for details see Chapter 5 of the Ciguatera Scientific Report).

Due to the limited budget, the FishPhytO project was unable to financially support field surveys in the Gili Matra region. Fortunately, our Indonesian partners have secured some funding from the Ministry of Finance's Research and Innovation for Advanced Indonesia Program to continue this work. A 3-year (2024–2026) project, entitled “Ciguatera Fish Poisoning and Hazardous Algae Disaster Mitigation Model Development Activities in the Gili Matra Aquatic Tourism Park (TWP) area”, includes budget for two 4-day surveys every year – in February–March (Wet Season) and in August (Dry Season), for collecting and processing data on water quality, water column and benthic plankton, and socioeconomics. The first of these surveys was successfully conducted from March 4–7, 2024. The second survey will take place from August 6–9, 2024.

APPENDIX 1: PROJECT PRINCIPLES

1. A 3-year (June 1, 2023 – March 31, 2026) project, entitled "*Creating a phytoplankton-fishery observing program for sustaining local communities in Indonesian coastal waters*", 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 objective of the project is to build, in collaboration with local fishers and research institutes and universities, a phytoplankton-fishery observing program in the Lombok Island region (Indonesia) using tools developed in the 2017–2020 PICES-MAFF project "*Building capacity for coastal monitoring by local small-scale fishers*" (FishGIS) and refined during the 2020–2023 PICES-MAFF project "*Building local warning networks for the detection and human dimension of Ciguatera Fish Poisoning in Indonesian communities*" (Ciguatera), to enable the detection of toxic benthic Harmful Algal Bloom (HAB) species that can threaten tropical reef fisheries, and to record images of the fishery catches for enumeration of fish species and sizes. The long-term goals are to (1) provide local communities with the capacity and knowledge to sustainably manage their fisheries resources and ensure seafood safety, and (2) identify research needs for deploying these tools in PICES member countries.

2. The maximum duration of the project is 3 years, with the ending date set as March 31, 2026.

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, with the PICES Scientific Committees on Human Dimensions (HD), Fishery Science (FIS), and Marine Environmental Quality (MEQ) (through the Section on *Ecology of Harmful Algal Blooms in the North Pacific* — S-HAB), PICES Technical Committee on Data Exchange (TCODE) and on Monitoring (MONITOR), and the PICES FUTURE (Forecasting and Understanding Trends, Uncertainty and Responses of North Pacific 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 PICES member countries and the above-mentioned groups are expected to be represented on PST.
   - The PST will be co-chaired by PICES members, with one Co-Chair from Japan, representing HD, and another from the USA, representing S-HAB. These Co-Chairs 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-Chairs are responsible for the scientific implementation of the project and for the annual reporting to MAFF/JFA and to PICES Science Board through the Committee on Human Dimensions. 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 next 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.
   - The main elements of the budget are organized into the following categories:
     - 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-Chairs. 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: PROJECT SCIENCE TEAM MEMBERS

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APPENDIX 3: SUMMARY OF THE FIRST FISHPHYTO PROJECT SCIENCE TEAM MEETING

The first meeting of the Project Science Team (PST) for the project "*Creating a phytoplankton-fishery observing program for sustaining local communities in Indonesian coastal waters*" (FishPhytO), funded by the Ministry of Agriculture, Forestry and Fisheries (MAFF) of Japan, through the Fisheries Agency of Japan (JFA), was held on July 8, 2023, immediately after the community training and knowledge dissemination workshop (July 5–7, 2023), in Lombok, Indonesia.

The main objectives of the meeting were to (1) review the outcomes of the July 2023 training workshop, and (2) discuss a workplan for Year 1 of the project in order to set up a logistically feasible sampling program for benthic phytoplankton and fisheries in the Lombok/Gili Matra region so that data collection can begin early in the project. Participants of the meeting are listed in Addendum.

Participants of the first FishPhytO PST meeting (July 8, 2023, Lombok, Indonesia). Naoki Tojo missing from photo.

The general sense of workshop leaders was that the training sessions effectively reached the capacity-building goals. Attendees seemed more motivated than in the previous workshops because the sessions contained fewer, more focused participants. A consensus was that small-group workshops may be better for technology training, but more extensive workshops are better for knowledge dissemination. The primary concern was to ensure that participants quickly begin using the knowledge so that the activity remains fresh in their minds. This will require frequent contact to generate and sustain momentum in obtaining and analyzing samples over the next few months. Dr. Naoki Tojo has plans to return to Lombok in October 2023 with his research team, which will be a significant help to the project in establishing a sampling effort.

The plankton sampling portion of the project will be based in the Gili Islands. This effort will require support and participation from local residents, and there need to be more funds to arrange sampling programs by the University of Mataram. Two organized groups are operating in the region: a group comprising tourism operators and an Observation Protection group are working together to pressure policy on the Islands. These groups will be essential collaborators, helping with collection of plankton and macroalgae samples as well as with dissemination aspects of the project. The intent will be to co-develop a monitoring program using individuals from the two groups and summer undergraduate students on the Gili Islands.

The fisheries portion of the project will be based mainly on the Lombok fish markets. The Gili Island fishers have been slowly turning to support the emerging ecotourism presence in the islands, so local fishing is minimal. One possible approach will be to form "university student sampling teams," perhaps through establishing a club-type linkage. Doing so would help to ensure continuing efforts, as the club membership regenerates with new members as older students graduate. This topic would be for follow-up discussion, perhaps with some financial incentives.

From financial and training effectiveness perspectives, the next workshop is expected to be small and focus on teaching the teachers (training the trainers). This workshop should be led by the users of the project's tools (*e.g.*, FishGIS and HydroColor smartphone applications, Planktoscope). To help identify these individuals, we should monitor who is adding data. Dr. Zamroni at the University of Mataram (Biology), would be the person to contact about providing some seed funds to assist students gather data (~$500 USD). If data are available by January 2024, we should teach a data processing class to show them how to use these data.

A new direction identified for the next workshop is to develop and implement social surveys, in collaboration with the director and faculty of Marine Studies at the University of Mataram, and any NGOs interested in the project goals.

Other comments of note were that we should be working to refine a model activity for project training that can be implemented in other countries. This would be developed from the current workshop strategies.

Addendum

First Project Science Team meeting participants

Members

Daisuke Ambe (Japan, representing TCODE)
Mitsutaku Makino (Co-Chair; Japan, representing HD)
Shion Takemura (Japan, representing HD)
Naoki Tojo (Japan, representing FIS)
Charles Trick (Canada, representing MEQ)
Mark Wells (Co-Chair; USA, representing MEQ)

Other

Adam Larson (Stanford University, USA)
Arief Rachman (BRIN, Indonesia)
Suhendar I Sachoemar (ITI and BRIN, Indonesia)
Drajad Seto (University of Maine, USA)

APPENDIX 4: SUMMARY OF THE SECOND FISHPHYTO PROJECT SCIENCE TEAM MEETING

The second meeting of the Project Science Team (PST) for the project on "*Creating a phytoplankton-fishery observing program for sustaining local communities in Indonesian coastal waters*" (FishPhytO), funded by the Ministry of Agriculture, Forestry and Fisheries (MAFF) of Japan, through the Fisheries Agency of Japan (JFA), was held from 09:00–17:00 on October 20, 2023, in the St. Helen Room at the Westin Hotel, Seattle, USA, prior to the 2023 PICES Annual Meeting.

The main objectives of the meeting were to (1) analyze the outcomes of the July 2023 activities in Indonesia, (2) assess the current state of data collection in the Lombok/Gili Matra region and the development of a feasible sampling program in Indonesia, (3) review the updates in the FishGIS smartphone application, and (4) discuss a workplan for the rest of Year 1 and for Year 2 of the project.

1. WELCOME REMARKS, INTRODUCTIONS, ADOPTION OF THE AGENDA

The meeting was opened with welcoming remarks to participants (listed in *Addendum 1*) and brief comments on the purpose of the meeting by Dr. Mitsutaku Makino. Dr. Vera Trainer joined the meeting later in the day due to her involvement in another workshop, and Dr. Moonho Son participated remotely for some time in the afternoon. Two PST members, Dr. Seung Ho Baek (Korea, representing MEQ) and Dr. Vladimir Kulik (Russia), were unable to attend this meeting. Invitees to the meeting were Dr. Yutaka Hiroe (MAFF, Japan), Dr. Suhendar I Sachoemar (BRIN and ITI, Indonesia), and Ms. Ruo Yu (SIO, Ministry of Natural Resources, China).

Following introductions, the attendees reviewed and adopted the provisional agenda circulated prior to the meeting (*Addendum 2*). Dr. Mark Wells served as the rapporteur.

The second FishPhytO PST meeting (October 20, 2023, Seattle, USA) in session.

2. REPORT OF THE MAFF CIGUATERA PROJECT AND INTRODUCTION TO FISHPHYTO PROJECT

Dr. Makino provided a detailed summary of the previous (2020–2023) MAFF-funded project for "*Building local warning networks for the detection and human dimension of ciguatera fish poisoning in Indonesian communities*" (Ciguatera), which has laid the foundation for the current FishPhytO project. This summary was based on the Ciguatera Scientific Report that now is posted on the PICES website.

Dr. Makino re-emphasized that the overall objective of the FishPhytO project is to establish, in collaboration with local fishers, research institutes and universities, a phytoplankton-fishery observing program in the Lombok

Island region (Indonesia) using tools developed and modified/refined during the previous two PICES/MAFF projects (2017–2023) in order to provide local communities with the capacity and knowledge to sustainably manage their fisheries resources and ensure seafood safety. The project is also expected to identify potential research needs for deploying the FishGIS application in PICES member countries.

3. INTERMEDIATE REPORT OF PROJECT ACTIVITIES IN YEAR 1

a) July 2023 training workshops in Lombok

The workshop report highlighted the successes of the selected training approaches. Dr. Mark Wells summarized the Planktoscope training led by Mr. Adam Larson (Stanford Laboratory). Dr. Shion Takemura reviewed training in using the FishGIS and HydroColor smartphone applications. Drs. Charles Trick and Naoki Tojo described fisheries sustainability/management training. One problematic issue that came up was that many individuals had difficulty operating the HydroColor application, which was not the experience at the January 2023 workshop. Dr. Wells will contact Dr. Thomas Leeuw (HydroColor application developer) to ask about whether there was a version update, as permissions do not seem to be working.

b) Data collection (Phytoplankton, HydroColor, Fish images) in Indonesia

Dr. Sachoemar presented results of data collection in Indonesia. The current plan is to establish a link between PICES, BRIN (National Research and Innovation Agency of Indonesia) and ITI (Institute of Technology of Indonesia), but there are other universities, local governments and NGOs who are interested in the FishPhytO project. These potential partners might be able to join in data collection, but this is beyond the scope of the project. They could though participate with their own budget, and we would be working only in an advisory role. Dr. Sachoemar has already accepted a proposal for BRIN to support sampling, education, and mitigation efforts. The proposal would use Planktoscope on East Borneo (Mulawarman University), on Seribu Island (local government), and on Belitung Island (local government). The field sampling began in Belitung in September 2023, with the next planned visits to Lampung Bay, Seribu Island, and Lembeh Strait to demonstrate the use of Planktoscope. Two biology students at ITI worked with Planktoscope from April to June 2023 for their thesis. They already submitted a manuscript for publication (under review), and a second paper will be submitted shortly (both to Indonesian journals). Ichthyology students at the University of Mataram (Lombok), plan to use the FishGIS application to collect fish data in Mataram after mid-semester exams. PST members unanimously agreed that there is a need to develop and implement a help strategy for users of our tools in Indonesia. These strategies should run through Mr. Arief Rachman (BRIN), who will be working directly with Stanford Laboratory when Planktoscope issues arise. The PST should also look into setting up a series of lectures for Mataram students on use of the FishGIS application, environmental sampling, and fisheries sustainability.

C) Update on smartphone applications

Dr. Takemura pointed out that a new version of the FishGIS application was released from Apple Store and Google Play on October 17, 2023. He reviewed the most recent updates to the application, which include: (1) an option to choose the application language among English, Indonesian-Bahasa, Chinese, Japanese, Korean, and Russian (multilingualization of the application is essential for deploying this tool in PICES member countries), (2) a reporting function enabling users to select image size from high- to medium- to low-resolution (the later is needed to lower costs for image transmission and/or in weak cellphone coverage zones), and (3) a reporting function allowing users to add comments to the image file. He expressed special thanks to Drs. Vladimir Kulik, Moonho Son and Pengbin Wang for support with translation to their native languages. It was also indicated that work is in progress on updating an account authorization function for PC management page (FishGIS dashboard), and this effort is expected to be completed in November 2023.

Dr. Takemura reported an increase in the number of observations submitted to the database (more than 500 reports in the first six months of Year 1), and that datasets can be now downloaded as CSV files. This change will facilitate data analyses by government officers, managers, students and community members. Programs for data analysis are readily available on the web, so it is possible for students to conduct their own projects

using the database. We would ask that students upload data they have collected to the fisheries database to ensure that it is retained.

Sorting fish images is difficult, and an important issue here is the identification of species using local names, for which Dr. Sachoemar's help is required. Dr. Tojo is working with Dr. Takemura to refine the segmentation approach in the FishGIS application, and there are also plans to write a concept paper about using community-based science to generate fisheries data. On a broader perspective, Dr. Takemura has done outreach in Japan about the FishGIS and HydroColor applications, and there have been enquiries from the Fisheries Research and Education Agency, Mizuho Bank, and Prefectural Research Institutes, all reflecting diverse needs which could be supported by these smartphone applications. Thus, it might be useful to consider the data policy for paid distribution of the FishGIS application (see item 7 below).

There were questions raised about who will have access to which data with the current database structure. This topic will need clarification moving forward given that the FishPhytO project will be adding more data. Is there a need to limit data access to non-Indonesian government users (communities, foreign interests)? How might this be structured?

After discussion ending, the PST was reminded that a catalog for the FishGIS smartphone application for collecting coastal fisheries and environmental information developed during the Ciguatera project was published in September 2023 and could be downloaded from the project website and from the website of the Japan International Research Center for Agricultural Sciences (JIRCAS).

4. Summary report on the project budget

Dr. Alexander Bychkov provided a summary of the Year 1 budget, showing the expenditures to date and the funds remaining ($23,388, or $17,797 if we are to cover expenses for Stanford Laboratory). The central message was that, most likely, there is insufficient funding to organize another training workshop of the same scale as in July by the Year 1 end. There was discussion about whether to have a smaller, more focused workshop in February–March 2024, or to enquire MAFF/JFA about the possibility of holding these funds over until Year 2 and to conduct a larger workshop in April–May 2024. It was decided to request permission to roll over a portion of the Year 1 budget to Year 2.

5. Related information to the project (by virtual participants from Korea and Russia)

There were no additional inputs to the project from Russia or Korea.

6. Workplan for the rest of Year 1 and Year 2

The specific plans for the remaining months in Year 1 depend largely on the outcome of the funding enquiry to MAFF/JFA whether a portion of the Year 1 budget could be rolled over to Year 2. Thus, the discussion instead centered on more general strategies/approaches for moving forward. It was decided that the focus should be on University of Mataram students and faculty who would be interested in collaborating in the project or in using the FishGIS application and Planktoscope for related projects. There was question about whether we might also invite government officials and NGOs who wish to participate by using these tools, including perhaps those identified by Dr. Sachoemar (see item 3b) on East Borneo (Mulawarman University), on Seribu Island (local government), and on Belitung Island (local government), assuming they will join at their own expense. It was suggested to consider conducting a 1-day workshop at the University of Mataram which could be joined easily by local participants, and then, perhaps, work more individually with interested groups to design their projects. It was clear that the next training workshop has to demonstrate how the information is going to be used (that is, data analysis and interpretation). It may be possible to do some of this as on-line training before or after the workshop.

7. Discussion on data policy and smartphone application use by other organizations

As noted in Item 3c, there have been enquiries from commercial and research enterprises about the potential use the FishGIS application in their projects. We currently lack a data policy to deal with this encouraging development. Dr. Takemura presented three potential options that could be applied in different situations:

(A) Allow for free distribution and use of the application, with collected data being stored in a database managed by PICES. This option was envisioned for other researchers (*e.g*., Universities, NGOs) gathering environmental data for scientific reports and publications. PICES would retain access to the reported data and use these data with the consent of the reporter.

(B) Create a paid distribution option, where users collect and store data in a database independent of PICES. In this case, the PICES data policy would need to be revised to state that PICES would not have access to the collected data.

(C) Allow GFL (Green Front Laboratory, Japan) to develop enterprise versions of the application, designed for specific uses by primarily government or commercial entities. In this case, PICES would not have access to the collected data. This option also would require modifications to the PICES data policy.

It was noted by PST members that funding support will be needed to maintain and update versions of the FishGIS application after the MAFF project is completed. Charging user fees for the application would limit its use by researchers in developing nations, and perhaps NGO's, but modest user fees would not be problematic for commercial and government enterprises. It was decided to explore more options A and C, given that GFL would be the natural provider for application maintenance and database operation. A fee structure will need to be developed that is graded for different users (*e.g.*, commercial vs. governments in developing nations).

8. CLOSING

In closing, it was decided to schedule an online PST meeting in late November/early December. By that time, we should know the remaining Year 1 funds and whether a portion of the Year 1 budget could be rolled over to Year 2. This information will enable us to determine the timing and structure of the next training workshop in Lombok.

Addendum 1

Second Project Science Team meeting participants

Members

Daisuke Ambe (Japan, representing TCODE)
Mitsutaku Makino (Co-Chair; Japan, representing HD)
Shion Takemura (Japan, representing HD)
Naoki Tojo (Japan, representing FIS)
Vera Trainer (USA, representing MEQ; only in the afternoon)
Charles Trick (Canada, representing MEQ)
Pengbin Wang (China, representing MEQ)
Mark Wells (Co-Chair; USA, representing MEQ)
Alexander Bychkov (PICES, *ex-officio*)

Members (remotely)

Moonho Son (Korea, representing MEQ; only afternoon)

Other

Yutaka Hiroe (MAFF/JFA, Japan)
Suhendar I Sachoemar (BRIN and ITI, Indonesia)
Ruo Yu (SIO, Ministry of Natural Resources, China

Addendum 2

Second Project Science Team meeting agenda

Friday, October 20, 2023 (09:00 – 17:30)
St. Helens Room at the Westin Hotel, Seattle, USA

1. Welcome remarks, introductions, adoption of the agenda and nomination of the rapporteur
2. Report of the last MAFF project (Ciguatera) and introduction to this project (FishPhytO)
3. Intermediate report of project activities in Year 1
    a) July 2023 training workshops in Lombok
    b) Data collection (Phytoplankton, HyroColor, Fish images) in Indonesia
    c) Update on smartphone applications
    d) Others (Project Design Matrix, etc.)
4. Summary report on the project budget
5. Related information to the project (by virtual participants from Korea and Russia)
6. Workplan for the rest of Year 1 and Year 2
7. Discussion on data policy and smartphone application use by other organizations
8. Closing

APPENDIX 5: SUMMARY OF THE THIRD FISHPHYTO PROJECT SCIENCE TEAM MEETING

The third virtual meeting of the Project Science Team (PST) for the project on "*Creating a phytoplankton-fishery observing program for sustaining local communities in Indonesian coastal waters*" (FishPhytO), funded by the Ministry of Agriculture, Forestry and Fisheries (MAFF) of Japan, through the Fisheries Agency of Japan (JFA), was held from 10:00–12:00 JST (Japan Standard Time) on February 2, 2024 (February 1, 2024 in the Western Pacific). Participants of the meeting are listed in Addendum.

Considering information from JFA that MAFF's funding for the project will end after completion of the first year (March 31, 2024), the sole objective of the meeting was to consider options for supporting FishPhytO-related activities. A number of confirmed and potential funding sources have been discussed:

1. Indonesian colleagues have secured funding for two projects to continue FishPhytO-related work in the Gili Matra region:
   - The Ministry of Finance's Research and Innovation for Advanced Indonesia Program will provide ~$40,000 CAD for a 3-year (2024–2026) project, entitled "Ciguatera Fish Poisoning and Hazardous Algae Disaster Mitigation Model Development Activities in the Gili Matra Aquatic Tourism Park (TWP) area". This budget will allow conducting two 4-day surveys every year – in February (Wet Season) and in August (Dry Season), for collecting and processing data on water quality, water column and benthic plankton, and socioeconomics. The FishGIS and HydroColor smartphone tools and Planktoscope are expected to be widely used in these surveys, as well as the methodology developed during the previous PICES/MAFF projects for gathering socioeconomic information (on-site surveys, questionnaires, and focus group discussions).
   - The Research Organization for Electronics and Informatics under the National Research and Innovation Agency (BRIN) will fund a 1-year project on "Utilization of Oceanographic and Landsat Satellite Image Data for Monitoring Eutrophication and Abundance of Fishery Resources in the TWP area". The budget for this activity and restrictions on the usage of these funds (normally limited to data collection and processing) have yet to be determined.
2. PICES will designate ~$30,000 CAD the Special Project Coordination Fund to cover time/work of an individual needed for coordination of FishPhytO-related research in the next two years – April 1, 2024 to March 31, 2026.
3. The Fisheries Research and Education Agency (FRA) of Japan is considering a possibility of allocating 1,500,000 JPY (~$14,000 CAD) from the FRA President Fund for FishPhytO-related activities for the period from April 1, 2024 to March 31, 2025 and, likely, the similar amount for the period from April 1, 2025 to March 31, 2026. If the budget is provided, there will be no restrictions on the usage of these funds.
4. FishGIS, a service that includes three components: a smartphone application (FishGIS application), a secure GIS-based cloud database (FishGIS database) and a web application for a desktop PC (FishGIS dashboard), is a product developed and refined during the previous two PICES/MAFF projects, FishGIS (2017–2020) and Ciguatera (2020–2023), and the first year of the FishPhytO project. All work on FishGIS was done by Green Front Laboratory, Inc. (GFL, Japan), contracted by PICES with funding from MAFF, and was conducted in consultations with members of the Project Science Team (Dr. Shion Takemura led this activity within the PST). According to the Project Principles documents for all PICES/MAFF projects, "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", and this means that FishGIS, as one of outcomes of these projects, belongs to both PICES and the Government of Japan (MAFF).

   Should "the intellectual property rights" issue be resolved, GFL could continue maintaining the FishGIS application and a FishGIS server in Japan under a new 3-year project between the Atmosphere and Ocean Research Institute of the University of Tokyo (AORI) and Nippon Foundation with an annual budget of 2,000,000–3,000,000 JPY. MAFF is considering to issue a document that (1) allows to modify the current version of the FishGIS application and to provide this application to other projects or businesses, including for a fee, and (2) confirms that MAFF will not claim ownership of any data collected from the use of the FishGIS application by PICES or any such projects or businesses.

A question was also raised on the accounting, considering that support for FishPhytO-related activities in the next two years might have several funding sources. It was pointed out that PICES has experience in conducting projects with several funding sources, when each source has its own rules and restrictions (examples here include the CPR project and joint symposia with numerous co-sponsors). In this situation, following the PICES Financial Regulations, an encumbered fund is normally created within the Working Capital Fund for all potential contributions.

Addendum

Third Project Science Team meeting participants

Members

Daisuke Ambe (Japan, representing TCODE)
Mitsutaku Makino (Co-Chair; Japan, representing HD)
Shion Takemura (Japan, representing HD)
Naoki Tojo (Japan, representing FIS)
Charles Trick (Canada, representing MEQ)
Pengbin Wang (China, representing MEQ; part of the meeting)
Mark Wells (Co-Chair; USA, representing MEQ)

Other

Yutaka Hiroe (MAFF/JFA, Japan)
Tatsuki Oshima (MAFF/JFA, Japan)
Arief Rachman (BRIN, Indonesia)
Suhendar I Sachoemar (BRIN and ITI, Indonesia)

APPENDIX 6: MAJOR FISHGIS UPDATES

1. MODIFICATION AND REFINEMENT PLAN

The needs for further improvements of the FishGIS smartphone application, that should allow to more effectively monitor coastal ecosystems, were identified through the sixth PST meeting of the PICES/MAFF Ciguatera project (October 2022, Busan, Korea), community training/capacity building workshops in Indonesia (January 2023 and July 2023, Lombok), and outreach in Japan (more than 10 presentation on the application at research meetings, academic conferences, *etc*.). Based on the stakeholders' opinions, a 3-year modification and refinement plan was formulated (Table 1), and the following four items were selected to work on during Year 1 (2023–2024) of the FishPhytO project: (1) multilingualization of the application, (2) a reporting function for the application enabling users to select image size, (3) a reporting function for the application allowing users to add comments to the image file, and (4) an account authorization function for PC web application.

Table 1 FishGIS service: A 3-year modification and refinement plan.

Plan	Additional functions	Feedbacks and needs from SHs
FY2023 (Year1)	Multilingualization of app	Necessary for horizontal deployment of FishGIS to PICES member states
	Reporting function for high-resolution image	Resolutions of images are sometime low. Also, the original images & movies should be stored on own smartphone.
	Reporting function for comments with images	Even if the relevant fish species is not an option, comments can be written if available.
	Account authorization function (for PC management page)	Necessary for horizontal deployment of FishGIS to PICES member states.
FY2024 (Year2)	Reporting function for new items	Some SHs want to report information on sea turtles, dolphins, seabirds, etc.
	Chat function	Interactive chat functions such like SNS app (LINE, What's up, FB etc.) would be easier to report.
	Water profile data visualization function	Some researchers want to transmit information on observation data to citizens via smartphone.
	Fish body size data visualization function	Some researchers want to transmit information on fish body size information for fishers via smartphone.
	Input/output function for water profile and fish body size data (for PC management page)	Functions required to visualize water quality and length composition data on smartphones.
FY2025 (Year3)	Function to protect information on fishing ground.	The location of fishing grounds should be secured.
	New system to store reporting data in a database* independent of PICES	ABS compliance; Data transfer to the Japanese server has been stopped. However, additional costs are incurred.

* Google Firebase

2. REFINEMENT OF THE FISHGIS SMARTPHONE APPLICATION

Multilingualization

The new version of the application is multilingual, supporting four languages (Chinese, Korean, Japanese, and Russian) in addition to Indonesian-Bahasa and English in the previous version (Fig. 1). The multilingualization of the application is essential for deploying this tool in PICES member countries and was achieved with the contribution of experts from PICES member countries. Users can select their language during the initial setup screen. After the initial setup, the language can be changed from the account setup screen. Fish groups and their illustrations can be customized according to the reality of each country's fishing industry. For example, Japan and Russia have modified their illustrations and reporting content to match the major fish species in their countries (Fig. 2).

Fig. 1 New multilingual version of the FishGIS application supporting six languages (English, Chinese, Japanese, Indonesian-Bahasa, Korean, and Russian).

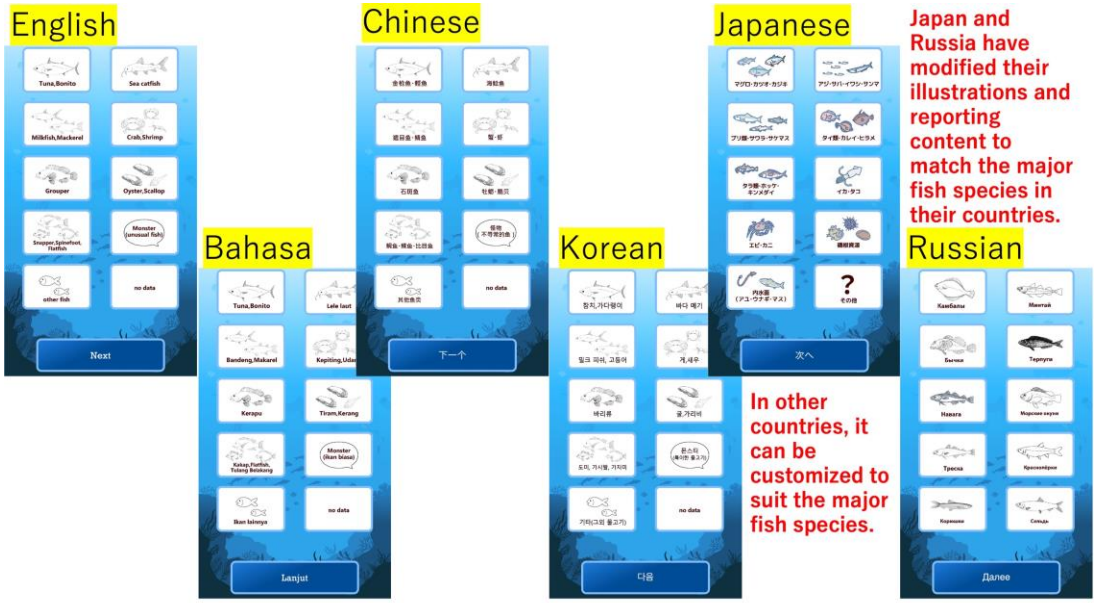

Fig. 2 Major fish species (names and illustrations) customized by country in the new multilingual version of the FishGIS application.

New reporting function for selecting image resolution

In previous versions of the FishGIS application, images were compressed to a width of 500 pixels across the image. As a result, images taken in the landscape orientation had very low resolution compared to those taken in the portrait orientation. In addition, portrait-orientated images, especially those taken early in the morning, had coarse resolution and, in some cases, it was difficult to identify the species of fish. In the new version, a reporting function enables users to select a size of the image (Fig. 3). They can choose one of three resolutions: (1) LARGE – the original (uncompressed) image, (2) MEDIUM – an image compressed to 1500 pixels on the short side (~1.5MB), and (3) SMALL – an image compressed to 500 pixels on the short side (~500 KB; the

same compression ratio as the previous version). Selecting SMALL is useful in weak cellphone coverage zones and/or to lower costs for image transmission. By selecting LARGE and MEDIUM, better quality images can be reported. On the other hand, these settings increase communication time required to transmit the reported data. Of importance is also that now the original images and recorded videos are stored in the device.

Fig. 3 Reporting function enabling users to select a size of the image in the new version of FishGIS application.

New reporting function for adding comments with images

The new version of the application allows users to add comments to the image file (Fig. 4). By utilizing the comment function, meta-information can be recorded along with the catch images. Table 2 shows examples of meta-information collected with catch images, including species, area of catch, price, and cooking method.

Fig. 4 Reporting function enabling users to add comments to the image in the new version of FishGIS application.

Table 2 Examples of meta-information collected with catch images when utilizing the comment function in the new version of the FishGIS application.

Date	Research Type	File Name	Country	Group Id	Report Comment
2024/03/10 11:13:00 JST	Fish	IMG20240310111300_SzcPQk1vBBnSnrhpCbpb.jpeg	Indonesia	000002	"nama pencaran, harga 20/Kg , laut Ampenan , goreng dan kuah kuning"
2024/03/10 11:10:40 JST	Fish	IMG20240310111040_y4aZa5Jgnjy9jONI1Dq1.jpeg	Indonesia	000002	"nama ikan lajang, 50/Kg, berasal laut Ampenan, bisa d olah lalapan dan kuah kuning"
2024/03/10 11:07:42 JST	Fish	IMG20240310110742_ogr9iLw9VtHrz2fXdFhq.jpeg	Indonesia	000002	"ikan tongkol putih , 20/Kg, pantai Ampenan, di olah bisa untuk goreng dan kuah kuning"
2024/03/10 11:04:46 JST	Fish	IMG20240310110446_I4TC9yhP7bbDPMsQAdZv.jpeg	Indonesia	000002	ikan kakap dengan harga 85.000 perkilo diambil di laut sekitaran ampenan biasa dimasak dan di bakar
2024/03/10 10:56:47 JST	Fish	IMG20240310105647_i4niNWFszowjZ2VANu3M.jpeg	Indonesia	000002	"Ikan lajang65.000 per kilogramDi laut ampenanBerfungsi dimasak digoreng"
2024/03/10 10:53:35 JST	Fish	IMG20240310105335_HAUGltVuUQZVaeUFeH5h.jpeg	Indonesia	000002	"nama ikan manila , lokasi tangkap ampenan,tanjung luar , harga 30/jg, bisa di olah menjadi ikan bakar bisa di kuah, kuah kuning soup"
2024/03/10 10:49:46 JST	Fish	IMG20240310104946_c1nEEQwXDxCsiT3ktAxN.jpeg	Indonesia	000002	"ikan beronang, diambil dari sekotong, harga perkilo 75rb, di dibakar, dan dibumbu kuning"
2024/03/10 10:46:36 JST	Fish	IMG20240310104636_vWQ0WCJ4XeEhwERxdRN4.jpeg	Indonesia	000002	"ikan lanjang, diambil dari Tanjung luar, dijual 1kg 70rb, dibakar,"
2024/03/10 10:05:20 JST	Fish	IMG20240310100520_49VZRD1SBNSHPyxoJFFq.jpeg	Indonesia	000002	"Ikan Barakudaperkilo 50.000lokasi pengambilan pantai ampenanbiasa di masak bumbu kuningdan digoreng"

1. MODIFICATION OF THE WEB APPLICATION FOR PC (FISHGIS DASHBOARD)

In the previous two PICES/MAFF projects, FishGIS (2017–2020) and Ciguatera (2020–2023), data managers in Indonesia or PICES experts in the project team needed only view and download survey data in Indonesia. In the FishPhytO project, the authorization should be changed to allow researchers in each member country to view and download their own survey data for horizontal deployment to PICES member countries (with limited access for researchers in other member countries). Data managers in each PICES member country also require the authorization to freely issue group IDs for their country. Thus, new account and data management functions need to be added to the system, and the user dashboard interface should be redesigned.

User interface

The FishGIS dashboard has now a completely reformed user interface. The data search page in the previous version only allowed users to search for data by monitoring item, group ID, or reporter name. This constraint made data handling difficult and prevented rapid utilization of reported data (Fig. 5). In the new version, data managers can search by monitoring item, data reporting date (period), group ID, reporter name, and comments, and also download images and meta-information (CSV) that match the search criteria in a batch (Fig. 6).

The data viewing page has been redesigned to provide a seamless transition from the data search page. In the previous version, the screen transition from the data search page to the data viewing page was not continuous, making it difficult to review the reported data. The new version allows users to browse the data viewing page from the data search page, and then smoothly transition back when viewing is complete (Fig. 7).

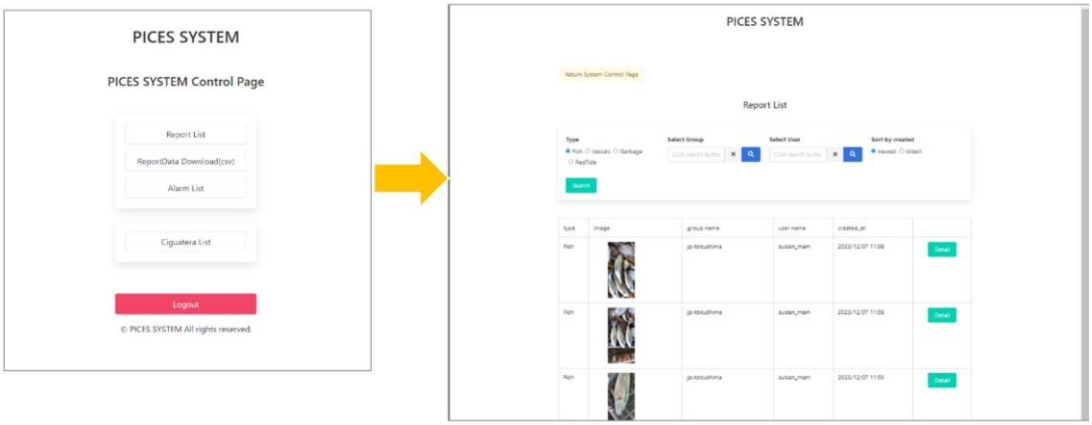

Fig. 5 Data search page in the previous version of the FishGIS dashboard.

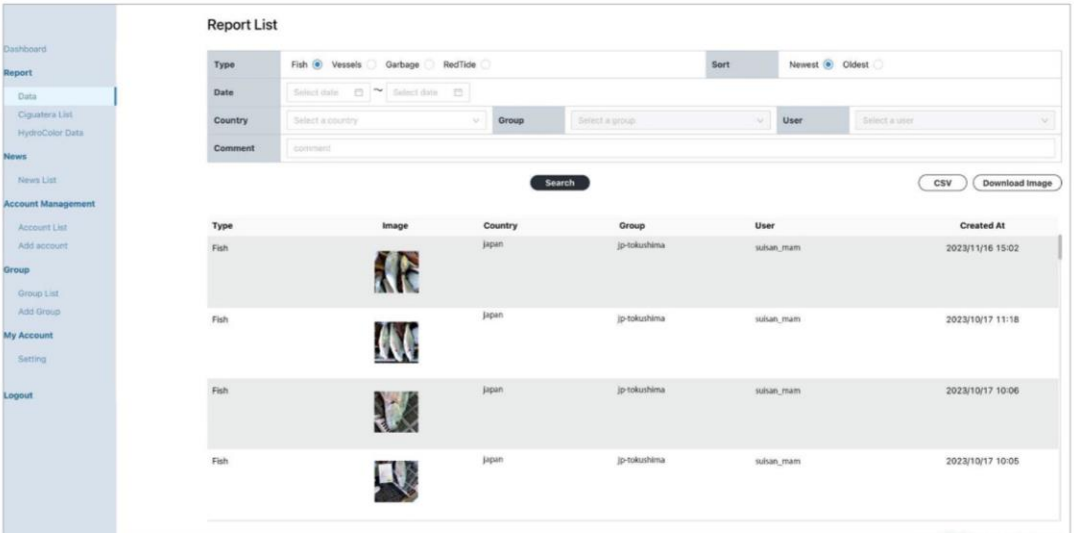

Fig. 6 Data search page in the new version of the FishGIS dashboard.

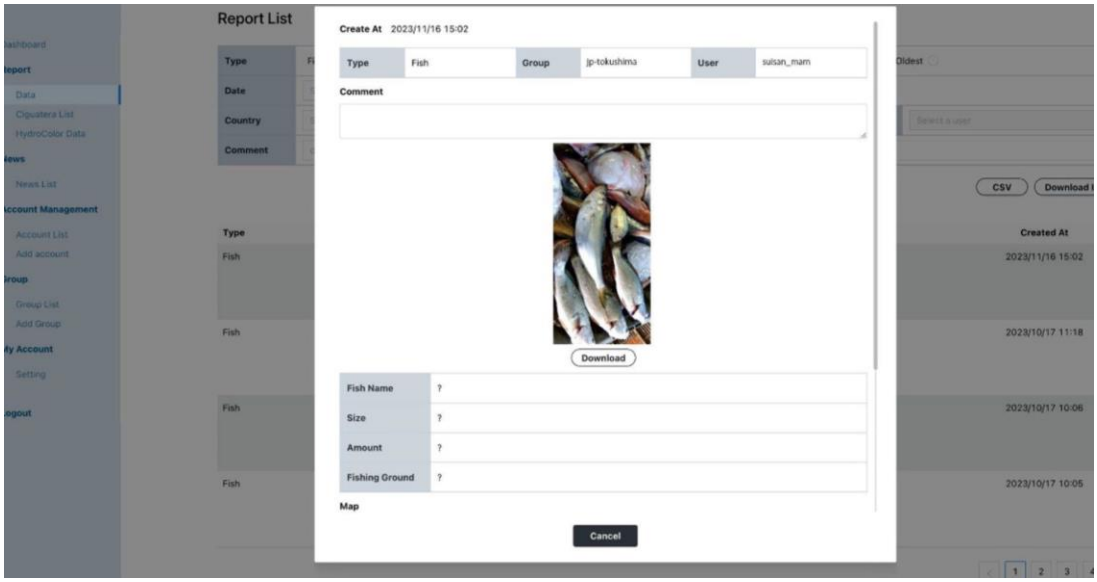

Fig. 7 Screen transition from the data search page to the data viewing page in the new version of the FishGIS dashboard.

New function for account management

The functions available to an account in the new version of the FishGIS dashboard differ by the level of permission. There are four types of accounts: full authority administrator, country administrator, group administrator, and general user (Table 3). Only those with administrator-type accounts are allowed to add new accounts, change the permissions for existing users, and register new group IDs (Fig. 8). Country administrators are permitted to manage accounts and group IDs associated with their own country, but they do not have the authority to manage accounts associated with other countries. Similarly, group administrators are only authorized to deal with accounts related to their own group. General users do not have permission to manage accounts.

Table 3 Account types and account management permissions in the new version of the FishGIS dashboard.

	Account management		
	Add/Edit GroupID	Add/Edit accounts	Add/Delete news
admin	yes	yes (all accounts)	yes
Country administrator	yes	yes (Group administrators and Users)	no
Group administrator	no	yes (Users)	no
User	no	no	no

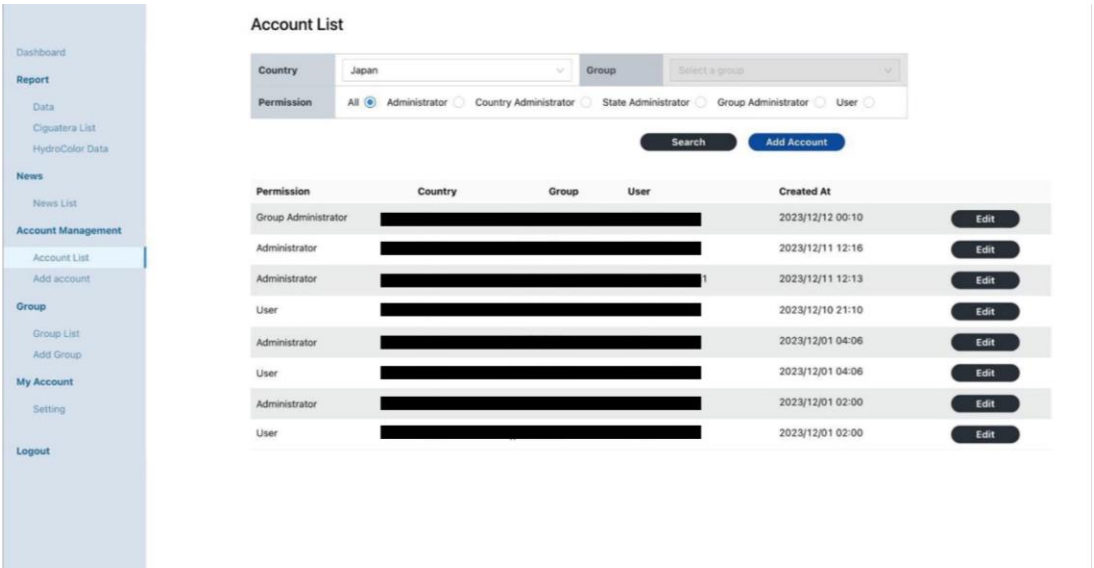

Fig. 8 Account management function in the new version of the FishGIS dashboard.

New function for data management

The new version of the FishGIS dashboard also has an enhanced data management function allowing to restrict data viewing by account type. Account types and data management permissions are shown in Table 4. Country administrators are allowed to manage submitted data (*e.g.*, FishGIS images, HydroColor data) tied to their own country, but do not have the authority to do this for other countries and cannot view data reported from other

countries. Similarly, group administrators are authorized to manage only data associated with their own group. General users are permitted only to view data associated with their group.

Table 4　Account types and data management permissions in the new version of the FishGIS dashboard.

	Data Management			
	View image data	Download image data	Import/Expot HydroColor data	Import/Expot Ciguatera data
admin	yes (all data)	yes (all data)	yes (all data)	yes (all data)
Country administrator	yes (limited to own country data)	yes (limited to own country data)	yes (limited to own country data)	yes (limited to own country data)
Group administrator	yes (limited to own group data)	yes (limited to own group data)	yes (limited to own group data)	yes (limited to own group data)
User	yes (limited to own group data)	no	no	no