NORTH PACIFIC MARINE SCIENCE ORGANIZATION (PICES)
PROJECT ON "*MARINE ECOSYSTEM HEALTH AND HUMAN WELL-BEING*" (MarWeB)

SCIENTIFIC PROGRESS REPORT FOR YEAR 2 (APRIL 1, 2013–MARCH 31, 2014)

1. BACKGROUND

In December 2011, the Ministry of Agriculture, Forestry and Fisheries (MAFF) of Japan, through the Fisheries Agency of Japan (JFA), approved funding for a 5-year PICES project on "*Marine Ecosystem Health and Human Well-Being*". The project began in April 2012, and is expected to be completed by March 31, 2017. Its goal is to identify the relationships between sustainable human communities and productive marine ecosystems in the North Pacific, under the concept of fishery social-ecological systems (known in Japan as the "Sato-umi" fisheries management system). It recognizes that global changes are affecting both climate and human social and economic conditions. Key questions of the project are: a) how do marine ecosystems support human well-being? and b) how do human communities support sustainable and productive marine ecosystems? The project is also intended to foster partnerships with non-PICES member countries and related international programs and organizations. This contribution is from the Official Development Assistance (ODA) Fund and therefore, involvement of developing Pacific Rim countries in activities is required under this project.

The following organizational principles, agreed upon by MAFF/JFA and PICES, apply to the project:

- The Project is expected to have strong connections and interactions with, and to involve and support the relevant activities of, the PICES FUTURE (Forecasting and Understanding Trends, Uncertainty and Responses of North Pacific Marine Ecosystems) science program and PICES expert groups (Project Principle 3.1; Fig. 1).
- The project is directed by a Project Science Team (PST), co-chaired by Drs. Mitsutaku Makino (Fisheries Research Agency, Japan, mmakino@affrc.go.jp) and Ian Perry (Department of Fisheries and Oceans, Canada; Ian.Perry@dfo-mpo.gc.ca), with membership from PICES and non-PICES countries, as deemed appropriate (Project Principle 3.1).
- The PST Co-Chairmen are responsible for the scientific implementation of the project and reporting annually to MAFF/JFA and PICES Science Board. The report should be submitted to JFA within 120 days after the close of each project year ending March 31, and include a summary of the activities carried out in the year, with an evaluation on the progress made, and a workplan for the following year (Project Principle 3.2).

This progress report summarizes the activities carried out for Year 2 (FY 2013: April 1, 2013–March 31, 2014) and includes a workplan for Year 3 (FY 2014: April 1, 2014–March 31, 2015). The financial report for Year 2 is being submitted as a separate document simultaneously with this progress report.

2. WORKPLAN FOR YEAR 2

(1) Project Science Team meetings
- Organize two PST meetings, one inter-sessional and one in conjunction with the 2013 PICES Annual Meeting (October 2013, Nanaimo, Canada).

(2) Case studies

In Indonesia
- Set-up a pond experiment and carry out a Nutrient and phytoplankton training workshop;
- Model the carrying capacity of the experimental pond site;
- Conduct a social human well-being survey;
- Initiate preparations for an Indonesia training workshop to be conducted in Year 3.

In Guatemala
- Identify the potential topics to be investigated, which are likely to include issues of integrated multitrophic aquaculture and local development (to be comparable with the Indonesia case study) and initiate a field study.

In Palau

- Initiate information gathering for the workshop to be conducted in Year 3.

(3) Human well-being surveys

- Analyze the results from the 2012 human "well-being" survey in Japan and, based on these results, conduct human "well-being" surveys in Korea and USA to enable international comparisons.

(4) Database

- Initiate development of a database containing a bibliography of social-ecological systems interactions, the well-being survey data and information from the Indonesia and Guatemala case studies.

3. PROGRESS OF YEAR 2

3.1 Project Science Team meetings

The Project Science Team (PST) was established in August 2012 (Year 1) in order to review the scientific progress, and make recommendations on the further implementation of the project. During Year 2, the PST membership was revised to better match the case studies that are being developed. As of June 2014, the PST membership includes 13 scientists: 4 from Canada, 3 from Japan, 2 from Korea and 3 from USA, and a representative from the PICES Secretariat (Table 1). A total of six PICES expert groups are represented on the Team: Section on *Hunan Dimensions of Marine Systems* (S-HD), Section on *Climate Change Effects on Marine Ecosystems* (S-CCME), Section on *Ecology of Harmful Algal Blooms in the North Pacific* (S-HAB), Working Group on *Non-indigenous Aquatic Species* (WG 21), Working Group on *Development of Ecosystem Indicators to Characterize Ecosystem Responses to Multiple Stressors* (WG 28) and FUTURE Scientific Steering Committee (FUTURE SSC).

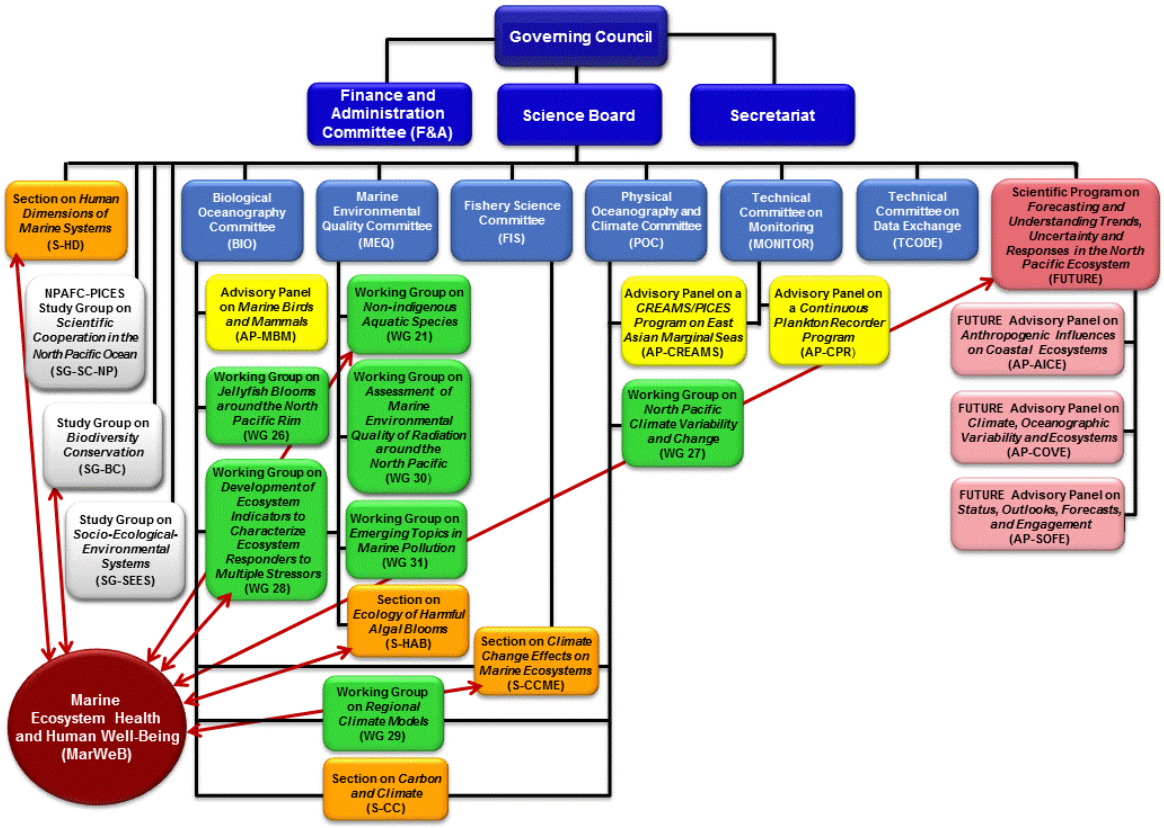


Fig. 1 PICES (North Pacific Marine Science Organization) structure for 2013–2014 showing links between the MarWeB project and expert groups.

Table 1 Membership of the Project Science Team (as of June 2014)

Name	Affiliation	Country/Group
Dr. Harold Batchelder	PICES Secretariat	PICES
Dr. Keith Criddle	University of Alaska, Fairbanks	USA/S-HD
Ms. Juri Hori	Rikkyo University	Japan/S-HD
Dr. Masahito Hirota	Fisheries Research Agency	Japan/S-HD
Dr. Suam Kim	Pukyong National University	Korea/S-CCME
Dr. Mitsutaku Makino	Fisheries Research Agency	Japan/S-HD
Dr. Grant Murray	Vancouver Island University	Canada/S-HD
Dr. Dohoon Kim	Nat'l Fisheries Res. and Development Inst.	Korea/S-HD
Dr. Ian Perry	Department of Fisheries and Oceans	Canada/WG 28
Dr. Thomas Therriault	Department of Fisheries and Oceans	Canada/WG 21/FUTURE SSC
Dr. Vera Trainer	Northeast Fisheries Science Center	USA/S-HAB
Dr. Charles Trick	University of Western Ontario	Canada/S-HAB
Dr. Mark Wells	University of Maine	USA/S-HAB

In Year 2, two PST meetings were organized. The first meeting was held June 10–12, 2013, in Honolulu, USA, and focused on plans for workshops, experiments and social science surveys in Indonesia. Also, the name "MarWeB", for Marine Ecosystem Health and Human Well-Being, was adopted as an acronym for the project. The second meeting was convened October 10, 2013, in Nanaimo, Canada, in conjunction with the 2013 PICES Annual Meeting, and focused on developing plans for research activities in Guatemala. A 0.5-day Topic Session on "*Ecological and human social analyses and issues relating to Integrated Multi Trophic Aquaculture (IMTA)*", led by the MarWeB project, was proposed and accepted for the 2014 PICES Annual Meeting (Yeosu, Korea), and is currently being organized. The reports from both of these meetings and other materials, including two PICES Press articles describing the project's goals and activities, are available at http://meetings.pices.int/projects/marweb.

3.2 Case studies

3.2.1 Indonesia

Intensive shrimp aquaculture was developed in the Karawang area (3 hours from Jakarta) in the 1990s. This led to de-forestation, then marine pollution, shrimp mass-diseases, and ultimately to pond abandonment. The main issue is serious environmental degradation and land erosion due to removal of mangroves and building of coastal shrimp ponds. This has resulted in a current ecological system with intensive shrimp monoculture. The MarWeB project is developing a study on the use of IMTA (including seaweed, shrimp and fish) to demonstrate low emissions of deleterious materials into the natural environment and to provide alternative sources of protein and livelihoods for the local human population.

During Year 2, MarWeB activities included the following:

- Ecological systems:
  - Nutrient and phytoplankton training workshop;
  - Preparation for a pond experiment for IMTA;
  - Material circulation box-model development for analysing the carrying capacity of these systems.
- Social systems:
  - Basic social information collection (*i.e.*, statistics);
  - Commodity chain analysis for IMTA products;
  - Psychological analysis for human "well-being" ("Well-Being Cube" analysis).

Ecological systems

Project activities in Indonesia are being conducted in collaboration with BPPT (Badan Pengkajian dan Penerapan Teknologi; the Agency for the Assessment and Application of Technology, Jakarta), which is a non-departmental government agency under the coordination of the Ministry of Research and Technology,

responsible for carrying out government duties in the field of assessment and application of technology. An experimental plan has been developed for a MarWeB-sponsored GEMPITA (Sato-umi) pond experiment, to be conducted at the National Center for Brackishwater Aquaculture in Karawang. The main purpose of this experiment is to investigate the effects of IMTA on: (1) the economic return of pond operations, and (2) the water quality of the ponds. Water quality is defined in terms of the concentrations of nitrate/nitrite, ammonia, and phosphate, in addition to other parameters (*e.g.*, salinity, oxygen, phytoplankton, bacteria, *etc*.). The hypothesis being studied is whether the addition of bivalves (oysters) and seaweed into pond aquaculture of fish (*Tilapia* species) or shrimp will allow successful growth of all species, and decrease the nutrient (nitrite/nitrate, ammonia, phosphate) concentrations in the pond waters.

To build the methodological skills to conduct the experiment, a Nutrient and phytoplankton training workshop, led by Drs. Mitsutaku Makino and Mark Wells, was held March 25–26, 2014, at the National Center for Brackishwater Aquaculture. There were 16 official Indonesian participants. The workshop was a success, with the objectives fully met and the skills raised to the quality needed for publication of the pond experiment results (Fig. 2). Another training workshop is being planned to be held in Pekalongan in Year 3.

Dr. Susanna Nurdjaman (Bandung Institute of Technology) started the construction of the material circulation box-model in order to analyze the monitoring results from the pond experiment.

Fig. 2 Nutrient and phytoplankton training workshop held March 25–26, 2014, at the National Center for Brackishwater Aquaculture, Karawang, Indonesia.

Social systems:

Two social science field surveys were conducted in October 2013 and March 2014, with focus on mapping the commodity chains and collecting statistics in Karawang (Java) and Indonesia more broadly. This information consisted of the human dimensions (number of employees, income level of owner and employees, employee's education, age, sex, side jobs, work schedule, welfare or medical costs in terms of employment), business (commodities and commodity chain, value and amount of production, price, types of trading partners), and technical matters (original method, costs, environmental damages, new culture methods, strategies/perspectives

for the future). Figure 3 shows the commodity chain of the IMTA products, which was developed based on the information from the above two surveys. Also, in February and March 2014, the social survey for well-being ("Well-Being Cube" analysis), which was developed in Year 1, was conducted in Indonesia. A total of 200 samples were collected and now are being analyzed.

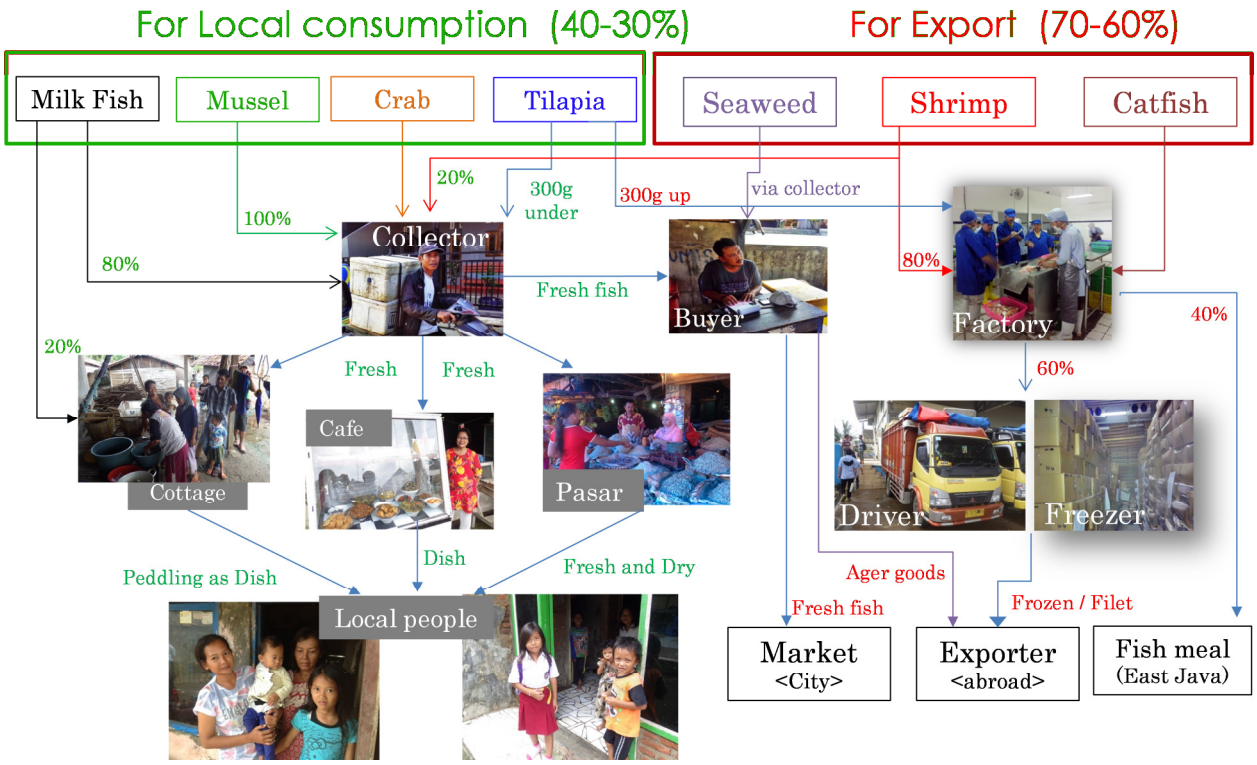


Fig. 3 Commodity chain of the IMTA products in Karawang area, Indonesia.

3.2.2 Guatemala

A scoping visit to Guatemala was conducted from January 27–31, 2014, to assess the possibility of this country being a case study within the MarWeB project to evaluate the relationships between coastal communities and the sea, and the potential to develop the use of IMTA. Four representatives from PICES met and discussed potential options for this work with government representatives, academic researchers, and community leaders and members in Guatemala City and along portions of the Pacific coast (Fig. 4).

The villages visited were Monterrico, Hawaii, and Las Lisas. It was apparent that complex relationships exist between members of the communities, shrimp farmers and government and academic institutions that varied in every community. These relationships appeared to be influenced by the degree of financial stability, the health of the estuaries and the degree of diversification of occupations, including fishing, aquaculture, agriculture and emerging tourism. A possible goal for the MarWeB project in Guatemala is being developed in collaboration with Guatemalan experts to expand the economic potential (shellfish aquaculture) to bring greater well-being to coastal communities. This would be a self-sustaining enterprise managed by a Guatemalan cooperative. A project which focusses on oyster aquaculture is proposed in collaboration with University of San Carlos professors, which will consider growth, processing and marketing aspects.

A social science survey to address "Sato-umi in developing nations" will be developed and applied to Guatemala in collaboration with Guatemalan University faculty and students, and coastal communities.

Fig. 4 At a Pacific coast village during a scoping visit of PICES representatives to Guatemala.

3.2.3 Palau

The original plan for the MarWeB project included 3 case studies: Indonesia, Guatemala, and Palau. However, based on the latest information collected from literature reviews, news media reports, and personal contacts with the people of Palau, it was decided to discontinue Palau as a third case study because of: (1) reductions in the project annual budget and (2) banning of fishing and conversion of all of Palau's Exclusive Economic Zone (EEZ) into a marine protected area. This decision was reported to MAFF/JFA by Dr. Makino.

3.3 Analysis of human well-being in relation to environmental conditions

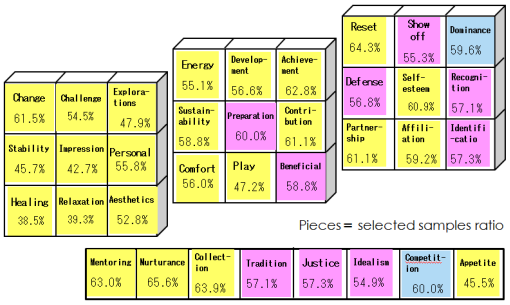
"Well-being" is defined by psychologists as involving peoples' positive evaluations of their lives such as positive emotions, engagement, satisfaction, and meaning. As indicated in the UN Millennium Ecosystem Assessment, human well-being (HWB) has multiple constituents, including basic materials for a good life, freedom and choice, health, good social relations, and security. The constituents of well-being, as experienced and perceived by people, are situation-dependent, reflecting local geography, culture, and ecological circumstances. These factors are complex and value-laden. In the present study, HWB is being explored as a means to connect ecosystem services, human well-being, and freedom of choice and action, and in part to understand motivations for these choices and actions.

In Year 1, a survey of 1000 people in Japan was conducted to further develop a methodology and to assess their relationships with the sea. In Year 2, the same type of questionnaire was used to survey 500 people in each Korea and the United States. In addition, as mentioned above, a survey of 200 people was conducted in collaboration with BPPT in several Indonesian provinces to provide data for analysis of well-being in relation to the sea (*i.e.*, in a Sato-umi context). Preliminary analysis of the results from these four countries shows significant differences. Overall results for Indonesia were consistent with a "high expectation"-type outcome, although results separated by different regions within Indonesia showed different outcomes indicating many important factors are involved. These results are currently being prepared for scientific publication (Fig. 5).

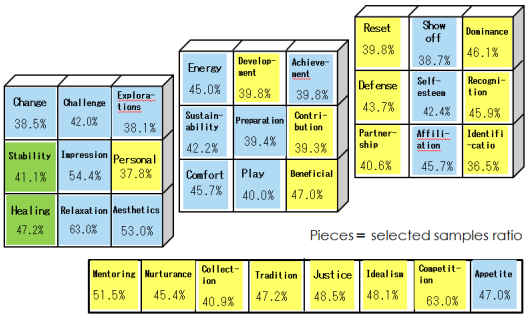
3.4 Database

Development of the database containing a bibliography of human–natural systems interactions and the well-being survey data and information from the Indonesia and Guatemala case studies is continuing.

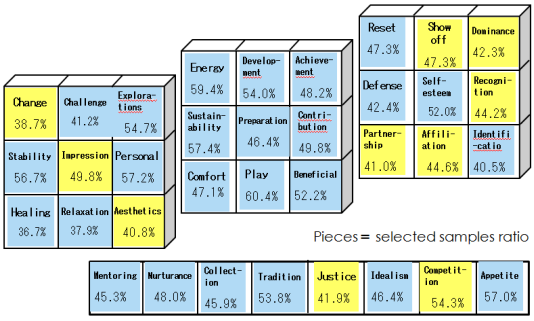
(a) Japan



(b) Korea



(c) USA



(d) Indonesia

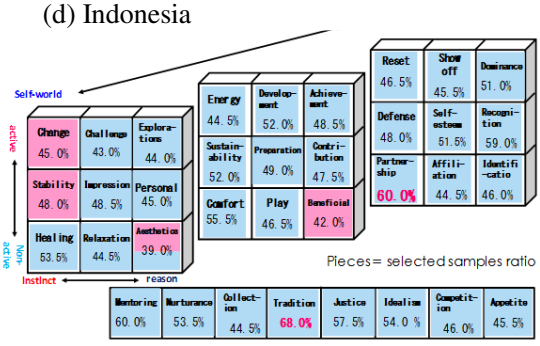


Fig. 5 Preliminary results of the human well-being (HWB) analysis in four countries.

4. WORKPLAN FOR YEAR 3

(1) Project Science Team meetings

- Organize two PST meetings, one inter-sessional (April 2014, Hawaii) and one in conjunction with the 2014 PICES Annual Meeting (October 2014, Yeosu, Korea).

(2) Case studies

In Indonesia

- Continue the IMTA pond experiment and theoretical modeling of potential carrying capacity with Indonesian partners at the Karawang experimental site;
- Hold a workshop in Pekalongan for manual development and transfer of lessons learned during the Karawang experiments to a second location;
- Conduct additional social survey.

In Guatemala

- Design a social survey to understand the local situation;
- Conduct a social science assessment of "Sato-umi" with local partners;
- Design and conduct an IMTA experiment, with a focus on development of oyster aquaculture, processing and marketing, in collaboration with local partners.

(3) Human well-being surveys

- Analyze the data and review the results from the human well-being surveys conducted in Japan, Korea, United States, and Indonesia.

(4) Database

- Continue to develop the database containing a bibliography of human–natural systems interactions and the well-being survey data and information from the Indonesia and Guatemala case studies;
- Start to build the on-line access system for sharing the contents of the database.