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Piloting and scaling of artificial intelligence technology for coastal fisheries data collection through USAID OurFish OurFuture activity

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Background

1. The purpose of this information paper (IP) is to briefly present the current work under the OurFish OurFuture activity to pilot and scale artificial intelligence (AI) technology for coastal fisheries data collection in the Pacific Islands. It is the intent of the authors to both connect our work to IP 13, “Boosting data collection in Pacific Island’s coastal fisheries using artificial intelligence technologies” (Shedrawi et al.), as well as provide CBFD3 participants and observers with an understanding of what these technologies look like and how they are used in the field right now.
2. The OurFish OurFuture (OurFish) activity is a five-year (2021-2026) cooperative agreement awarded by the U.S. Agency for International Development (USAID). OurFish is a regional activity with the overall goal to address community, national and ecosystem level drivers of illegal, unreported, and unregulated (IUU) fishing that are degrading coastal fisheries and biodiversity and negatively impacting local livelihood food stability and maritime security in the Pacific Island region. OurFish is implemented by a consortium of partners, including the University of Rhode Island (prime), the World Wildlife Fund (WWF), the Locally-Managed Marine Area Network (LMMA), and the University of the South Pacific.

OurFish’s AI technology

3. OurFish recognizes that modern fisheries management controls fishing by relying on data-driven assessments of fish population health, productivity, and the potential for sustainable extraction. Despite its importance, quantitative documentation of species composition and size distribution is often foregone because it requires enumerators to interrupt fishers or fish buyers. To address this problem and make the collection of landings data easier, faster, more accurate, more secure, easily sharable, and storable forever, OurFish is currently piloting a tool called Fisheries AI Sampling Technology (FAST), developed by MER Consultants, LLC.
4. FAST is high-tech, yet simple and robust tool designed to allow communities in the Pacific to collect high quality biological information on coastal fisheries in the most efficient and standardized way possible. In short, the data stream begins with hardware (“Smart Sampling Stations”), designed to fit each field site, with which the weight and a photograph of fish are very quickly captured (~2 seconds/fish). An open-source algorithm is then used in each country to automatically record length and species of each fish into a standardized database (see Figure 1). Initially, in each engagement, local experts verify the species IDs and length determinations until enough photos are collected from each location to allow the model to correctly ID and determine length for most key species in very little time. Once trained, the technology reduces both the training and amount of work required of a fisheries sampler so that anyone who can snap a picture can contribute data for management.

Current Status

5. Last August-October, OurFish piloted FAST at locations in three of its six target countries: (1) the Republic of the Marshall Islands, where stations were assembled at the MISCO market in Majuro and are being operated by the Marshall Islands Conservation Society (MICS) and in collaboration with the

Marshall Islands Marine Resource Authority (MIMRA); (2) Vanuatu, where stations were assembled at market locations in Port Vila (Shefa Province) and Tanna (Tafea Province) and are being operated by the Vanuatu Fisheries Department; and (3) the Solomon Islands, where stations were mobile stations were assembled and are being operated by WWF and in collaboration with private sector partners and the Ministry of Fisheries and Marine Resources (MFMR). To date, over 2,000 pictures with weights have been gathered and are currently being processed to train locally tailored algorithms and analyze data for delivery back to communities according to their needs.

Next Steps

6. Over the next year, OurFish will focus on validating and socializing FAST data with existing partners and other actors to demonstrate proof-of-concept, while also securing agreements to establish the data protocol for use in official management decisions. In years 4-5 of the OurFish, we will work to scale FAST—both scaling out to new locations, as well as scaling up via adoption by national agencies. In addition to enabling actions like developing a roadmap for program rollout based on sound statistical design, we believe the success of scaling adoption will flow from the realization of the following benefits by users, researchers, and scientists:
 - Accelerating the development and adoption of other data collection and decision-support applications, including other AI systems, such as IkaSavea, TAILS, SPS, and FishKit. FAST can be easily tailored to feed data directly to these systems, thereby quickly increasing the data available to users and developers.
 - Reducing the time and cost required to collect large amounts of high quality catch, weight, and length data, including from multispecies coastal fisheries.
 - Minimizing education or training requirements for data collection. While we strive to start each engagement with a fisheries representative guiding the process, once species ID is automated and length-weight relationships are specified, anyone with a camera can snap a picture and contribute data for management.
 - Quality Control and standardization. FAST does not require paper/pencil or transcription of field notes into data sheets or databases, thereby greatly reducing errors. Additionally, standardization will allow for universal quality control routines and data visualization packages to be established and used to support both localized and cross-site analysis.
 - Length-frequency data rapidly used for management advice. Given that data are available very quickly following data collection, samples can be taken directly into Length-Based Indicator (LBI) frameworks and used to guide community or national level management (depending on the amount/location of samples collected).
7. Through FAST, OurFish hopes that coastal communities will be able to improve their own locally-led management through the collaborative research process, assisted data analysis, and application of effective rules that are easy to understand, support, and follow. At the same time, we hope to support fisheries departments in project countries to be able to use this technology and approach to collect more and better data, thereby enabling better monitoring, management, and reporting on the status and trends in coastal fisheries that underpin the health and wellbeing of the Pacific Islands.



OurFish OurFuture REPUBLIC OF THE MARSHALL ISLANDS

Advanced Technology and Artificial Intelligence in Fisheries Sampling Leading data collection efforts in Pacific Coastal fisheries

The Future → FAST (Fisheries Assisted Sampling Technology)

Artificial intelligence (Ai) -assisted catch documentation provides a fast and easy way for fishers, community members, and fisheries professionals to collect reliable data. The hardware automatically captures the weight and a picture of each fish in less than 2 seconds. If fish are moved continuously, about 300 fish can be completed in 10 minutes. The Ai module will be trained specifically on the Marshall Island fish so that length and species ID (for those species commonly encountered) can be automatically generated after the first few months of sampling.

The Past → SLOW (and Expensive)

The days of extensive training, clipboards, rulers, and mis-identification / handwriting errors are gone. Recent advances in computer vision technology provides a new opportunity to process large amounts of high-quality data that can be submitted from members of all communities.

A world class comprehensive database, collected by Marshall Islanders, curated remotely, and owned by MIMRA is now a cost-effective option.

We have the Technology!



The Marshall Islands Marine Resource Authority (MIMRA) National Fisheries Policy, 2019-2029 (2019) includes the recognition and vision that:

“As a large ocean nation with a rich history in sustaining and being sustained by the resources of the sea, we commit to ensuring that our resilience in the face of global oceans challenges endures for generations to come.”

While there is no obvious 'silver bullet' solution, the pathway to making scientifically informed management decisions begins with data evaluations and:

Efficient Data Collection for a Sustainable Future



Figure 1. The automation of data collection in the field

Why this approach?

- **Efficient** – Faster and cost-effective data collection.
- **Collaborative** – Fishers, students, and virtually all community members can participate → greater transparency and faith in the data and decisions.
- **Defensible and Verifiable** – Quality controlled, standardized, and documented with a *curated library of pictures*.
- **Simple Standardized Data** – Over time, or across the Pacific, a consistent format facilitates visualization tools, remote analysis, and basin wide use (e.g. evaluating impacts of Climate Change).
- **Rapid Availability** – Minimal data-entry is required and thus information is almost immediately available for analyses and/or adaptive management advise.
- **Proven** – Five-years and 60,000 images of use in Puerto Rico, USA. Currently expanding to other Caribbean partners.

How does it work?

Phase I – Create Marshall Islands legacy image library

A local expert uses the first photographs captured in the field to identify species, then a basic spectral analysis is used to evaluate color patterns by species. This initial 'library' of images/color histograms then contains the reference information on the most common species in the Vanuatu coastal fisheries, from which our simple image analysis can begin to suggest the correct species within a specific fishery very quickly.



Figure 2. Annotation and species verification – Suggested species on right and length points shown in red circles.

Phase II – Ai Training for Length and Species ID

In simple terms, the hard technical work has already been completed. A process called 'Transfer – Learning' will be used to train all the algorithms developed for fish ID and length determination in Puerto Rico to the Marshall Islands. We will simply use images from the groupers and snappers landed in the Marshall I. fisheries, for example, to train the new model.



Figure 3. Automated object identification (tag for traceability; left), annotated lobster (center), and the heat map (right) of automated lobster carapace measurement.

Phase III – Length-based analyses, management advice and review of sampling design

Our collaboration with Jeremy Prince (*author of barefootecologist.com.au*) provides a practical, globally experienced team of experts in using length-based approaches. Even in Year 1, the size of the fish can be used to provide preliminary management advice. Evaluating the data streams and ensuring that sampling locations are representative of the fishery of interest allows for stronger conclusions to be drawn with each year of data collection.

A curated database for adaptive management and a standardized time-series for a changing environment



Figure 4. Dr. Todd Gedamke (above) and Dr. Jeremy Prince (right) lead community fisheries science in Belize and in Solomon Islands.

Phase IV – Visualization tools, assessment workshops and adaptive management

The standardization of data allows for the development of sophisticated visualization and analytical tools for multiple countries. At MIMRA's request, analyses, assessments, and even compiling annual reports can now be facilitated remotely. If desired, virtual annual workshops can be used to support analyses for adaptive management of the Solomon Islands coastal fisheries or collaborations to address larger scale Climate Change questions.

ABOUT US

OurFish OurFuture team is a partnership of University of Rhode Island's Coastal Resources Center; Locally Managed Marine Area Network; World Wildlife Fund, and The University of the South Pacific, and also collaborates closely with the Pacific Community (SPC), other regional fishery organizations, non-governmental organizations and civil society organizations, and relevant government authorities.

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Figure 1. Flyer on FAST distributed to partners and stakeholders in the Republic of the Marshall Islands. Separate versions were also produced for Vanuatu and the Solomon Islands.