Smartphone application to collect coastal fisheries and environmental information for adaptation to changes in the marine environment (FishGIS)

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Outline

Local fishers can quickly share information on changes in the marine environment and catches due to climate change among stakeholders through reporting of images such as catches and ocean colours, and the location where they were taken, using their smartphones.

Background/effect/note

The marine environment has considerably changed worldwide in recent years, and the species composition of catches is also changing. To adapt to changes in the marine environment and achieve sustainable fisheries, it is important to detect changes in the marine ecosystem and immediately share this information with stakeholders. Therefore, as part of the PICES/MAFF project "Building Local Warning Networks for the Detection and Human Dimension of Ciguatera Fish Poisoning in Indonesian Communities", funded by the Ministry of Agriculture, Forestry and Fisheries (MAFF) of Japan through the Fisheries Agency of Japan (JFA) from the Official Development Assistance (ODA) Fund, a research team consisting of researchers from the Japan Fisheries Research and Education Agency (Japan), Canada, China, South Korea, Russia and the USA developed a smartphone application for collecting coastal fisheries and environmental information (Fig. 1). With this application, local fishers can collect fish size distribution data from catch images (Fig. 1, left) and water quality parameters from ocean colour images (Fig. 1, right), as well as share the reported results with local stakeholders (e.g., fishers' groups, government officials). Thus, this application is a useful tool to facilitate fisheries resource assessment and management in Southeast Asia.

Fig.1. Examples of coastal fisheries and environmental information collected by FishGIS

Japan Fisheries Research and Education Agency

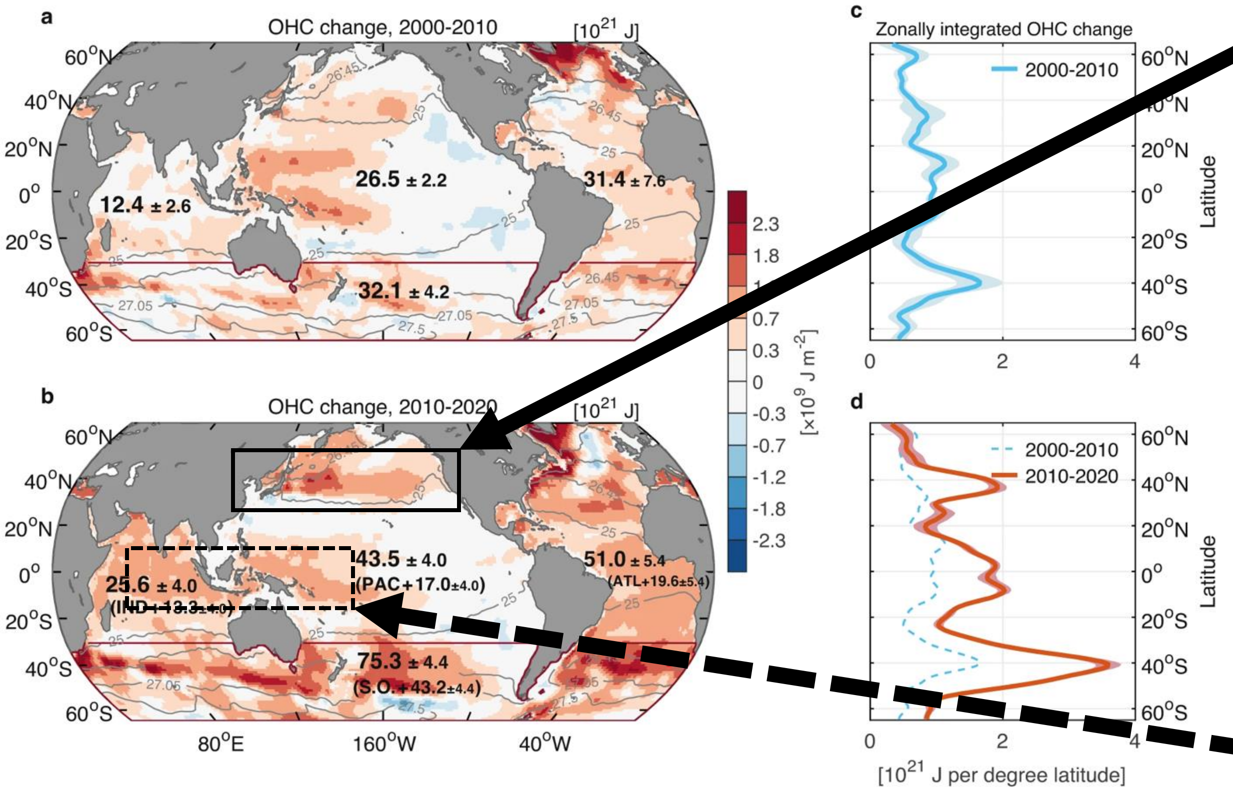
North Pacific Marine Science Organization

https://meetings.pices.int/projects/FishGIS
https://meetings.pices.int/projects/Ciguatera
https://apps.apple.com/jp/app/fishgis/id1550904014
https://play.google.com/store/apps/details?id=com.gfken.fishgis

Shion TAKEMURA

Japan Fisheries Research and Education Agency

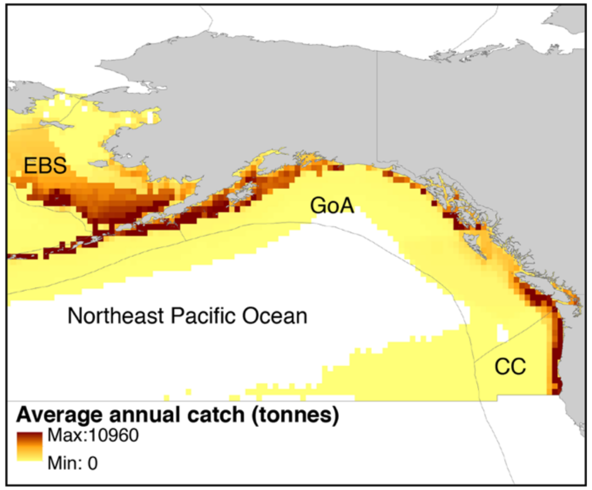
Global heat water

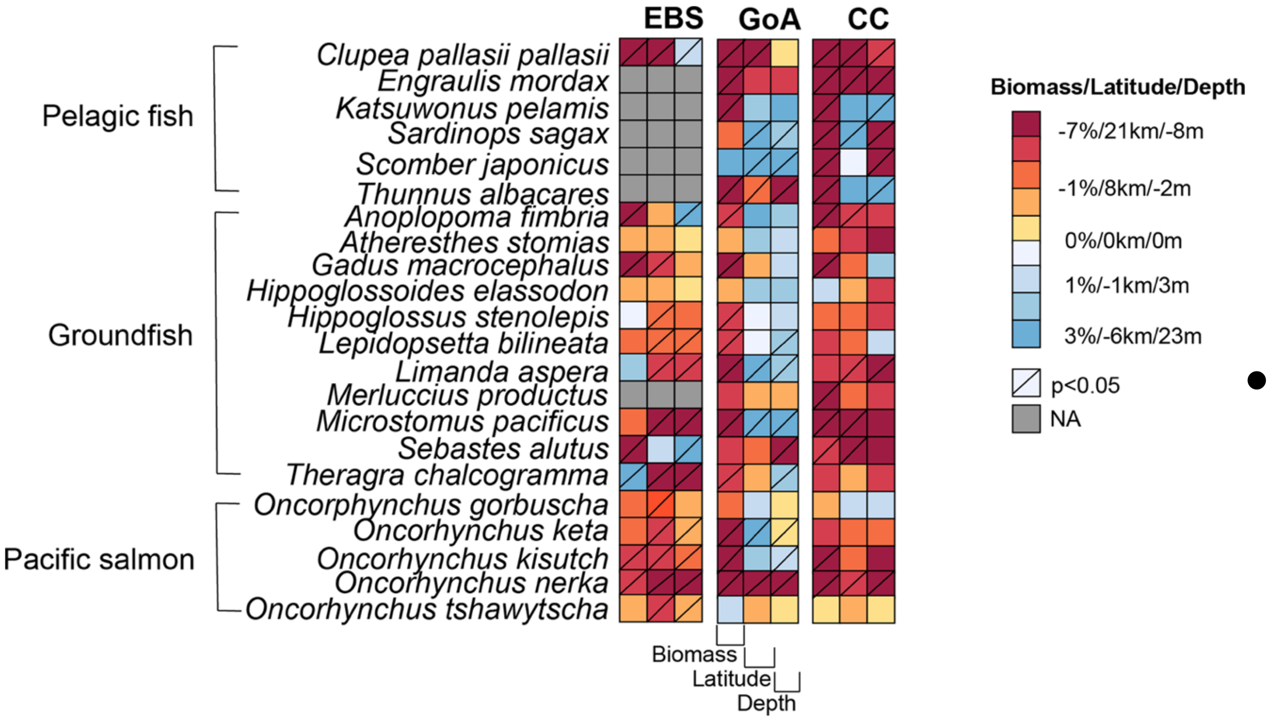


- Water temperatures are rising in the North Pacific Ocean (40°N).
- Sea waters are also rising in the surrounding waters of Indonesia (0°N).

Li et al (2023) Nature Communications, 14: 6888. Fig.2

Global heat water affects to fish community





Cheung & Frölicher (2020) Scientific Report, 10: 6678
Fig1, Fig4

- The biomass and distribution of fish (pelagic fish, groundfish and salmon) on the east coast of the North Pacific Ocean are changing due to global heat water.

- What about the Indonesian waters?
  → Fish are important resource for coastal communities. (small scale fisheries)
  → But, fisheries data is limited…

Challenges for adaptations to climate change in data-limited small scale fisheries (SSF) mgmt

1. to **detect** changes in the ocean ecosystem
2. to **share** this information rapidly among stakeholders
3. to **use** it for decision making on adaptation measures

Community-based monitoring

Humber et al (2017) Fisheries Research 186:131-143

Fisheries Research 186 (2017) 131–143

Contents lists available at ScienceDirect

Fisheries Research

journal homepage: www.elsevier.com/locate/fishres

Data collectors were also trained to use a simple digital camera to record catch in order to check the reliability of the data and reduce the possibility of falsified data. For each shark landed, biological data: species, pre-caudal length (PCL) (cm), pre-first dorsal length (cm) and sex were recorded, as were fisheries data: fishing site, method of capture and name of lead fisher.

Assessing the small-scale shark fishery of Madagascar through community-based monitoring and knowledge

Frances Humber[a,b,*], Emmanuel Trabonjy Andriamahaino[a], Thomas Beriziny[a], Radonirina Botosoamananto[a], Brendan John Godley[b], Charlotte Gough[a], Stephanie Pedron[a,1], Volanirina Ramahery[a], Annette Cameron Broderick[b]

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Scalloped hammerhead
Small-scale fisheries

ABSTRACT

Over 90% of those employed in commercial capture fisheries work in the
sector and an estimated 97% of small scale fishers are found in least deve
the capacity for monitoring SSF globally is low and there is a paucity of dat
areas within developing nations. The methods presented here demonstrat
approach for gathering data on small-scale fisheries, in particular for those th
areas. Community-based data collectors were trained to record biological a
the traditional (non-motorised) shark fishery in the Toliara region of Madaga
(2007–2012). An estimated 20 species of shark were recorded, of which 31
lewini (scalloped hammerhead), a species listed by the IUCN as Endangered (
number of sharks landed annually has not decreased during our survey peri
decrease in the average size of sharks caught. Despite multiple anecdotal r
declines, interviews and focus groups highlight the possibility that shark lan
maintained through changes in gear and increases in effort (eg. number of f
which may mask a decline in shark populations. The numbers of sharks tak
ery in our study region was estimated to be between 65,000 and 104,000 yea
national export and import of dried shark fin from Madagascar, and shark le

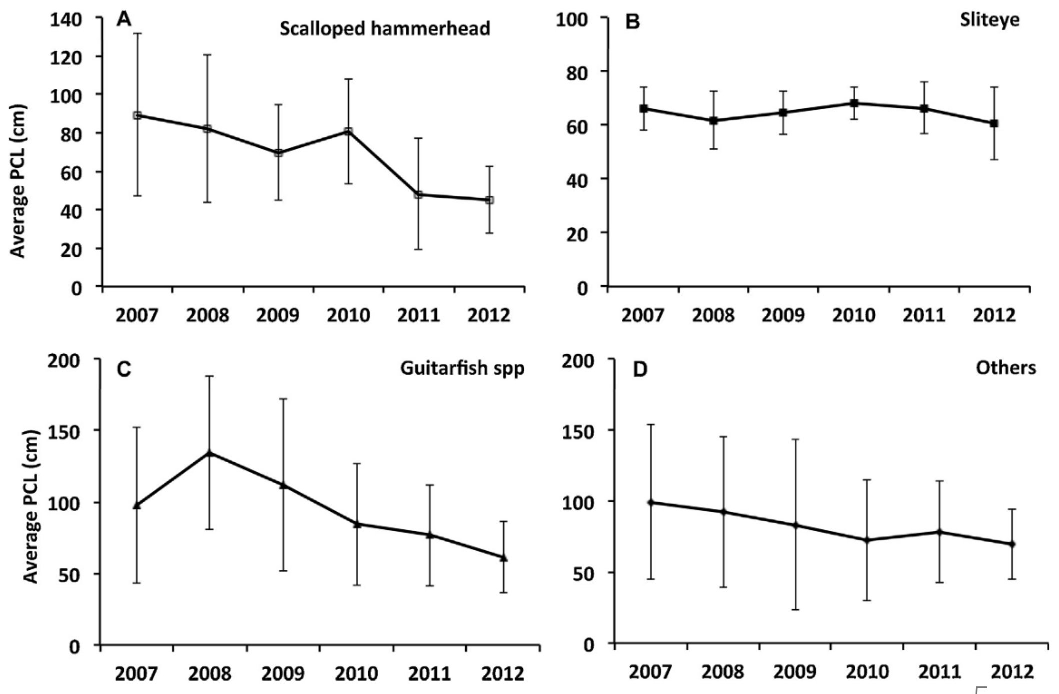

Fig. 4. Average shark size (PCL) by the species (a) scalloped hammerhead (b) sliteye or the family (c) guitarfish species over both regions (2007–2012). Error bars are standard deviations. Others (d) contains all sharks recorded that were not classified as one of the three species/family.

Challenges for adaptations to climate change in data-limited small scale fisheries (SSF) mgmt

1. to **detect** changes in the ocean ecosystem
2. to **share** this information rapidly among stakeholders
3. to **use** it for decision making on adaptation measures

- The rapid evolution of IT (e.g., **smartphones**, **AI** etc.) are expected to be a **breakthrough** in solving these challenges.

https://en.wikipedia.org/wiki/Supercomputer

eBird

- Over hundreds of thousands of users have been reporting more than hundreds million reports per year using by web and smartphone apps.

- Biodiversity information reported by volunteers is used for bird conservation research.

Callaghan et al (2021) PNAS, 118:e2023170118

Global abundance estimates for 9,700 bird species

Corey T. Callaghan[a,b,1], Shinichi Nakagawa[b,2], and William K. Cornwell[a,b,2]

[a]Centre for Ecosystem Science, School of Biological, Earth and Environmental Sciences, UNSW Sydney, Sydney, NSW 2052, Australia; and [b]Ecology & Evolution Research Centre, School of Biological, Earth and Environmental Sciences, UNSW Sydney, Sydney, NSW 2052, Australia

Edited by Simon Asher Levin, Princeton University, Princeton, NJ, and approved March 28, 2021 (received for review November 16, 2020)

Quantifying the abundance of species is essential to ecology, evolution, and conservation. The distribution of species abundances is fundamental to numerous longstanding questions in ecology, yet the empirical pattern at the global scale remains unresolved, with a few species' abundance well known but most poorly characterized. In large part because of heterogeneous data, few methods exist that can scale up to all species across the globe. Here, we integrate data from a suite of well-studied species with a global dataset of bird occurrences throughout the world—for 9,700 species (~92% of all extant species)—and use missing data theory to estimate species-specific abundances with associated uncertainty. We find strong evidence that the distribution of species abundances is log left skewed: there are many rare species and comparatively few common species. By aggregating the species-level estimates, we find that there are ~50 billion individual birds in the world at present. The global-scale abundance estimates that we provide will allow for a line of inquiry into the structure of abundance across biogeographic realms and feeding guilds as well as the consequences of life history (e.g., body size, range size) on population dynamics. Importantly, our method is repeatable and scalable: as data quantity and quality increase, our accuracy in tracking temporal changes in global biodiversity will increase. Moreover, we provide the methodological blueprint for quantifying species-specific abundance, along with uncertainty, for any organ

global biodivers

global abundance estimates for nearly all the world's bird species (92%) and consequently a gSAD focused on absolute abundances.
Global-scale data sources of abundance are heterogeneous, often with few species' global abundances estimated. Creating a systematic global data collection effort to estimate abundance for a given taxa (e.g., through distance sampling) is logistically prohibitive (32). Additionally, the few studies which model abundance at regional or continental scales (12, 33) are generally limited in taxonomic coverage (i.e., failing to fully sample all potential species in the regional or continental pool of species). One of the most successful approaches to providing data at broad spatial (e.g., global) scales is data integration, in which small sets of high-quality data are used to inform much larger but less precise data (34). This general approach has progressed the entire field of remote sensing, in which, for example, high-quality on-the-ground data informs remote spectral measurements (35). We apply this same general data integration framework to solve previous shortcomings of abundance estimation by integrating expert-derived population estimates of bird abundance with global citizen science data (36). This approach allows us to estimate species-specific abundance for 9,700 species of bird—about 92% of all extant bird species. First, we modeled the re-

ECOLOGY

Youngflesh et al (2021) Nat. Ecol. Evol., 5:987–994

nature ecology & evolution

ARTICLES

https://doi.org/10.1038/s41559-021-01442-y

Check for updates

Migratory strategy drives species-level variation in bird sensitivity to vegetation green-up

Casey Youngflesh[1], Jacob Socolar[2,3], Bruna R. Amaral[4], Ali Arab[5], Robert P. Guralnick[6], Allen H. Hurlbert[7,8], Raphael LaFrance[6], Stephen J. Mayor[9], David A. W. Miller[4] and Morgan W. Tingley[1,2]✉

Animals and plants are shifting the timing of key life events in response to climate change, yet despite recent documentation of escalating phenological change, scientists lack a full understanding of how and why phenological responses vary across space and among species. Here, we used over 7 million community-contributed bird observations to derive species-specific, spatially explicit estimates of annual spring migration phenology for 56 bird species across eastern North America. We show that changes in the spring arrival of migratory birds are coarsely synchronized with fluctuations in vegetation green-up and that the sensitivity of birds to plant phenology varied extensively. Bird arrival responded more synchronously with vegetation green-up at higher latitudes, where phenological shifts over time are also greater. Critically, species' migratory traits explained variation in sensitivity to green-up, with species that migrate more slowly, arrive earlier and overwinter further north showing greater responsiveness to earlier springs. Identifying how and why species vary in their ability to shift phenological events is fundamental to predicting species' vulnerability to climate change. Such variation in sensitivity across taxa, with long-distance neotropical migrants exhibiting reduced synchrony, may help to explain substantial declines in these species over the last several decades.

Phenology, that is the timing of seasonal life history events such ... asynchronies, including the role that these might play in observed

MantaMatcher

- Participants from around the globe reported photos of manta rays' ventral markings with information about where the photos were taken.
- These data were utilized in a study to clarify the number of individuals, migration patterns, and population structure of manta rays using AI.

frontiers in Marine Science
ORIGINAL RESEARCH
published: 01 May 2019
doi: 10.3389/fmars.2019.00215

Check for updates

Germanov et al (2019) Front. Mar. Sci., 6:215

Contrasting Habitat Use and Population Dynamics of Reef Manta Rays Within the Nusa Penida Marine Protected Area, Indonesia

Elitza S. Germanov[1,2,3]*, Lars Bejder[3,4], Delphine B. H. Chabanne[1,3], Dharmadi Dharmadi[5], I. Gede Hendrawan[6], Andrea D. Marshall[2], Simon J. Pierce[2], Mike van Keulen[1,3] and Neil R. Loneragan[1,3,7]

OPEN ACCESS

Edited by:
Mark Meekan,
Australian Institute of Marine

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Check for updates

Received: 5 November 2021 | Revised: 19 July 2022 | Accepted: 22 August 2022
DOI: 10.1002/aqc.3883

RESEARCH ARTICLE

Knochel et al (2022) Aquat. Conserv.: Mar. Freshw. Ecosyst., 32:1774-1786

WILEY

Crowdsourced data reveal multinational connectivity, population demographics, and possible nursery ground of endangered oceanic manta rays in the Red Sea

Anna M. Knochel[1] | Jesse E. M. Cochran[1] | Alexander Kattan[1] | Guy M. W. Stevens[2] | Elke Bojanowksi[3] | Michael L. Berumen[1]

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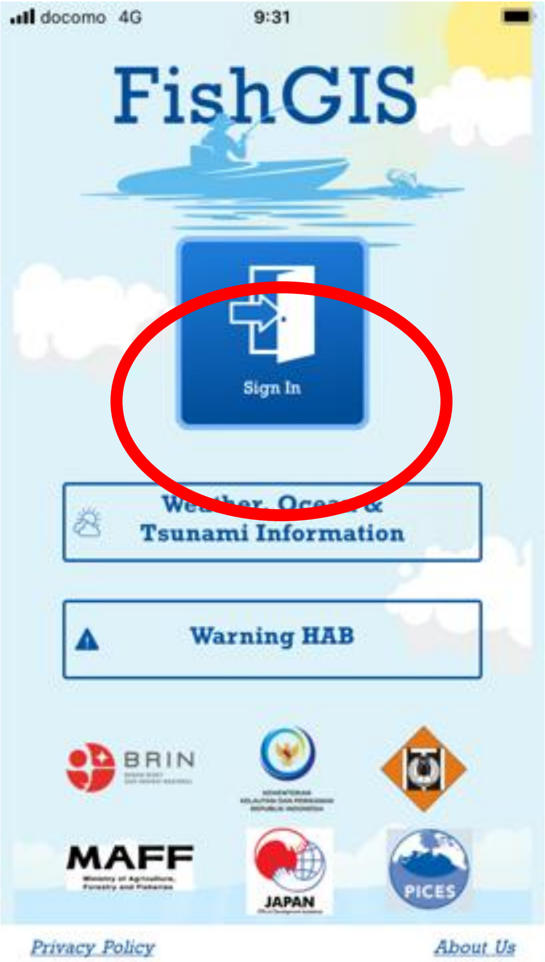
[2]The Manta Trust, Catemwood House, Norwood Lane, Corscombe, Dorset, UK
[3]Red Sea Sharks, UK

Correspondence
Anna M. Knochel, Red Sea Research Center, Division of Biological and Environmental Science and Engineering, King Abdullah University of Science and Technology, Thuwal

Abstract
1. Despite the large size and economic value of the species, populations of oceanic manta ray (*Mobula birostris*) are often poorly studied and almost completely undescribed in the Red Sea. Here, photo-identification (photo-ID) was used to provide the first description of *M. birostris* movement patterns and population demographics for the northern Red Sea.
2. Images collated from social media, researchers, and photo-ID databases from 2004 to 2021 identified 267 individual *M. birostris* from 395 sightings in Egypt,

FishGIS App (target users: local fishers)



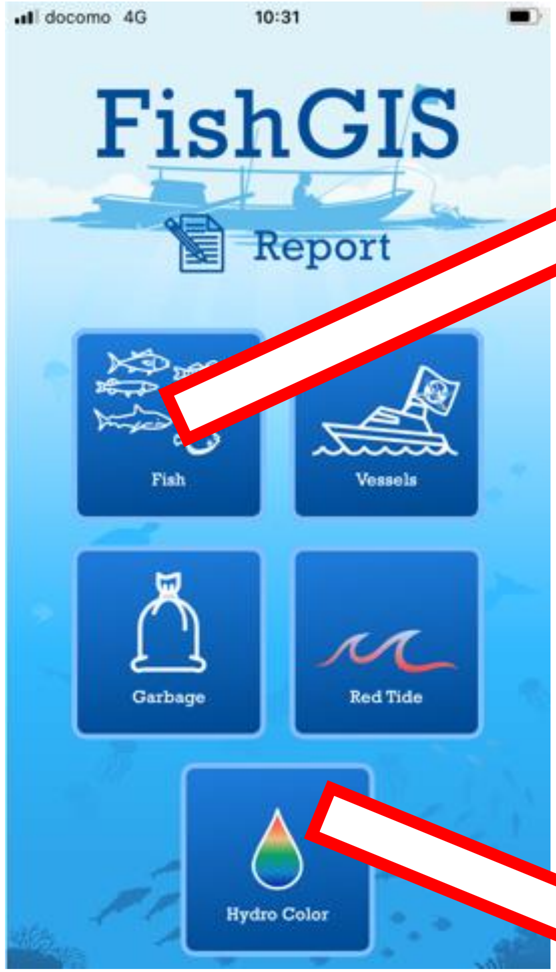
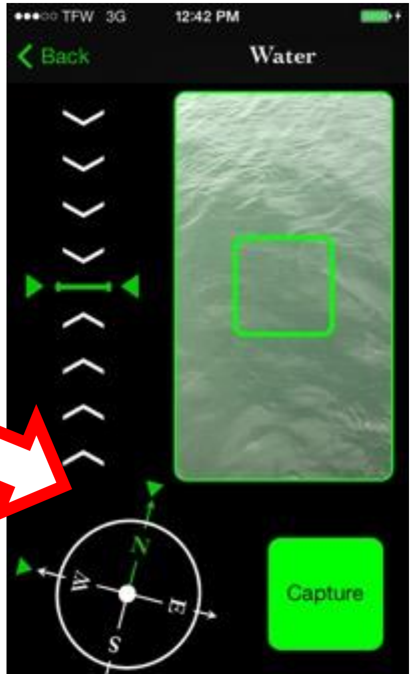


Photo of Fish

Photo of watercolor



How the ocean is changing?

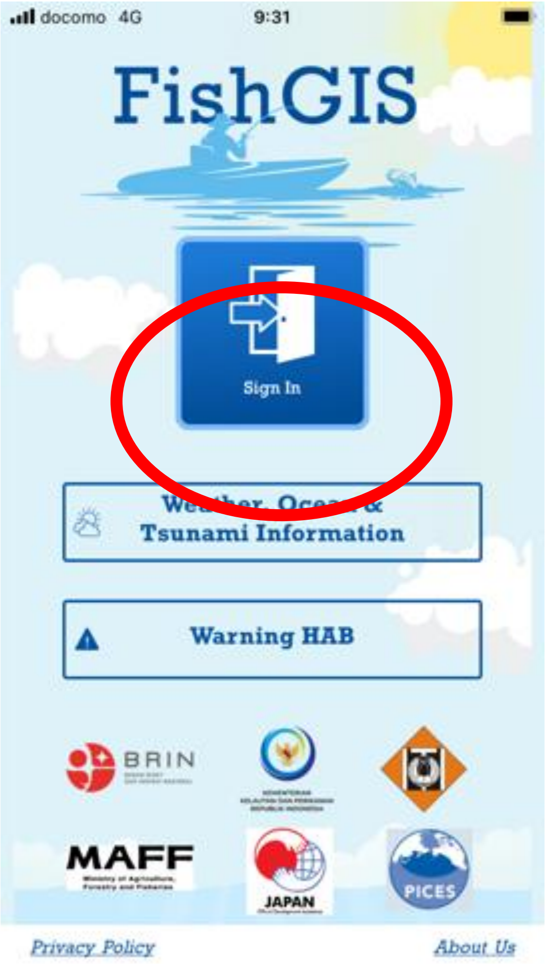
→ Tools for reporting photos of ocean conditions

FishGIS can be installed from Apple Store and Google Play!!

iOS（iOS10 or later）
Search for “FishGIS” in Apple Store

Android（Android7 or later）
Search for “FishGIS” in Google Play

FishGIS App (target users: local fishers)



Today's topic

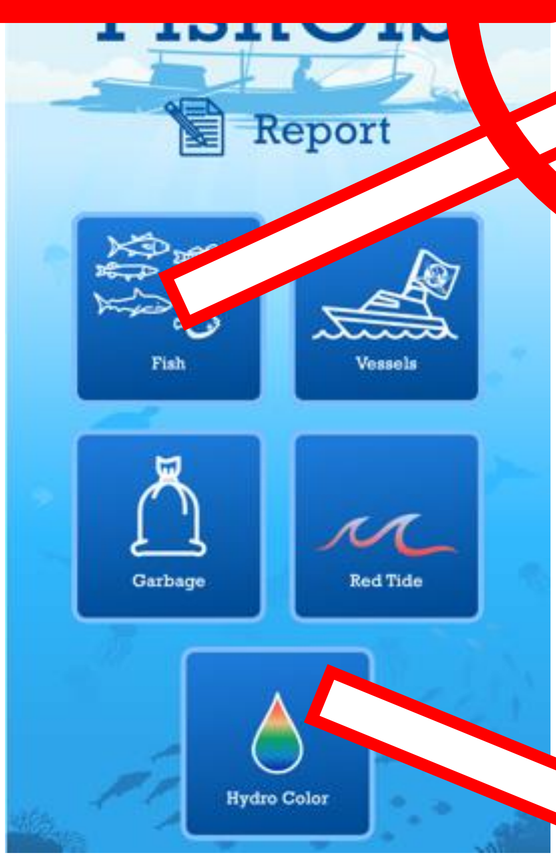
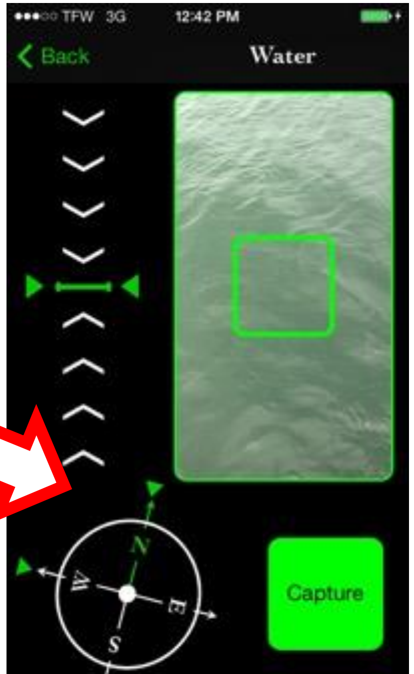


Photo of Fish

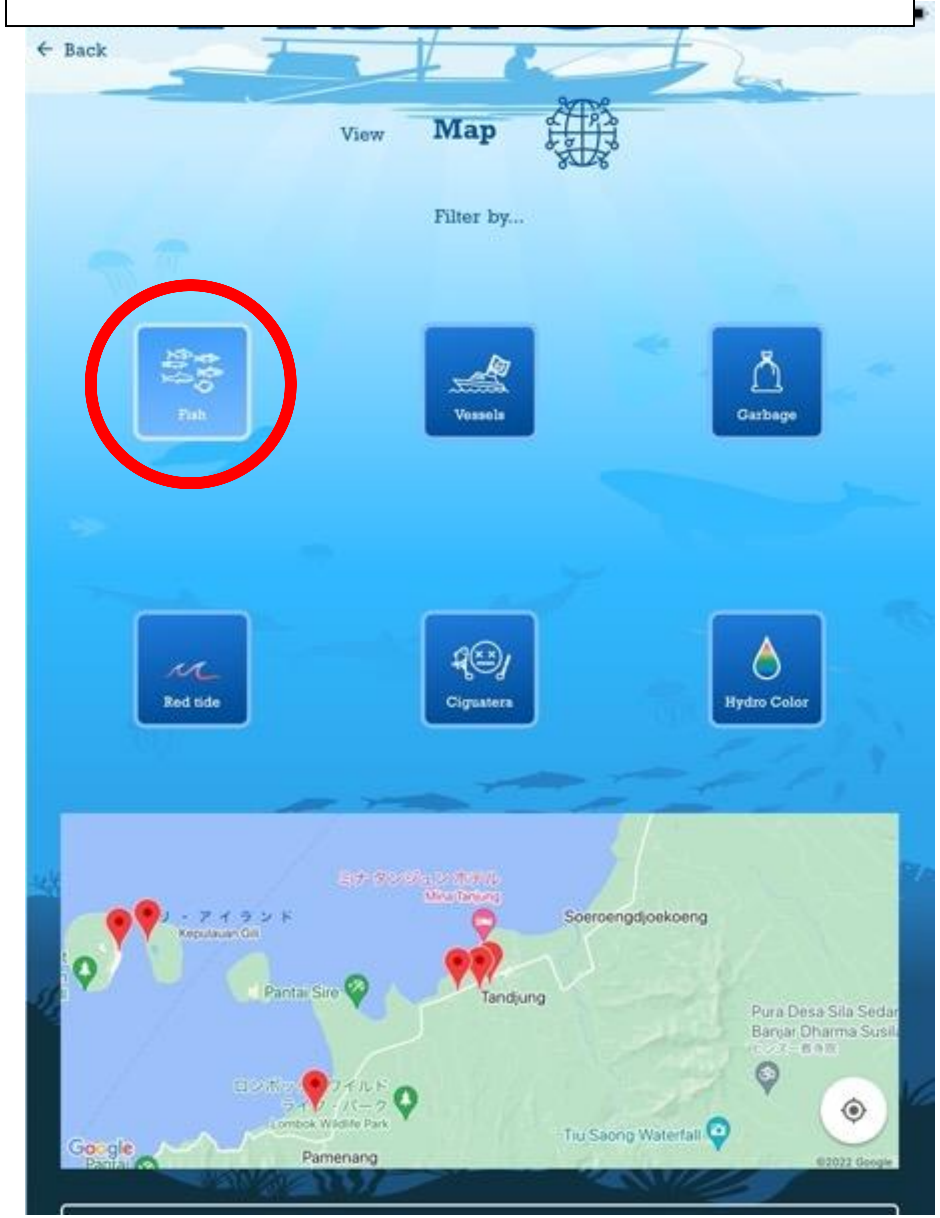
Photo of watercolor



How the ocean is changing?
→ Tools for reporting photos of ocean conditions

Examples of **fish photos** collected by the ***FishGIS*** App

Our research teams collected data.

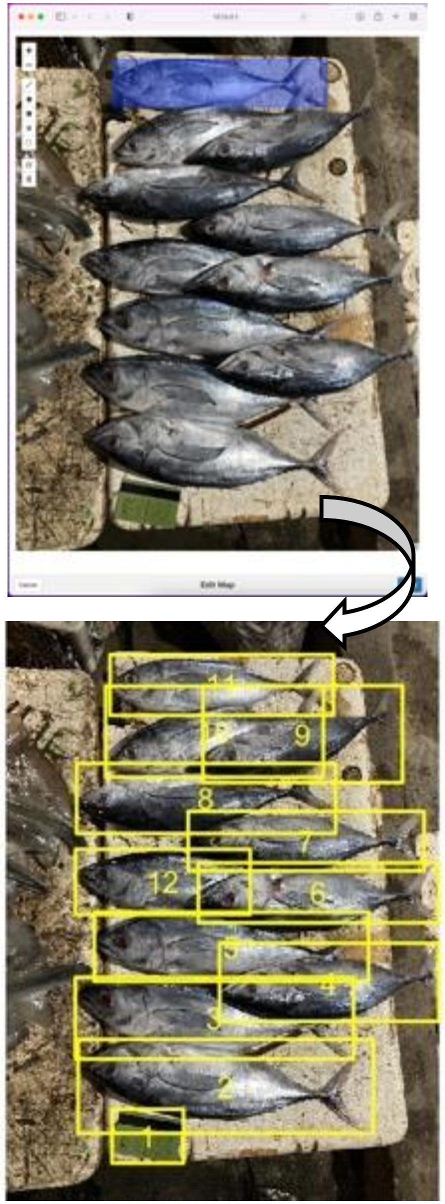


These photos help to understand not only fish diversity and but also important fishes for local community in Lombok!

Report images

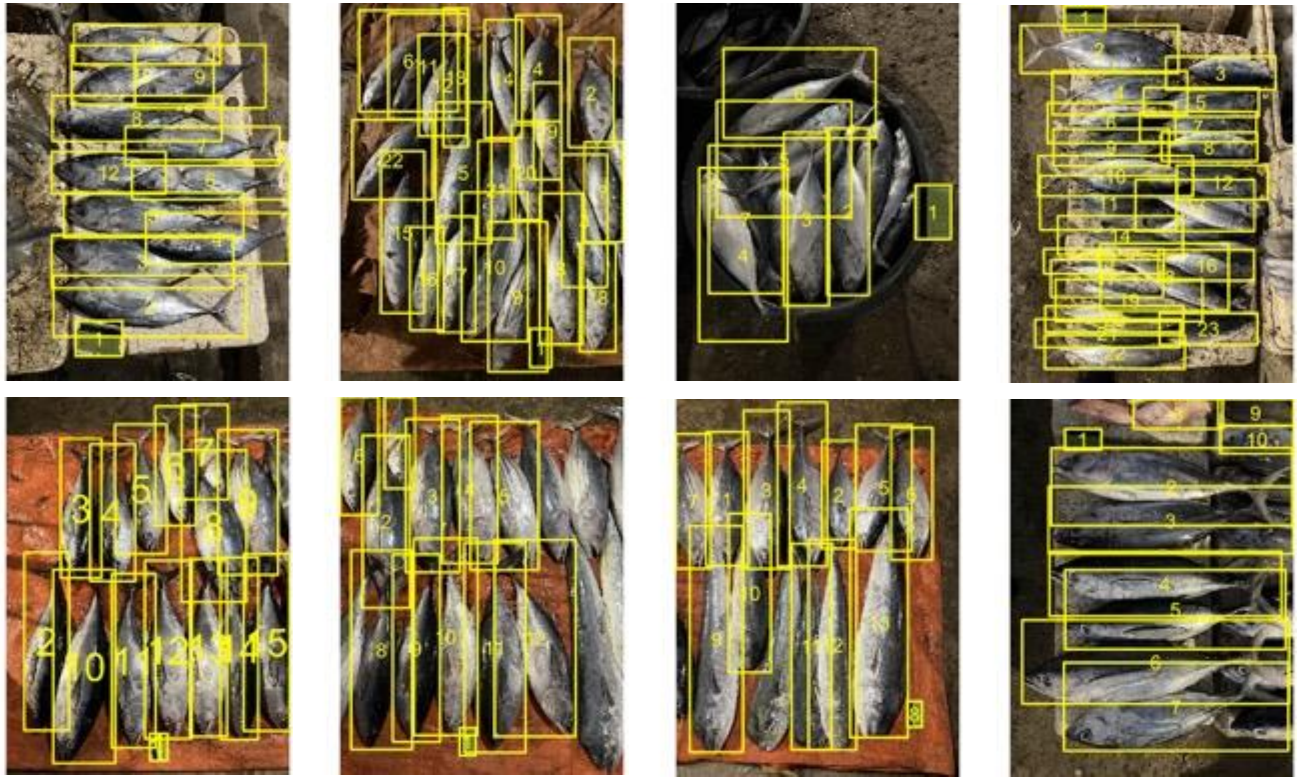
Work time per image:
less than 1 minute

Identify fish

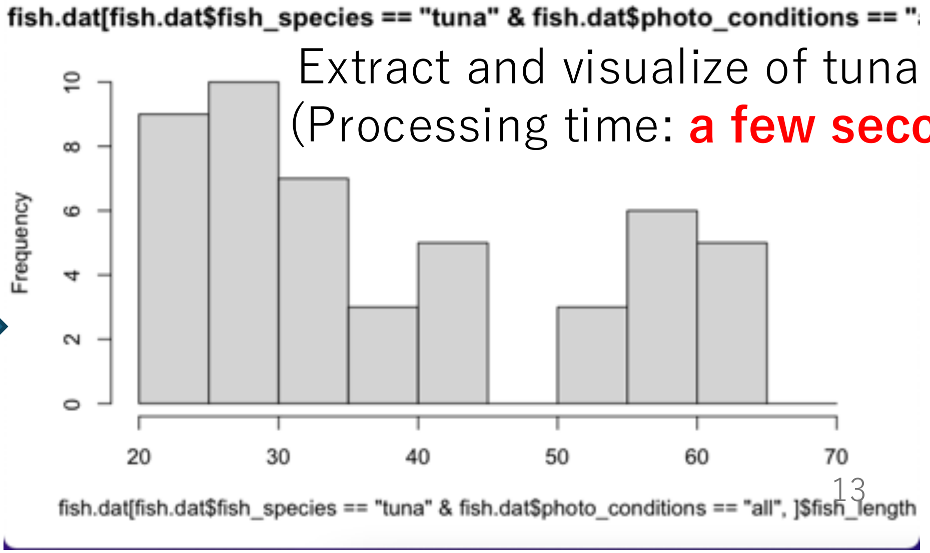


Work time per image:
about 5 minutes

Measuring total length from images



Extract and visualize of tuna data
(Processing time: **a few seconds**)

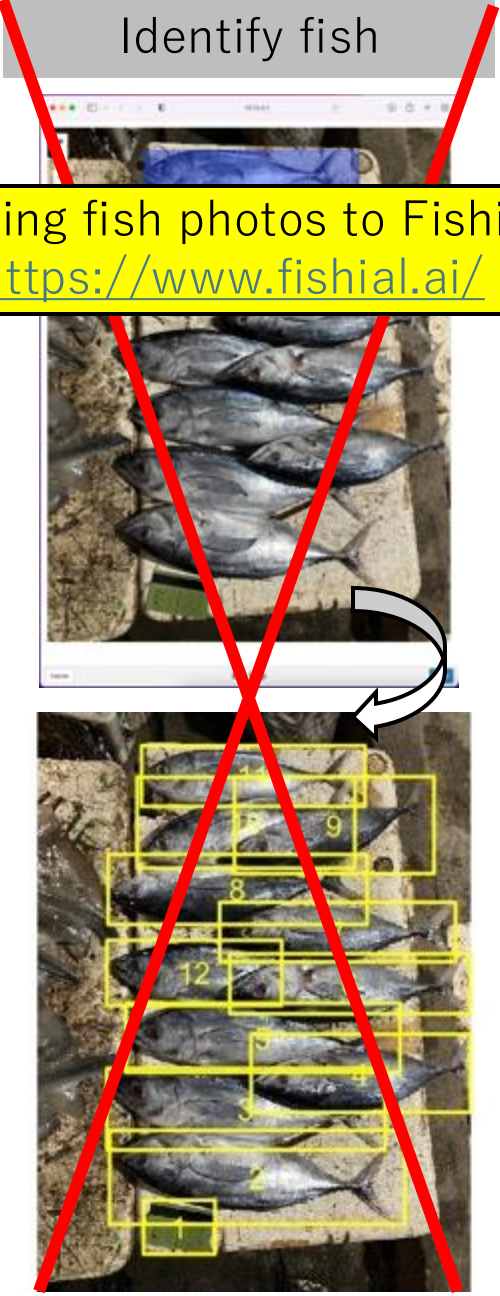


Workflow; Before 2024

Report images

Work time per image:
less than 1 minute

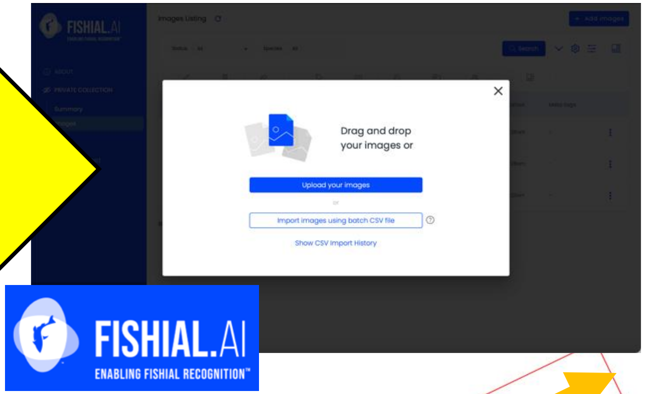
Identify fish

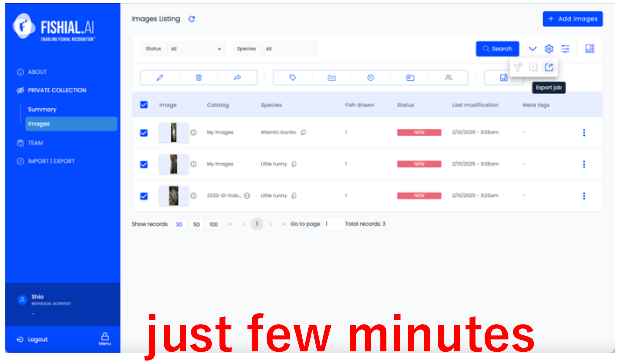


~~Work time per image:~~
~~**about 5 minutes**~~

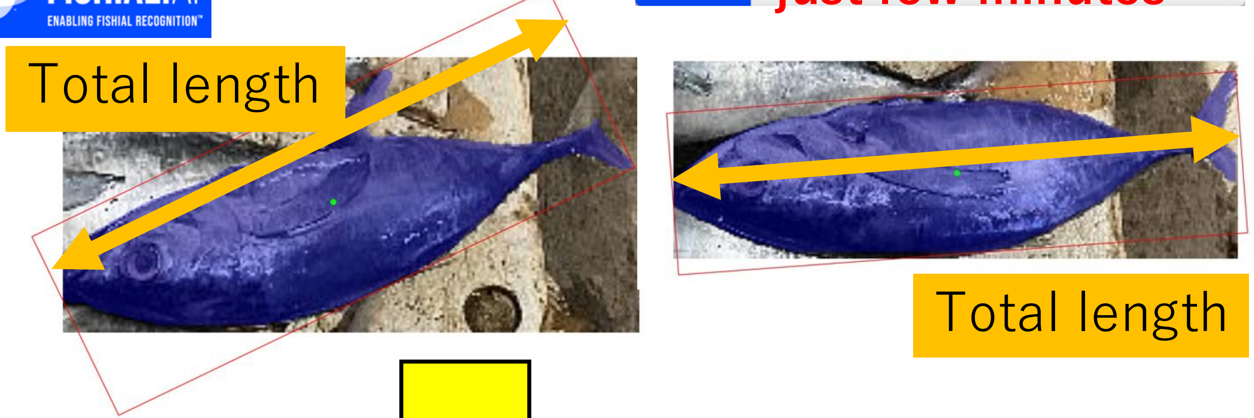
Uploading fish photos to Fishial. AI
https://www.fishial.ai/

Analyzing fish photos by Fishial.AI (automatically)

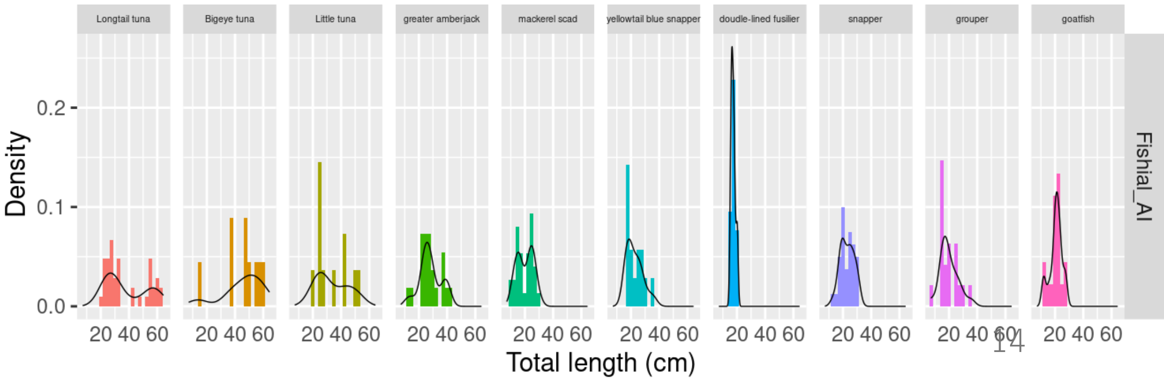




just few minutes

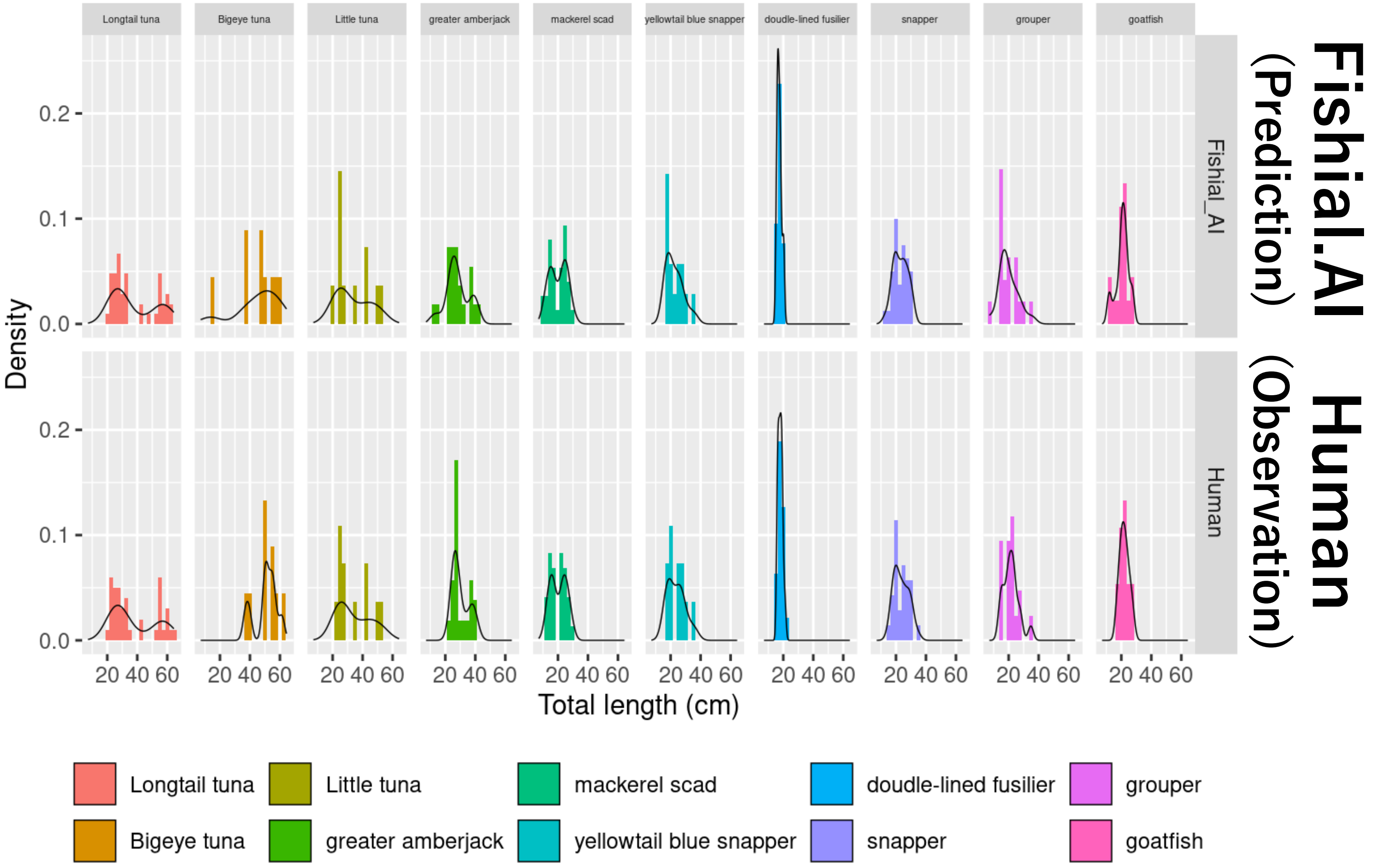


Export: Text file (JSON Format)



Workflow; After 2025

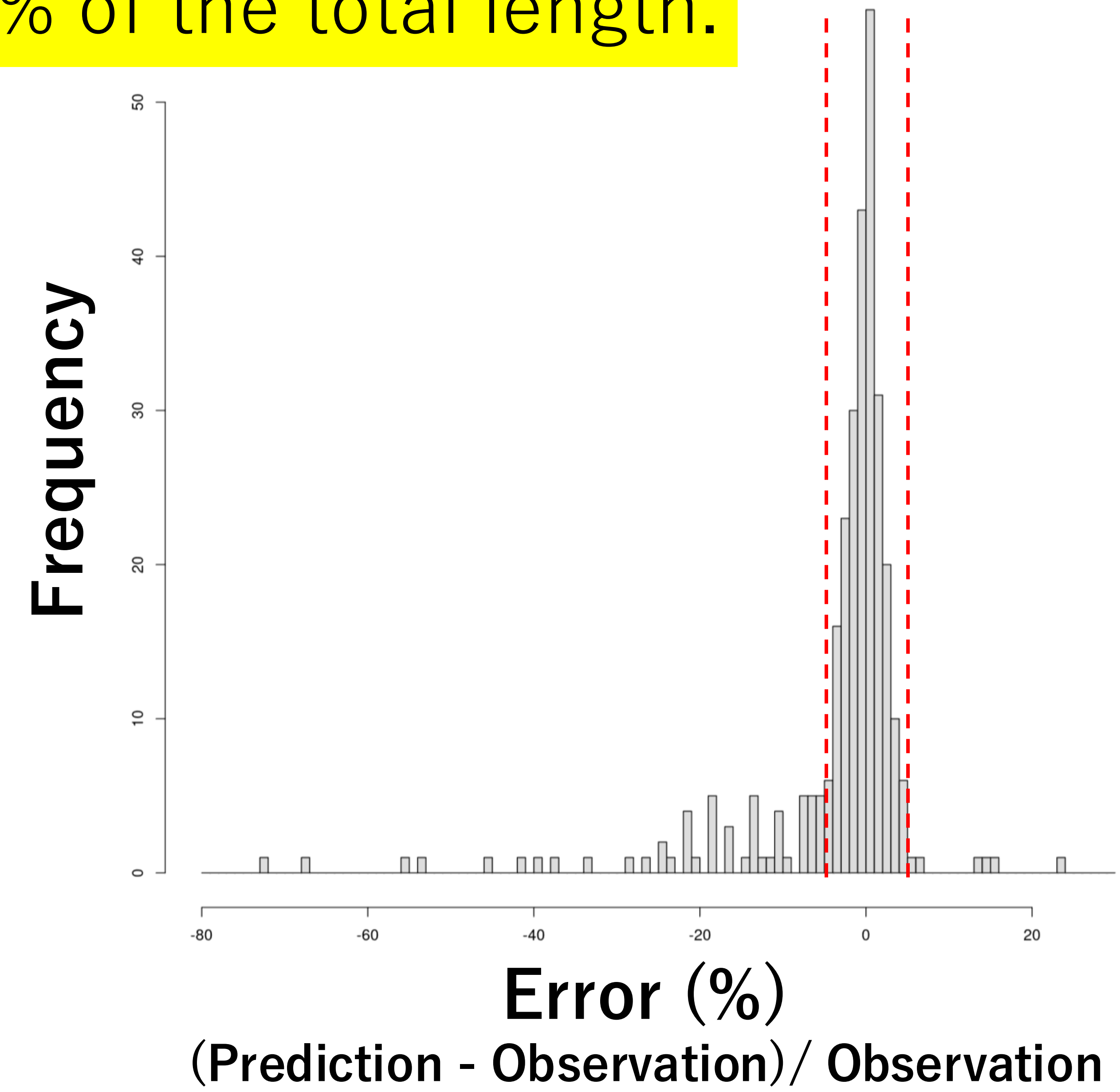
Human VS Fishial.AI



The results of Fishial.AI and human results show the same trends!!

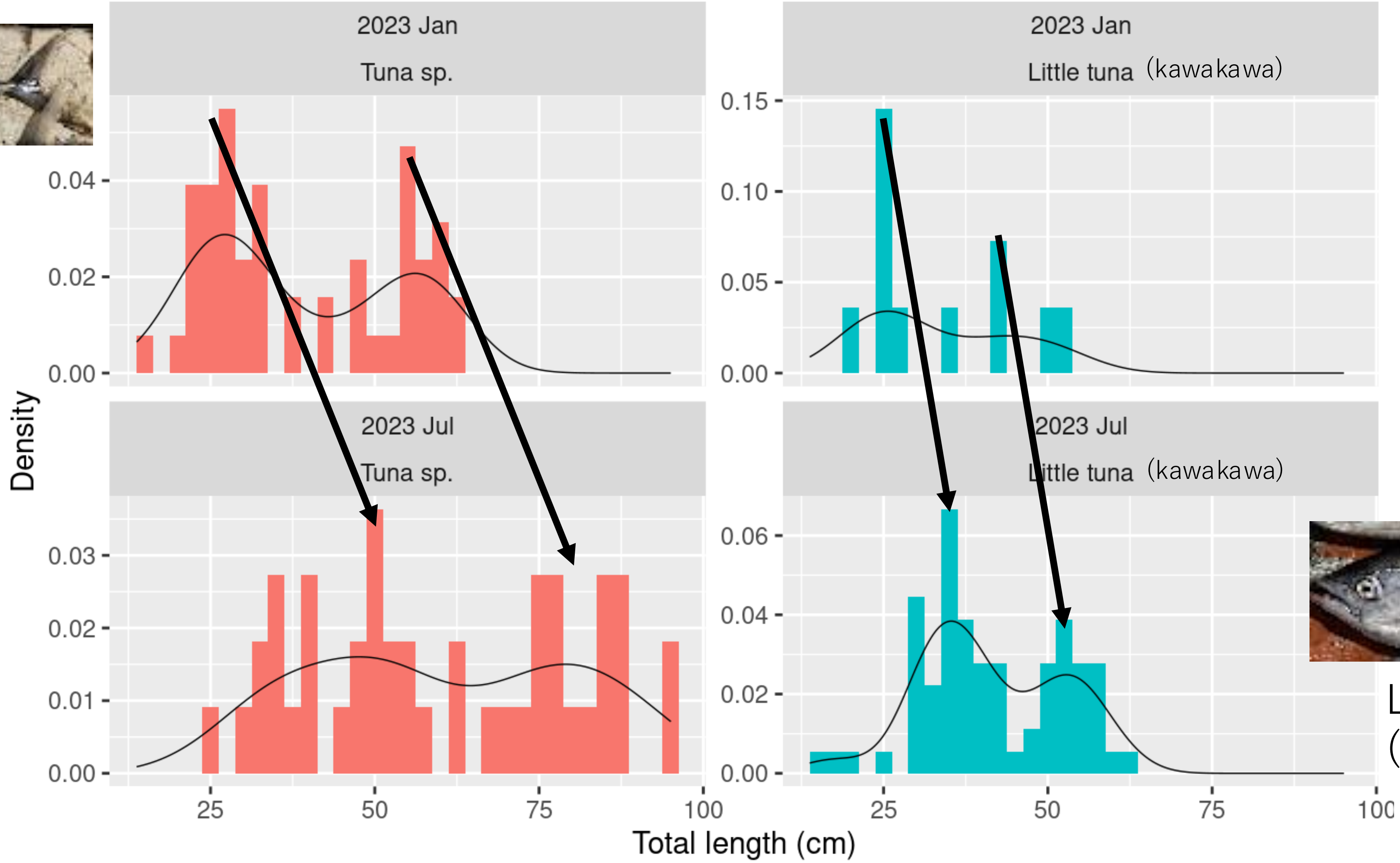
Errors by Fishial.AI are within ±5% of the total length.

Human VS Fishial.AI



Preliminary result to monitor seasonal changes of size distribution for tuna species using by Fishial.AI

Long tail tuna



Little tuna
(kawakawa)

Fishial.AI allows to detect seasonal changes of size distribution!!

Jan 2023 (Dry)

Jul 2023 (Wet)

Jan 2024 (Dry)

Jul 2024 (Wet)

Jan 2025 (Dry)

Jul 2025 (Wet)

Jan 2026 (Dry)

Jul 2026 (Wet)

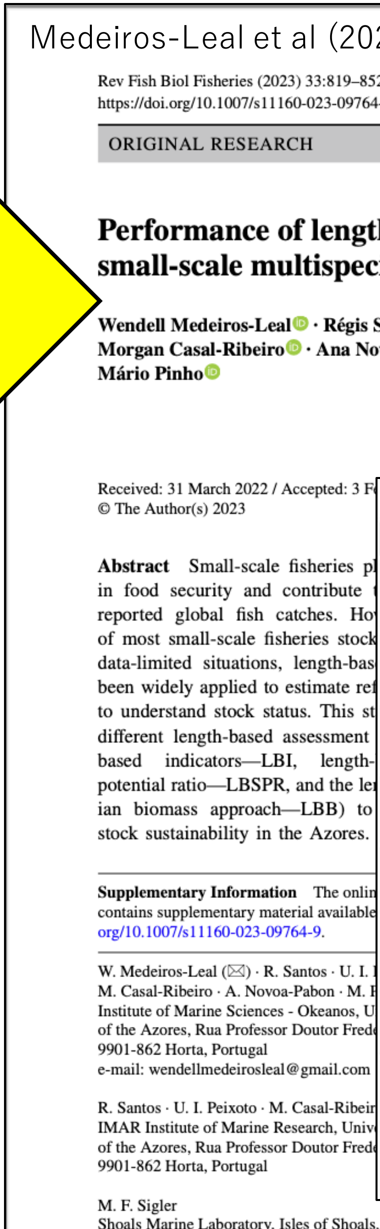
Jan 2027 (Dry)

Jul 2027 (Wet)

Accumulating data

Next step: Data accumulation and length-based stock assessment

Medeiros-Leal et al (2023) Rev. Fish Biol. Fish., 33:819-853.



Rev Fish Biol Fisheries (2023) 33:819–852
https://doi.org/10.1007/s11160-023-09764-9

ORIGINAL RESEARCH

Performance of length-based assessment in predicting small-scale multispecies fishery sustainability

Wendell Medeiros-Leal · Régis Santos · Ualerson I. Peixoto · Morgan Casal-Ribeiro · Ana Novoa-Pabon · Michael F. Sigler · Mário Pinho

Received: 31 March 2022 / Accepted: 3 F

Abstract Small-scale fisheries pl in food security and contribute reported global fish catches. Ho of most small-scale fisheries stock data-limited situations, length-bas been widely applied to estimate ref to understand stock status. This st different length-based assessment based indicators—LBI, length- potential ratio—LBSPR, and the le ian biomass approach—LBB) to stock sustainability in the Azores.

Supplementary Information The onlin contains supplementary material available org/10.1007/s11160-023-09764-9.

W. Medeiros-Leal (✉) · R. Santos · U. I. M. Casal-Ribeiro · A. Novoa-Pabon · M. Institute of Marine Sciences - Okeanos, U of the Azores, Rua Professor Doutor Fred 9901-862 Horta, Portugal
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M. F. Sigler
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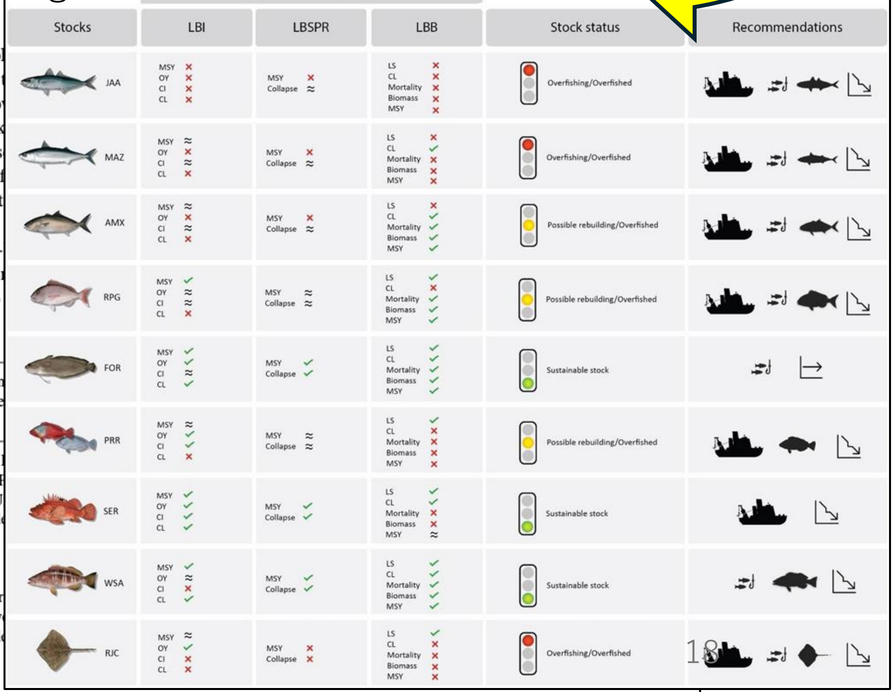
Fig.10



Conclusion and future challenge

- IT such as smartphone and AI are expected to be a breakthrough in solving challenges in data-limited SSFs management under climate change.

- FishGIS is a tools for monitoring ocean conditions for climate change adaptation.

  → Fish images (Fishial.AI) supports to understand changes of fish stocks.

  →Watercolor images (HydroColor) helps to understand of changes in the marine environment.

- A future challenge is not only a collecting data but also establishment of a mechanism for local stakeholders to utilize monitoring data for decision making on adaptation measures.

Thank you for your attention!