2024 Report of WG48

The fourth business meeting of Working Group 48 (WG 48) on 'Towards Best Practices Using Imaging Systems for Monitoring Plankton' took place virtually on October 3, 2024. A total of 11 members attended the meeting. This session focused on the review paper and discussing the next steps for WG48. The meeting's agenda can be found in WG48 Endnote 2.

AGENDA ITEM 1

Status of the Working Group

- WG48 is nearing the end of its term, which began in 2020.
- Two one-year extensions have been granted.
- The final report will be due one year after the completion of the WG.

AGENDA ITEM 2

Potential Future Working Group

- Proposed topic: Deep Learning in Marine Biology (potential focus on plankton).
- Members interested in participating should reach out via email.

AGENDA ITEM 3

Status of the Review Paper

- A complete draft of the review paper is now available.
- Comments have been received from a few members.
- All members are encouraged to submit comments by the end of October.

AGENDA ITEM 4

Discussion of Potential Journals for Publication

- Potential journals for submission:
    - Annual Reviews in Marine Science
    - Progress in Oceanography
    - Limnology and Oceanography Letters
    - Journal of Plankton Research
    - Marine Ecology Progress Series
- Annual Reviews in Marine Science process:
    - The journal does not accept unsolicited reviews.
    - Topics are selected at the annual editorial committee meeting.
    - The next meeting will be in Spring 2025 to plan for Volume #19 (published in early 2027).
    - If interested, confirmation should be sent by January 2025 for potential inclusion in the editorial discussion.

AGENDA ITEM 5

Open Discussion & Next Steps

- Finalizing review paper comments and submission timeline.
- Feedback on the potential future working group and participation.
- Identifying key steps for WG48’s final report.

WG 48 Endnote 1

WG48 participation list

Members
Hongsheng Bi (USA, Co-chair)
Xuemin Cheng (China, Co-chair)
David Kimmel (USA, Co-chair)
Paul Covert (Canada)
Akash Sastri (Canada)
Haiyong Zheng (China)
Lindsay Dhugal (Japan)
Satoshi Kitjima (Japan)
Kazutaka Takahashi (Japan)
Robert Campbell (USA)
Julie Keister (USA)

Members unable to attend
China: Haifeng Gu
Korea: Park Wongyu
USA: Mark Benfield

WG48 Endnote 2

WG 48 Meeting Agenda

October 2024

1. **Status of Working Group**
    - WG 48 is nearing the end of its term (initiated in 2020).
    - Two one-year extensions granted; final report due after WG completion.
2. **Potential Future Working Group**
    - Proposed topic: *Deep Learning in Marine Biology* (focus on plankton).
    - Interested members should reach out via email.
3. **Review Paper Status**
    - Complete draft available; comments due by the end of October.
4. **Co-Authorship & Invited Speaker**
    - Potential co-author: Dr. Cowen (2022 Busan Annual Meeting speaker).
5. **Journal Submission Discussion**
    - Potential journals: *Annual Reviews in Marine Science, Progress in Oceanography, Limnology and Oceanography Letters, Journal of Plankton Research, Marine Ecology Progress Series.*
    - *Annual Reviews in Marine Science* selection process discussed; confirmation needed by January 2025 for editorial review consideration.
6. **Open Discussion & Next Steps**
    - Finalizing review paper submission timeline.
    - Feedback on future WG participation.
    - Steps for WG 48's final report.

WG48 Endnote 3

PICES/ICES Working Group Preliminary Proposal

Title

Best Practices for Using Deep Learning in Processing Plankton Images

Acronym

WGDLP

Abstract

Plankton are fundamental to marine ecosystems, serving as the base of food webs and responding rapidly to environmental changes. Recent advancements in deep learning (DL) offer transformative tools for analyzing large datasets generated by plankton imaging systems, significantly improving the speed and accuracy of monitoring efforts. However, the lack of standardized best practices for applying DL and managing data presents challenges to achieving consistent and comparable results. To support global plankton monitoring efforts, there is a clear need to compare among different imaging systems to assess their performance, the adoption of comparable image processing methods to ensure robust analyses, and the implementation of consistent data reporting protocols to enable meaningful comparison and validation. By fostering international collaboration and harmonizing methodologies, this working group (WG) aims to establish guidelines for DL-based plankton image processing by addressing key challenges such as building comprehensive training libraries with appropriate metadata, ensuring effective data reporting and accessibility, refining species identification, and harmonizing methodologies across different regions.

The proposed WG will focus on:

- Assessing current deep learning approaches for plankton image analysis.
- Developing standardized protocols for training and validating DL models.
- Establishing libraries and datasets for benchmarking DL algorithms with metadata best practices.
- Promoting collaboration and knowledge-sharing among experts in deep learning and plankton ecology.

Scientific Background

With the increasing adoption of imaging systems for monitoring plankton, the need for automated image processing has grown. Traditional manual identification methods are labor-intensive and slow, making deep learning an attractive alternative. DL models, particularly deep learning algorithms, have demonstrated their potential to classify plankton species rapidly and with high accuracy. However, challenges remain, including the need for large, annotated datasets, handling species diversity, and ensuring reproducibility across studies. By establishing best practices for applying DL to plankton images, this WG aims to enhance the reliability and comparability of plankton monitoring efforts across PICES regions.

Rationale

Recent advancements in deep learning have led to breakthroughs in automating plankton image classification, but the lack of standardized approaches hinders progress in global monitoring efforts. This WG will develop protocols for:

- Training DL models with diverse plankton datasets.
- Evaluating the performance and accuracy of DL algorithms through intercomparison.

- Standardizing image annotation and dataset management practices.

We anticipate this WG will work with ICES Zooplankton Groups, PICES WG52 on Data Management.

Terms of Reference

This WG will:

1. Review the state of deep learning applications in plankton image analysis.
2. Develop a framework to standardize DL model training, validation, and evaluation.
3. Create shared libraries and benchmarking datasets for testing different DL algorithms.
4. Build a network of scientists working on deep learning and plankton monitoring.
5. Promote international collaboration through PICES and other scientific organizations.
6. Publish a final report summarizing the best practices for using DL in plankton image analysis.

WG48 Endnote 4

Summary of the Working Group Accomplishment against ToR items (PICES-2021-PICES-2024)

*****This information was reported to the Science Board meeting at PICES-2024.

List of TOR Items	How did you achieve the TOR items?
ToR 1: Assess the capacity of statistical models to incorporate temperature-dependency of growth and compare their predictions of growth variation across specific warming scenarios and locations. Output/deliverable expected is a paper suitable for a peer-reviewed fisheries journal.	The Sarla model (a state-space statistical model for fish length-at-age, written in the Stan language and packaged in the R package Sarla) has been developed based on Stawitz et al. (2015; Can J. Fish. Aquat. Sci. 72:1316-1328) to allow for wider use. The model was applied to length-at-age data from the California Current.
	The ss3sim (a large and commonly used program for stock assessment), and ProDynR (an independent program for conducting projections of fish recruitment, abundance, and growth) have been identified for applications to TSR. Additionally, a set of simulation scenarios have been identified, focusing on simulating either the temperature-size rule or constant growth, and simulating a range of sampling effort. These simulations will allow evaluation of various statistical estimation models for detecting the influence of temperature on fish size-at-age.
ToR 2: Analyze long-term growth patterns across multiple large marine ecosystems that are experiencing different trends in temperature, including the direct comparison of empirical length at age data for specific species across their range, and the application of a common modelling approach. Output/deliverable expected is a peer-reviewed paper in a high impact journal.	Compiled and cleaned size-at-age data for fish species from the Gulf of Alaska and from the North Sea (20 species total, up to 49 years in length). Conducted comparative studies on fish size between North Sea, Gulf of Alaska, and western North Pacific and found regional specific responses of fish size to changing environmental temperatures.
	Applied a state-space modelling to the fish weight interannual fluctuations in the western North Pacific and found out the importance of density dependence with multiple effects including prey plankton production and fishing pressure.
	Compared fish weight interannual fluctuations in the North Sea and western North Pacific and found that the temperature is the primarily driver in the North Sea while the density dependence is the primarily driver in the western North Pacific (because WNP is a wasp-waist control ecosystem).
ToR 3: Assess the impacts of warming on past yield per recruit of commercial fisheries and forecast trends in future yield given plausible warming scenarios. Output/deliverable expected is a peer-reviewed paper in a high impact journal.	Applied a state-space modelling to the fish weight interannual fluctuations in the western North Pacific (North Sea) and found only Japanese anchovy and chub mackerel (Atlantic cod) showed negative impacts of fishing pressure on their weight. Applied a state-space modelling to the fish weight interannual fluctuations in the western North Pacific (North Sea) and found an antiphase fluctuation between biomass and weight in Japanese sardine, amberjack, Spanish mackerel, thornyhead, chub mackerel, and pointed flounder (haddock and European plaice).

ToR 4: Identify options for expanding scientific community access to global length-at-age data that are routinely collected by fisheries agencies worldwide. Output/deliverable expected is a strategic plan assessing options for enhancing access to length-at-age data collected routinely.	Developed the metadata describing the age/length information that are available for collation and analysis from Gulf of Alaska, Eastern Bering Sea, West Bering Sea, California Current, Northeastern US Shelf, Barents Sea, Newfoundland-Labrador Shelf, Icelandic Shelf, Gulf of Mexico, South-East Pacific, North Sea, Baltic Sea, Celtic-Biscay Shelf, Southeastern Australian Shelf.
	Age-specific weight data for 17 (6) populations of 13 (4) fish species around Japan from 1995 (1978) to 2018 were mined and the common trend was investigated using dynamic factor analysis. The output revealed common weight decrease in 1980s and 2010s.
	Compiled and cleaned size-at-age data for fish species from the Gulf of Alaska and from the North Sea (20 species total, up to 49 years in length).
ToR 5: Create a brief, clear, concise outreach product to communicate WG findings to a broader audience, especially the general public.	Press release: Climate change shrinking fish: Global warming increased competition for food in the 2010s, leading to decreased fish weight in important fishing area (https://www.aori.u-tokyo.ac.jp/english/research/news/2024/20240228.html). Newspaper articles: EurekAlert!, AlphaGalileo
	Press release in Japanese for Zhen and Ito (2024) (https://www.aori.u-tokyo.ac.jp/research/news/2024/20240228.html). Newspaper articles: Jiji Press, Kyodo News, Mainichi Newspaper, Sankei Newspaper, Nihon Keizai Newspaper, Asahi Newspaper
	PICES Press article: ICES Annual Science Conference, 2022: Theme Session J Temperature impacts on fish growth and consequences for fisheries (Summer 2023: PICES Press Vol.31, No.2)
	PICES Press article: PICES-2023 Reports: S9 – Understanding the implications of body size change for stock productivity and fisheries management (GRAFY; BIO/FIS) (Winter 2024: PICES Press Vol.32, No.1)