2024 Report of WG 45 Joint PICES/ICES Working Group on Impacts of Warming on Growth Rates and Fisheries Yields (GRAFY)

The Joint PICES/ICES Working Group on Impacts of Warming on Growth Rates and Fisheries Yields (WG 45/WGGRAFY) held its annual WG meeting on September 16 at 6 AM Pacific Time US & Canada online, under the chairing of Drs. Paul Spencer (USA, PICES) and Shin-ichi Ito (Japan, PICES). The purpose of the meeting was to discuss 1) updated activities and accomplishments in WG 45; 2) future schedules; and 3) requests for SB. In addition to the online meeting, an in-person meeting was held on 26th October during the PICES 2024 Annual Meeting. The agenda was almost the same.

AGENDA ITEM 1
Introduction by Co-Chairs

The meeting began with a brief introduction of WG 45 ToR and topics of WG 45.

AGENDA ITEM 2
Introduction of members and adoption of agenda

After the introduction of members (*WG45 Endnote 1*), the agenda was adopted (*WG45 Endnote 2*).

AGENDA ITEM 3
Reports on 2024 WG45 (GRAFY) Activities & Accomplishments

1) ICES Final Report
ICES co-chair Max Lindmark reported that "Joint ICES-PICES Working Group on Impacts of Warming on Growth Rates and Fisheries Yields (WGGRAFY; outputs from 2023 meeting)" was published on 8th August 2024. The citation is as below.

> ICES. 2024. Joint ICES-PICES Working Group on Impacts of Warming on Growth Rates and Fisheries Yields (WGGRAFY; outputs from 2023 meeting). ICES Scientific Reports. 6:70. 48 pp. https://doi.org/10.17895/ices.pub.26356351

2) PICES Press article for PICES 2023 Theme Session
Co-chairs reported the publication of a PICES Press article for PICES 2023 Theme Session. The lead author is an ECOP member of WG45 (GRAFY), Chenying Guo.

3) Publication from WGGRAFY
Co-chairs shared the information with the members regarding a publication from WG45 (GRAFY), listed below.
> Lin Z., S. Ito, 2024, Fish weight reduction in response to intra- and interspecies competition under climate change. Fish and Fisheries, 25, 455-470. https://doi.org/10.1111/faf.12818
The lead author is an ECOP of WG45 (GRAFY), Zhen Lin.

4) Shin-ichi Ito reported on progress for several WG45 Terms of Reference, including the Lin and Ito (2024) publication listed above and: 1) application of a state-space model to observations of fish weight for western North Pacific stocks; and 2) further compilation and processing of fish size-at-age from various locations,

including the Gulf of Alaska and the North Sea. Saang-Yoon Hyan presented research on a management strategy evaluation to examine the effect of growth and maturation of Pacific chub mackerel on fisheries management. Steve Latham presented time-series of decreasing body size for Fraser River pink salmon, and its implication for fecundity and stock productivity.

4) PICES Topic Session
Co-chairs reported on S11: BIO/FIS Topic Session "Impacts of warming-induced changes in body sizes on marine fish ecology and their consequences for ecosystems and associated fisheries" which will be held on 30th October 2024 at PICES 2024. The convenors are Chenying Guo (ECOP, China), Christine Stawitz (USA), Paul Spencer (USA), and Shin-ichi Ito (Japan). The invited speaker is an ECOP, Dr. Julia Indivero (USA). 14 ECOP presentations are scheduled in total of 21 presentations (67%).

5) Report for PICES
Co-Chairs reported the contents of Expert Group Information submitted to the FIS committee from WG45 (GRAFY). The activities and achievements of WG45 (GRAFY) were assessed based on ToR.

AGENDA ITEM 4
Future schedules

1) WG45 (GRAFY) Final Report to PICES
Members discussed the contents and style of the WG45 (GRAFY) Final Report to PICES. Considering the ICES Scientific Reports "Joint ICES-PICES Working Group on Impacts of Warming on Growth Rates and Fisheries Yields (WGGRAFY; outputs from 2023 meeting)" 1) contains achievements from all ToR, 2) include co-chairs as editors, 3) include WG45 (GRAFY) members as authors, and 4) include the PICES logo on the front page, the members agreed to request PICES to accept the ICES Scientific Reports as the WG45 (GRAFY) Final Report to PICES.

2) Potential session at 2025 PICES meeting
Christine Stawitz mentioned that other PICES scientists are developing a session proposal for the 2025 PICES Annual Meeting focused on climate impacts in stock assessments, and we discussed whether WG45 (GRAFY) members might be interested in co-convening this proposed session.

AGENDA ITEM 5
Requests and other business

Requests to PICES were discussed.
The members agreed to request PICES to accept the above ICES Scientific Reports as the WG45 (GRAFY) Final Report to PICES.

WG45 Endnote 1
PICES/ICES joint WG45 participation list (both online and in-person meetings)

Members

Shin-ichi Ito (Japan, Co-Chair)
Paul Spencer (USA, Co-Chair)
Max Lindmark (Sweden, ICES Co-Chair)
Yue Jin (China) (online only)
Shuyang Ma (China) (in-person only)
Yongjun Tian (China) (in-person only)
Saang-Yoon Hyun (South Korea)
Melissa A. Haltuch (USA) (online only)
Christine Stawitz (USA) (in-person only)

Members unable to attend

Canada: Sean Anderson
Japan: Kunihiro Fujiwara, Takeshi Tomiyama

Observers

Stephen Latham (Canada) (in-person only)
Soyeon Nam (South Korea) (online only)
Jennifer Bigman (USA) (in-person only)

WG45 Endnote 2

PICES/ICES joint WG45 meeting agenda

1. Introduction
2. Introduction of members and adoption of Agenda
3. Reports on 2024 WG45 (GRAFY) Activities & Accomplishments
4. Future directions
5. Requests and other business

WG45 Endnote 3

PICES/ICES joint WG45 Group photo at the in-person meeting

Summary of WG Accomplishments against TOR items (PICES-2021–PICES-2024)

*This information was submitted as a part of the biannual activity report to SB 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 fish 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)