Joint ICES/ PICES Working Group on Impacts of Climate Warming on Growth Rates and Fisheries Yields (WGGRAFY)

2019/FT/EPDSG06 A Joint **ICES-PICES Working Group on Impacts of Warming on Growth Rates and Fisheries Yields** (WGGRAFY), chaired by C. Tara Marshall*, UK (ICES), Paul Spencer*, USA (PICES), Alan Baudron*, UK (ICES), Shin-ichi Ito*, Japan (PICES) and John Morrongiello*, Australia (Guest) will work on ToRs and generate deliverables as listed in the Table below.

The ToRs describe a programme of co-ordinated research to be undertaken by a global network of scientists. The ToRs have been developed jointly through discussions at an earlier workshop (Aberdeen 2018). Given the specific nature of the ToRs it is the intention of the co-chairs to minimise the need for face-to-face meetings. Instead work on the ToRs is progressed via remote working and communicated via technological means, including email and skype. WG meetings will be timed to coincide with other international meetings that the co-chairs are attending. Meetings will use video conferencing to allow other WG members to participate remotely. This has several practical advantages. It minimises the requirement for WG participants to secure the substantial funding required for international travel. Secondly, it minimises cumulative carbon emmissions of the WG thereby constituting a more climate-friendly programme of research. This working practice will be challenge but is logical given that the WG concerns climate impacts.

	MEETING DATES	VENUE	REPORTING DETAILS	COMMENTS (CHANGE IN CHAIR, ETC.)
Year 2019	September	ICES ASC, Sweden		Information meeting with co-chairs and prospective members attending the ASC. Develop strategy for securing participants meeting WG needs.
Year 2020 (Year 1)	7-10 September	By correspondence		(ICES ASC- progress reporting on ToR activities; chairs attend, optional attendance by member)
Year 2021 (Year 2)	October	TBA		(PICES ASC- progress reporting on ToR activities; chairs attend, optional attendance by member)
Year 2022 (Year 3)	September	TBA		(ICES ASC- progress reporting on ToR activities; chairs attend, optional attendance by member)
Year 2022	November	Seattle, Washington (proposed)		Final meeting to complete publications (ToRs a,b,c) and strategy document (ToRd)
			Final report by January 2023	

ToR descriptors

ToR	Description	Background	Science plan codes	Duration	Expected Deliverables
a	Assess the capacity of statistical models to incorporate temperature-dependency of growth, and then compare their predictions of growth variation across specific warming scenarios and locations		1.3, 1.7, 2.5	Year 1	Paper suitable for peer-reviewed fish journal
b	Analyse long-term growth patterns across multiple large marine ecosystems that are experiencing different trends in temperature, using a common modelling approach		1.7, 5.2, 6.1	Years 1, 2 and 3	Papers suitable for peer-reviewed, high impact generic journal
c	Assess the impacts of warming on past yield per recruit of commercial fisheries, and forecast trends in future yield given plausible warming scenarios		1.3, 5.2, 6.1	Year 3	Paper suitable for peer-reviewed, high impact generic journal
d	Identify options for expanding scientific community access to global length-at-age data that are routinely collected by fisheries agencies worldwide.		3.2	Years 1,2,3	Strategic plan assessing options for widening access to length-at-age data collected routinely (similar to how data can be accessed via Datras)

Summary of the Work Plan

Year 0	Initial information meeting will take place in September 2019 at the ICES ASC which will be attended by all four co-chairs and interested individuals. The meeting will present and discuss the longterm goals of the WG, the individual ToRs and the specific requirements for prospective WG members. Following on from this meeting targetted email will be sent to individual scientists who are felt to have access to relevant data and/or valuable modelling skills. Members of the WG will come from both ICES and PICES communities but also a broader array of global scientists from regional seas experiencing warming, cooling or upwelling who hold longterm length-at-age data (e.g., Chile).
Year 1	A meeting may take place at the ICES Annual Science Conference to review progress towards ToRa and ToRd. Sub-groups meet remotely as required; full WG remotely meets once per year for progress reporting

Year 2	A meeting may take place at the PICES Annual Science Conference to discuss progress towards ToRs a, b and d. Planning for an international theme session will be convened (tentatively in Year 3 at ICES ASC). Sub-groups meet remotely as required; full WG remotely meets once per year for progress reporting
Year 3	Aweek-long meeting of the full WG will be held to complete writing of papers and will possibly be held at the University of Washington (UW). This location will facilitate discussion of data archiving using the arrangements for maintenance of RAM Legacy database UW as an example.

Supporting information

Priority	The Temperature Size Rule (TSR) proposes that fish at warmer temperatures have rapid early growth and lower adult size (Forster et al. 2012). Several North Sea fish stocks have exhibited a synchronous, common trend towards smaller maximum body sizes that was correlated with increasing temperature. This "shrinking" decreased per-capita yields of those stocks by ca. 23% (Baudron et al. 2014). Similarly, it has been projected that by 2050 global fish yields will decrease by 14-24% due to shifting biogeography and the TSR (Cheung et al 2012). The aim of WGGRAFY is to determine whether temporal trends in individual growth rates of marine fish are consistent with the TSR and, if so, evaluate the impacts for fish yields. Length and age have been routinely measured for many commercial fish stocks on time scales that are associated with warming. These substantial data have never been compiled as a single, analytical resource for climate change research on global scales. The WG will compile length at age datasets for large marine ecosystems experiencing differential rates of warming or cooling or no overall trend (e.g., upwelling regions). A customised statistical approach for modelling growth will be developed to specifically test whether there is a component of the total variation in growth rates that can be attributed to temperature. This knowledge could provide a empirical foundation for forecasting the impacts of future climate warming on yields. The unique spatial and temporal scale of length-at-age data are valuable resource for ecological research. The WG will also develop a strategic plan for archiving length-at-age data similar to how ICES archives data for European waters (Datras) or how global data on recruitment and catch are reported and maintained (e.g., RAM Legacy). This will require engaging with various agencies (ICES, EMODnet, FAO, universities, tech specialists) and national fisheries laboratories as well as potential funding sources. References Baudron, A.R., Needle, C.L., Rijnsdorp, A., Marshall, C.T. 2014. Warming temperatures and smaller body sizes: synchronous changes in growth of North Sea fishes. Global Change Biology 20: 1023-1031. Cheung, W. W. L., et al. 2012. Shrinking of fishes exacerbates impacts of global ocean changes on marine ecosystems. Nature Climate Change, 3:254–258. Forster, J., Hirst, A.G., Atkinson, D. 2012. Warming-induced reductions in body size are greater in aquatic than terrestrial species. PNAS 109:19310 LP-19314.
Resource requirements	None anticipated due to nature of remote working.
Participants	The WG is expected to attract between 25 to 35 members including guests giving broad coverage of large marine ecosystems within and outside ICES and PICES regions.
Secretariat facilities	The group will request meeting rooms / times associated with the ASC. This will require some assistance from members of the secretariats organizing those events. It is envisioned that video conferencing facilities will be required such that non-attending WG members can participate.
Financial	Funds may be requested to support travel of key participants to the final and only meeting.
Linkages to ACOM and groups under ACOM	The group will identify how climate has influenced the productivity and yields of commercial fish stocks within ICES areas retrospecitively. In addition, it will develop

	knowledge relavant to forecasting future impacts on fish growth rates. This information is compatible with the evolving knowledge base relating to climate-driven distributional shifts. This information will be useful to ACOM in recommending adaptation options for fisheries management.
Linkages to other committees or groups	Unknown but ICES WG related to otolith and aging, fish population dynamics and climate change would be relatively straightforward linkages.
Linkages to other organizations	Joint partnership between ICES and PICES: the proposal is simultaneously submitted to PICES; UN Decade of the Oceans: The mandate of this joint ICES/PICES activity is relevant to the objectives of the UN Decade of Ocean Science for Sustainable Development and UN Strategic Development Goals (*e.g.*, SDG 14, Life Below Water).