

Report of Working Group 37 on Zooplankton Production Methodologies, Applications and Measurements in PICES Regions

The third meeting of the Working Group on *Zooplankton Production Methodologies, Applications and Measurements in PICES Regions* (WG 37) was held on October 20, 2019 from 14:00 to 18:00 h in Victoria, Canada, under the chairmanship of Dr. Toru Kobari (Japan) and Dr. Akash Sastri (Canada). Sixteen participants including national representatives and observers attended the meeting (**WG 37 Endnote 1**). Several members who could not attend the meeting reported progress on their inter-sessional activities (see **WG 37 Endnote 2**) and/or provided comments through the E-mail communication.

AGENDA ITEM 1

Activities in 2019

Drs. Kobari and Sastri reported the following WG activities achieved in 2019.

- Drs. Sastri, Jennifer Jackson (Hakai Institute), Lidia Yebra and Kobari organized a Practical Workshop Phase 2 during October 11 to 14, 2019 (just before the PICES-2019) at the Hakai Institute, Quadra Island, British Columbia, Canada (see [pp. 12–13, 17](#) in PICES Press, 2020, Vol. 28, No. 1). Eight students and 6 scientists participated. Onboard sampling, laboratory work and lectures on how to measure chitobiase activity and aminoacyl tRNA synthetases activity for zooplankton were conducted.
- The Co-Chairs and Dr. Lidia Yebra (*ex-officio* member representing ICES, Spain) convened a Workshop (W10) on “*PICES/ICES collaborative research initiative*” on October 16, 2019 at PICES-2019 in Victoria. Eighteen people attended, and 9 talks and 3 posters were presented.
- Drs. Sastri and Yebra reviewed the outcomes of the practical and 1-day workshops held on October 12–14, 2019 and October 16, respectively, with the WG.
- Dr. Yebra summarized the “Discussion” section of W10 in detail (Dr. Sastri presented the slides from the introduction of the workshop).

AGENDA ITEM 2

Plans to promote terms of references

Dr. Kobari described the WG 37 work plan and progress on terms of references after which participants provided comments and suggestions. The Co-Chairs asked members to confirm that they could meet the new deadline of each task owing to the 1-year extension given to the WG for summarizing the WG 37 final report.

1. *Review papers on traditional and biochemical methodologies (ToR1)*

- A review paper on traditional methodologies by the WG members (T. Kobari, A. Sastri, L. Yebra, H. Liu and R. Hopcroft) was submitted to a Special Issue (Dr. Bill Peterson Commemorative Issue) of *Progress in Oceanography* by the end of April 2019. Following comments and suggestions provided by two reviewers, a revised manuscript was resubmitted to the journal in mid-July, accepted in late July and published online in August 2019 (<https://doi.org/10.1016/j.pocean.2019.102137>).

2. *Guidelines and recommendations (procedures/protocols) of traditional and biochemical methodologies (ToR2)*

- Dr. Yebra will make a draft based on the review paper on biochemical methodologies by Yebra *et al.*, (2017, <https://doi.org/10.1016/bs.amb.2016.09.001>).
- Similar guidelines for traditional methodologies are being developed by the WG members and

colleagues. At the PICES-2018 meeting, Co-Chairs had asked for guidelines on the following: molting rate by Dr. Hopcroft (US member; T. Kobari will also provide), artificial cohort by H. Liu (US member), egg production by Dr. Shinji Shimode (materials for Practical Workshop Phase 1), empirical models by Dr. Koichi Ara (materials for Practical Workshop Phase 1), and physiological model (to be provided by T. Kobari).

- Dr. Kobari asked all corresponding authors to send the guidelines and recommendations to him by the end November 2019. These will be posted on the PICES website in January 2020 and will be included in the WG 37 final report.
- Dr. Kobari clarified that the procedures are detailed step-by-step.
- WG members agreed that the level of understanding/experience for the procedures would be aimed at undergraduate or graduate student readers.

3. *Develop practical models for estimating zooplankton production to time-series (ToR3)*

- At the PICES-2018 workshop ([W6](#), *Regional evaluation of secondary production observations and application of methodology in the North Pacific*) and WG 37 business meeting, the Ikeda-Motoda was judged to be a suitable model that could be applied to zooplankton time-series due to the wide coverage of various taxonomic groups, locations and situations, minimum requirements of variables only for temperature and animal body weight, and high temporal and spatial resolutions.
- Drs. Kazuaki Tadokoro and Kobari demonstrated the applications of the Ikeda-Motoda model to some Japanese zooplankton data sets. They had already demonstrated the applications to zooplankton data sets in the Inland Sea of Japan and on the Canadian coast at W6 during PICES-2018. These results will be included in the WG 37 final report (expected to be completed by the end of February 2020).
- Dr. Kobari has contacted Dr. Kym Jacobson (NOAA Newport Zooplankton Program) requesting zooplankton time-series results along the Oregon coast.

4. *Build a platform of information exchange on zooplankton production measurements through an interactive website for regional and/or global mapping (ToR4)*

- The following zooplankton data sets will be run with the Ikeda-Motoda model in order to make regional-to-basin-scale comparisons of zooplankton production rates:
 - Station P and Line P in the subarctic North Pacific (I. Perry, A. Sastri, Canada)
 - Newport Line in the western US coast (K. Jacobson, USA)
 - Tsushima Strait (T. Kobari, Japan)
 - Kuroshio in the East China Sea (T. Kobari, Japan)
 - A-Line in the western North Pacific (T. Tadokoro, Japan)
 - Inland Sea of Japan (K. Tadokoro, Japan)
 - Strait of Georgia (I. Perry, A. Sastri, K. Suchy, Canada)
 - CalCOFI and HOT time series (will be included if permission is obtained from the data owners).
- Prof. Uye suggested including a general picture (*i.e.*, spatial or temporal patterns); members agreed to include temporal or spatial averages based on the zooplankton time series. Ultimately, these comparisons will be to depict similar maps of phytoplankton biomass and primary production even if using different methodologies, which Dr. Liu pointed out.
- The WG will compare zooplankton production within each time series as a first step. However, there is a difficulty in comparing biomass data collected with different mesh sizes. A comparison of trends or anomalies rather than direct data was suggested as possibility to overcome dissimilarities between time series.

5. *Build a network of scientists and laboratories measuring zooplankton production among PICES and ICES nations as well as developing countries (ToR5)*
 - Information on scientists and laboratories (*e.g.*, name, institute, email, methodology used, selected publications) was reviewed by WG 37. WG members were requested during PICES-2019 to email any more information on scientists and laboratories measuring zooplankton production for entry into tables. Dr. Yebra provided a list of laboratories from ICES Working Group on Zooplankton Ecology and MedZoo. The completed list will be posted on the WG 37 website by the end of November 2019.
6. *Promote international collaborations among zooplankton production researchers through international organizations such as PICES, ICES and IMBER (ToR6)*
 - A joint AP-NPCOOS/WG 37 [PICES Spring School on “Coastal Ocean Observatory Science”](#) will be held in early March 2020 in Kagoshima, Japan. The theme is “What is the Deep Scattering Layer (DSL) in the coastal region?”.
 - *In situ* and laboratory experiments for comparing traditional methodologies have been conducted by Drs. Kobari and Sastri and the preliminary results were presented at PICES-2017. Further results were shown at PICES-2019. These results will be included in the WG 37 final report.
 - WG 37, including *ex-officio* member, Dr. Yebra (Chair of ICES WGZE), will contribute a session or workshop at the 7th Zooplankton Production Symposium (Hobart, Australia, 2022).
 - WG 37 submitted a proposal for a workshop at PICES-2020 (**WG 37 Endnote 3**)
7. *Publish a final report summarizing results (ToR7)*
 - Dr. Kobari presented a tentative plan for contents, and authors responsible for the final report, referring to previous reports of past working groups as examples (see **WG 37 Endnote 4**).

AGENDA ITEM 3

Bibliography for zooplankton production methodology and measurements in the PICES region

Published papers for Korean and Japanese waters have been added to a zooplankton production methodology and measurements bibliography. The Co-Chairs will contact national representatives to collect more published papers, in particular papers from the China and Russian regions. The bibliography will be included to the WG final report (as Appendix 5) and will be uploaded to the WG 37 website.

AGENDA ITEM 4

Report of the Practical Workshop Phase 2 on Quadra Island

Dr. Sastri showed members a draft article that will be submitted to the PICES Secretariat by the end of November 2019 for publication in PICES Press [since published in PICES Press, 2020, Vol. 28, No. 1, [pp. 12-13, 17](#)].

AGENDA ITEM 5

Report of Workshop W10 at PICES-2019

Dr. Yebra presented a draft article that will be submitted to the PICES Secretariat by the end of November 2019 for publication in PICES Press [since published in PICES Press, 2020, Vol. 28, No. 1, [pp. 22–23, 26](#)].



Attendees at the WG 37 meeting on October 20 at PICES-2019, Victoria, Canada. Back row, from left: Fukutaro Karu, Toru Kobari, Hui Liu, Russ Hopcroft, Shin-ichi Uye, Kazuaki Tadokoro, Akash Sastri. Front row, from left, Takeru Kanayama, Megu Iwazono, Naoki Yoshie, Karyn Suchy, Lidia Yerba, Pei-Chi Ho, Hyunjin Yoon.



WG 37 members (left photo, from left) Lidia Yebra, Russell Hopcroft, Hui Liu and Karyn Suchy and (right photo, at front) Akashi Sastri and Se-Jong Ju enjoying a collegial dinner together with other PICES members (from left) Taewon Kim, Julie Keister and Lisa Eisner.

WG 37 Endnote 1

WG 37 participation list

Members

- Toru Kobari (Co-Chair, Japan)
- Akash Sastri (Co-Chair, Canada)
- Russell Hopcroft (USA)
- Se-Jong Ju (Korea)
- Hui Liu (USA)
- Karyn Suchy (Canada)

- Kazuaki Tadokoro (Japan)
- Lidia Yebra (Spain, *ex officio* member representing ICES)

Observers

Megu Iwazono (Japan)
 Takeru Kanayama (Japan)
 Fukutaro Karu (Japan)
 Wongyu Park (Korea)
 Pei-Chi Ho (Chinese Taipei)
 Shin-ichi Uye (Japan)
 Hyunjin Yoon (Korea)
 Naoki Yoshie (Japan)

Members unable to attend

China: Qing Yang
 Korea: Min-Chul Jang, Hyung-Ku Kang, Jung-Hoon Kang
 Russia: Vladimir Napazakov
 USA: Todd O'Brien

WG 37 Endnote 2**WG 37 meeting agenda**

1. Activities in 2019
 - Practical Workshop Phase 2
 - Workshop W10 in the PICES 2019 Annual Meeting
2. Plans to promote terms of references
 - 1) Review papers on traditional and biochemical methodologies (ToR1).
 - 2) Guidelines and recommendations of traditional and biochemical methodologies (ToR2).
 - 3) Develop practical models for estimating zooplankton production to time-series (ToR3).
 - 4) Build a platform of information exchange on zooplankton production measurements through an interactive website for regional and/or global mapping (ToR4).
 - 5) Build a network of scientists and laboratories measuring zooplankton production among PICES and ICES nations as well as developing countries (ToR5).
 - 6) Promote international collaborations among zooplankton production researchers through international organizations such as PICES, ICES and IMBER (ToR6).
 - 7) Publish a final report summarizing results (ToR7).
3. Bibliography for zooplankton production methodology and measurements in the PICES region
4. Report of Practical Workshop Phase 2
5. Report of Workshop at PICES-2019

WG 37 Endnote 3

**Proposal for a Workshop on
“Can we link zooplankton production to fisheries recruitment?”
at PICES-2020**

Convenors: Hui Liu (USA), Toru Kobari (Japan), Karyn Suchy (Canada), Russ Hopcroft (USA)

Duration: 1 day

Invited speaker: Xianshi Jin (China)

Sustainability of fisheries requires a better understanding of stock dynamics and resilience to environmental and anthropogenic forcing. Zooplankton play a vital nexus between primary producers and higher level consumers and are thus highly relevant to fisheries production and ecosystem functions. Understanding the impact of trophic relationships on the nutrition of larvae and foraging fishes is a critical step needed to forecast the stock response and resilience to environmental changes. However, limited attention has been paid to the role of zooplankton in sustaining fisheries production, which is largely because routine measurements of secondary production remain rare. This workshop will discuss prospective ways for understanding functional and structural roles of secondary production on fisheries dynamics and production. In particular, we encourage presentations and discussions on research using experimental, observational and modeling approaches linking zooplankton productivity and fish larvae and foraging fishes.

WG 37 Endnote 4

**Report of Working Group 37
Table of Contents**

In Memoriam (T. Kobari and A. Sastri): almost done

Executive Summary (A. Sastri and L. Yebra): write after completed all information and circulate among all members

1. Introduction

1.1. Background (T. Kobari): almost done

(WG to explain that target was meso to macrozooplankton in this final report and microzooplankton should be target as future prospects.)

1.2. Rationale: almost done

1.3. Working Group Timeline: almost done

2. Principle, Advantages/Disadvantages and Recommendations

2.1. Introduction (T. Kobari): almost done

2.2. Traditional Methodologies (from review paper: T. Kobari)

2.2.1. Natural Cohort: partially done

2.2.2. Artificial Cohort: partially done

2.2.3. Molting Rate: partially done

2.2.4. Egg Production: partially done

2.2.5. Empirical Models: partially done

- 2.3. Biochemical Approaches (from review paper: [L. Yebra](#))
 - 2.3.1. Nucleic Acid Indices: [not yet](#)
 - 2.3.2. Chitobiase Activity: [not yet](#)
 - 2.3.3. Aminoacyl tRNA Synthetases Activity: [not yet](#)
 (These sections would be described and summarized using the tables for traditional and biochemical approaches rather than repeating the review papers.)
3. Zooplankton Production Measurements in Regional Seas ([R.R. Hopcroft](#))
 - 3.1. Introduction
 - 3.2. Zooplankton Production Measurements
 - 3.2.1. Gulf of Alaska ([R.R. Hopcroft](#) and [H. Liu](#)): [not yet](#)
 - 3.2.2. Canadian waters and Bering Sea (from PICES 2018 workshop: [A. Sastri](#) and [K. Suchy](#)): [not yet](#)
 - 3.2.3. Okhotsuk Sea ([Russian members?](#)): [not yet](#)
 - 3.2.4. Japanese waters (from PICES 2018 workshop: [T. Kobari](#)): [not yet](#)
 - 3.2.5. Korean waters ([Hyung-Ku Kang](#) and [Jung-Hoon Kang](#)): [almost done](#)
 - 3.2.6. East China Sea ([Chinese members?](#)): [not yet](#)
 (These sections are described using the bibliography as described below.)
4. Application of Production Models to Zooplankton Data Sets in PICES region
 - 4.1. Introduction ([T. Kobari](#)): [almost done](#)
 - 4.2. Station Papa ([A. Sastri](#), [K. Suchy](#), and [L. Kwong](#)): [not yet](#)
 - 4.3. Strait of Georgia ([K. Suchy](#) and [A. Sastri](#)): [not yet](#)
 - 4.4. West coast of Vancouver Island ([A. Sastri](#), [K. Suchy](#), [L. Kwong](#))
 - 4.5. Northern Gulf of Alaska ([R. Hopcroft](#)): [not yet](#)
 - 4.6. Chukchi Sea ([R. Hopcroft](#)): [not yet](#)
 - 4.7. Inland Sea of Japan ([K. Tadokoro](#)): [not yet](#)
 - 4.5. Other Japanese waters ([T. Kobari](#)): [not yet](#)
5. Comparisons of Zooplankton Production among Methodologies
 - 5.1. Introduction ([T. Kobari](#)): [almost done](#)
 - 5.2. Copepod Culture ([T. Kobari](#)): [almost done](#)
 - 5.3. Natural Cohort and Modified Natural Cohort ([T. Kobari](#)): [almost done](#)
 - 5.4. AARS activity and Natural Cohort ([T. Kobari](#) and [Megu Iwazono](#)): [almost done](#)
 - 5.5. Chitobiase Activity and Natural Cohort ([A. Sastri](#)): [not yet](#)
 - 5.6. AARS activity and Physiological Model ([Megu Iwazono](#) and [T. Kobari](#)): [not yet](#)
 - 5.6. AARS activity and Chitobiase Activity ([A. Sastri](#) and [T. Kobari](#)): [not yet](#)
6. Concluding Remarks ([T. Kobari](#), [A. Sastri](#) and [L. Yebra](#))
 - 6.1. Recommendations ([T. Kobari](#), [A. Sastri](#) and [L. Yebra](#)): [not yet](#)
 - 6.2. Future Prospects ([T. Kobari](#), [A. Sastri](#) and [L. Yebra](#)): [not yet](#)
 (WG describe that target was meso to macrozooplankton in this final report and microzooplankton should be target as future prospects.)
7. Acknowledgements ([T. Kobari](#)): [almost done](#)
8. References: [not yet](#)
9. Supplemented Information
 - Appendix 1 WG 37 Terms of References: [will be provided by the Secretariat](#)
 - Appendix 2 WG 37 Membership: [will be provided by the Secretariat](#)

Appendix 3 Business Meeting Reports from Past PICES Annual Meetings: will be provided by the Secretariat

Appendix 4 Session/Workshop Summaries of International Conference Related to WG37 (T. Kobari): not yet

Appendix 5 Bibliography (T. Kobari): partially done

Appendix 6 Information on Laboratories Working on Zooplankton Production (T. Kobari): partially done

Appendix 7 Guidelines and procedures for traditional and biochemical methodologies: not yet

Appendix 7.1. Traditional methodologies

Append.7.1.1. Artificial Cohort (Russ Hopcroft): not yet

Append.7.1.2. Molting Rate (T. Kobari): almost done

Append.7.1.3. Egg Production (Shinji Shimode and T. Kobari): almost done from Workshop Phase 1

Append.7.1.4. Empirical Models (Koichi Ara and T. Kobari): not yet

Append.7.1.5. Physiological Models (T. Kobari): not yet

Appendix 7.2. Biochemical methodologies

Append.7.2.1. Nucleic Acid Indices (L. Yebra): needs formatting from published version prior to posting at the PICES website

Append.7.1.2. Chitobiase Activity (A. Sastri): needs formatting from published version prior to posting at the PICES website

Append.7.1.3. Aminoacyl tRNA Synthetases Activity (L. Yebra): needs formatting from published version prior to posting at the PICES website

Proposed deadlines:

Section 3: April 1, 2020

Section 4: end of November 2019

Section 5: end of November 2019

Practical Workshop Report Phase 2 and PICES workshop W10: end of November, 2019