

Report of Working Group on *Development of Ecosystem Indicators to Characterize Ecosystem Responses to Multiple Stressors*

The meeting of the Working Group on *Development of Ecosystem Indicators to Characterize Ecosystem Responses to Multiple Stressors* (WG 28) was held from 14:00–18:00 h on October 15, 2011 at the PICES-2011 in Khabarovsk, Russia. Dr. Motomitsu Takahashi (Japan) acted as meeting Chair. Seventeen people were present, representing 5 PICES member countries (WG 28 Endnote 1). Dr. Takahashi recommended asking Drs. Ian Perry (Canada) and Chaolun Li (China) to serve as Co-Chairs of the Working Group. This report reflects discussions at the meeting on some of the Agenda Items (WG 28 Endnote 2).

AGENDA ITEM 2

Schedule of Working Group activities

Each of 7 terms of reference of WG 28 was divided into the year when it would be addressed.

Year 1

1. Identify and characterize the spatial (and temporal) extent of critical stressors in North Pacific ecosystems both coastal and offshore and identify locations where multiple stressors interact. Identify trends in these stressors if possible.
2. Review and identify categories of indicators needed to document status and trends of ecosystem change at the most appropriate spatial scale (*e.g.*, coastal, regional, basin).

Year 2

1. Using criteria agreed to at the 2011 PICES FUTURE inter-sessional workshop in Honolulu, determine the most appropriate weighting for indicators used for:
 - a. documenting status and trends,
 - b. documenting extent of critical stressors,
 - c. assessing ecosystem impacts/change.
2. Review existing frameworks to link stressors to impacts/change, assessing their applicability to North Pacific ecosystems and identify the most appropriate for application to North Pacific ecosystems.
3. Determine if ecosystem indicators provide a mechanistic understanding of how ecosystems respond to multiple stressors and evaluate the potential to identify vulnerable ecosystem components.

Year 3

1. For 1–2 case studies, identify and characterize how ecosystems respond to multiple stressors using indicators identified above. Are responses to stressors simply linear or are changes non-linear such that small additional stressors result in much larger ecosystem responses?
2. Do different parts of the ecosystem respond differently (*e.g.*, trophic level responses)? How do stressors interact? Publish a final report summarizing results with special attention to FUTURE needs. This Working Group will focus primarily on delivery of FUTURE Questions 1 and 3 (see http://www.pices.int/members/scientific_programs/FUTURE/FUTURE_IP_final_2009.pdf).

AGENDA ITEM 4

Proposals for Working Group activities at PICES-2012

The first year of WG 28's activities include a broad range of tasks, so the following activities were proposed for PICES-2012:

- 1-day WG meeting;
- 1-day Workshop on “*Identifying critical multiple stressors of North Pacific marine ecosystems and indicators to assess their impacts*” (WG 28 Endnote 3);
- ½-day Topic Session on “*Ecosystem responses to multiple stressors in the North Pacific*” (WG 28 Endnote 4).

WG 28 Endnote 1

WG 28 participation list

Members

Jennifer Boldt (Canada)
Ik Kyo Chung (Korea)
Shigeru Itakura (Japan)
Sachihiko Itoh (Japan)
Vladimir Kulik (Russia)
Jaebong Lee (Korea)
Steve Rumrill (USA)
Jameal Samhoury (USA)
Motomitsu Takahashi (Japan, Co-Chairman)

Naoki Yoshie (Japan)
Chang-Ik Zhang (Korea)

Observers

Robin Brown (Canada)
George Hunt (USA)
Sangjin Lee (NOWPAP of UNEP)
Thomas Therriault (Canada)
Atsushi Tsuda (Japan)
Yutaka Watanuki (Japan)

WG 28 Endnote 2

WG 28 meeting agenda

1. Welcome, Introduction and sign-in (all)
2. General review of Terms of Reference and discussion about WG frameworks
 - WG deliverables
 - Contributions to FUTURE
 - Timelines
 - Leads
3. Review of recent PICES activities related to this WG
 - Review of FUTURE Inter-sessional Workshop in Honolulu in April 2011
 - Forthcoming related workshop/symposium
4. Discussion on possible topic session at PICES-2012 and -2013
 - Review of a topic session proposal
 - Terms, invited speakers, program
 - Other related issue
5. Discussion on how to activate our WG
 - How to share papers and ideas
 - Next meeting (PICES-2012)

WG 28 Endnote 3

Proposal for a 1-day workshop at PICES-2012 on
“Identifying critical multiple stressors of North Pacific marine ecosystems and indicators
to assess their impacts”

Co-Convenors: Jennifer Boldt (Canada), Vladimir Kulik (Russia), Chaolun Li (China), Jameal Samhour (USA), Motomitsu Takahashi (Japan), Chang-Ik Zhang (Korea)

Multiple natural and human stressors on marine ecosystems are common throughout the North Pacific, and may act synergistically to change ecosystem structure, function and dynamics in unexpected ways that can differ from responses to single stressors. Further, these stressors can be expected to vary by region, and over time. This workshop seeks to understand responses of various marine ecosystems to multiple stressors, and to identify and characterize critical stressors in PICES regional ecosystems including appropriate indicators of their impacts. The goal is to help determine how ecosystems might change in the future and to identify ecosystems that may be vulnerable to the combine impacts of natural and anthropogenic forcing. Contributions are invited which identify and characterize the spatial and temporal extent of critical stressors in marine ecosystems (both coastal and offshore regions) of PICES member countries, and in particular the locations at which multiple stressors interact. Contributions will include a review and identification of broad categories of indicators which document the status and trends of ecosystem change at the most appropriate spatial scale (*e.g.*, coastal, regional, basin) in response to these multiple stressors. This workshop is linked with the topic session titled “Ecosystem responses to multiple stressors in the North Pacific” but is designed to provide more in-depth examination and discussion of the spatial and temporal extents of critical marine ecosystem stressors and their potential indicators. It will assist with progress towards the goals of PICES WG 28 on Development of Ecosystem Indicators to Characterize Ecosystem Responses to Multiple Stressors (http://www.pices.int/members/working_groups/wg28.aspx).

WG 28 Endnote 4

Proposal for a ½-day Topic Session at PICES-2012 on
“Ecosystem responses to multiple stressors in the North Pacific”

Co-Convenors: Vladimir Kulik (Russia), Ian Perry (Canada), Motomitsu Takahashi (Japan)

Marine ecosystems of the North Pacific, both coastal and offshore, are influenced by multiple stressors, such as increased temperature, change in iron supply, harmful algal blooms, invasive species, hypoxia/eutrophication, ocean acidification, and intensive fishing. These multiple stressors can (but do not always) act synergistically to change ecosystem structure, function, and dynamics in unexpected ways that can differ from responses to single stressors. Further, these stressors can be expected to vary by region and over time. This session seeks to understand the responses of various marine ecosystems to multiple stressors and to identify appropriate indicators of these effects. Contributions are invited which review and define categories of indicators to document the status and trends of ecosystem change at a variety of spatial scales (*e.g.*, coastal, regional, basin) in response to multiple stressors. Emphasis will be placed on empirical and theoretical approaches that forge links between ecosystem change and the intensities of multiple stressors. This session will form a contribution to the work of PICES WG 28 on Development of Ecosystem Indicators to Characterize Ecosystem Responses to Multiple Stressors (http://www.pices.int/members/working_groups/wg28.aspx).

Invited Speakers: Natalie Ban (James Cook University, Australia), Ben Halpern (University of California Santa Barbara, USA)