Working Group-28 Development of Ecosystem Indicators to Characterize Ecosystem Responses to Multiple Stressors

Business Meeting, Draft Agenda
Friday, October 17, 2013, 9:00-18:00
Expo Hall, Yeosu, Korea

Meeting objective:
To review activities during the 3rd (2013-14) of WG-28, plan for activities during the 4th year (2014-15), and discuss the contents of the final report. Note that reports from previous WG28 meetings and sponsored sessions are on the WG28 web page at http://www.pices.int/members/working_groups/wg28.aspx

9:00 Welcome, Introduction and sign-in (all) (co-chairs; see Appendix 2 for list of WG members)

9:10 Review of activities during the 3rd year of WG-28

a) General review of Terms of Reference (see Appendix 1) plus discussion of expectations for the Working Group by PICES, and what we expect to be able to deliver (all)

b) Report on WG28-sponsored session at the PICES FUTURE Open Science Meeting in Hawaii, April 2014 (Perry); [see PICES Press July 2014 article: http://www.pices.int/publications/pices_press/volume22/v22-n2/pp_09-10_S1_Perry.pdf]

c) Report on Workshop 2 at the PICES FUTURE Open Science Meeting in Hawaii, April 2014 "**Bridging the divide between models and decision-making: The role of uncertainty in the uptake of forecasts by decision makers"** (Perry; see PICES Press July 2014 article: http://www.pices.int/publications/pices_press/volume22/v22-n2/article_pp_24-27_W2_Gregr.pdf)

d) Report on WG28-sponsored session at 2014 PICES FUTURE Open Science Meeting (Appendix 3; Martone/Samhouri)

e) Other related WG28 activities

10:30 Coffee Break

11:00 Review of progress on Terms of Reference

General discussion of how far we have progressed in addressing our ToR – which have we covered, which have we still to do? **To include brief reports from each country of activities of importance to WG28.**

12:00 Lunch

13:30 Presentations on progress on each of the draft report chapters, and plans for moving these ahead (see Appendix 4 for draft report outline and lead authors, as discussed at our meeting in Nanaimo)

Lead authors for the various chapters in our draft report outline are requested to present and lead a discussion of their proposed chapter outline, i.e. contents, contributors and task assignments, timelines. Additional contributors (in particular among new WG members or those not able to participate in Nanaimo) are welcome:

a) Chapter 2 "Frameworks linking pressures to impacts and changes in North Pacific marine ecosystems", and "Multiple pressures on North Pacific marine ecosystems" (discussion leads: Perry, Takahashi)

b) Chapter 3 "Ecosystem indicators" and "Indicators for ecosystem responses to multiple pressures" - to include presentation/discussion of article accepted for publication in *Oceanography* [discussion leads: Boldt, Samhouri, Itoh, Yoshie, Chung, others (?)]

c) Chapter 4 "Case study examples" :

Inland seas, e.g. Salish Sea (Strait of Georgia; Puget Sound), Seto Inland Sea (discussion leads: Samhouri, Perry, Takahashi)

High latitude seas, e.g. possibly Sea of Okhotsk, Bering Sea (discussion leads: Kullik, Zador, Lukyanova)

15:30 Coffee Break

16:00 Discussions of report outline continued

d) Re-look at proposed report chapter outline – are any topics missing (e.g. reference points/tipping points – or could that be added to Chapter 3)?

e) Conclusions and recommendations – can we begin to identify any of these now? (discussion leads: co-chairs)

16:45 Discussion of interactions with other PICES groups (co-chairs)

a) Relationships between WG28 and other Working Groups and Committees

b) Contributions to FUTURE

16:30 Discussion of plans for primary publications resulting from the WG28 report (Samhouri)

17:15 Any other business

18:00 End

Evening: WG28 group dinner??

NOTE: WG28 has available a second day (Saturday, October 18, 2014, 0900-1800) for its business meeting if needed for work on the various chapters, etc. At present the agenda for day 2 is unscheduled.

Appendix 1

Terms of Reference

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).
3. 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
4. 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.
5. Determine if ecosystem indicators provide a mechanistic understanding of how ecosystems respond to multiple stressors and evaluate the potential to identify vulnerable ecosystem components.
6. 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? Do different parts of the ecosystem respond differently (e.g., trophic level responses)? How do stressors interact?
7. Publish a final report summarizing results with special attention to FUTURE needs. This WG will focus primarily on delivery of FUTURE Questions 3 and 1 (outlined below).

Linkages to the FUTURE Science Plan:

1. What determines an ecosystem's intrinsic resilience and vulnerability to natural and anthropogenic forcing?
2. How do ecosystems respond to natural and anthropogenic forcing, and how might they change in the future?
3. How do human activities affect coastal ecosystems and how are societies affected by changes in these ecosystems?

Appendix 2. Working Group 28 members as of September 2013

Dr. Jennifer L. Boldt (Canada)

Dr. Ian Perry (Canada)
WG-28 Co-Chairman

Prof. Min Chao (China)

Dr. Baisong Chen (China)

Dr. Honghui Huang (China)

Dr. Chaolun Li (China)

Prof. Cuihua Wang (China)

Dr. Heng Zhang (China)

Dr. Shigeru Itakura (Japan)

Dr. Sachihiko Itoh (Japan)

Dr. Motomitsu Takahashi (Japan)
WG-28 Co-Chairman

Dr. Naoki Yoshie (Japan)

Prof. Chang-Ik Zhang (Korea)

Dr. Jaebong Lee (Korea)

Dr. Olga N. Lukyanova (Russia)

Dr. Vladimir V. Kulik (Russia)

Dr. Jameal F. Samhouri (US)

Dr. Rebecca G. Martone (US)

Dr. Stephani G. Zador (US)

Appendix 3. WG28-sponsored scientific session at 2014 PICES Annual Meeting (Korea)

S3: BIO/MEQ Topic Session (1-day)
Tipping points: defining reference points for ecological indicators of multiple stressors in coastal and marine ecosystem

Co-sponsors: International Council for the Exploration of the Sea (ICES) and Integrated Marine Biogeochemistry and Ecosystem Research (IMBER)

Co-Convenors:
Rebecca G. Martone (USA)
Ian Perry (Canada)
Jameal Samhouri (USA)
Motomitsu Takahashi (Japan)
Maciej Tomczak (Poland / ICES)
Chang Ik Zhang (Korea)

Invited Speakers:
Phil Levin (NOAA NW Fisheries Science Center, USA)
Tetsuo Yanagi (Research Institute for Applied Mechanics, Kyushu University, Japan)

Many coastal and marine ecosystems, ranging from reefs to estuaries to pelagic systems, are exposed to multiple stressors, which can lead to rapid changes with significant, long-term consequences that are often difficult to reverse. Changes in ocean climate, the abundance of key species, nutrients, and other factors drive these shifts, which affect ocean food webs, habitats, and ecosystem functions and people's livelihoods and well-being. Determining indicators of ecological changes due to multiple stressors and defining reference points for those indicators are key steps for managers to avoid ecological degradation and loss of keys goods and services. Setting ecological reference points in ecological systems presents a challenge to resource managers because (a) reference points are often difficult to determine due to the complexity of natural systems, including the presence of thresholds, tipping points, and non-linearities; (b) the paucity of theoretical modeling and empirical understanding needed to address these complexities, identify ecological thresholds and develop early warning indicators means that managers must make decisions based on high levels of uncertainty; and, (c) many institutional and governance structures do not allow managers the necessary flexibility to take up this information and react within relevant timeframes. This session will address these pressing challenges, and explore promising approaches to tackling them with the goal of catalyzing new research and management innovation. In particular, we invite presentations that (i) define the conceptual basis for reference points and management objectives surrounding reference points; (ii) use theoretical, modeling and observational approaches to identify potential reference points for indicators of changes in marine ecosystems; (iii) incorporate risk and sources of error (measurement, model, process) in such analyses; (iv) discuss how reference points may be used in helping to manage marine ecosystems, specifically in relation to the decision-making process related to evaluating and deciding on acceptable levels of risk. These discussions will be guided by the FUTURE science themes, with special attention to examining climate and anthropogenic drivers of ecological change, and identifying early warning indicators to enable forecasting to avoid crossing ecological thresholds. The outcomes will contribute to the work of PICES Working Group 28 on *Development of ecosystem indicators to characterize ecosystem responses to multiple stressors*.

Appendix 4.

Updated and revised (draft) outlines for each chapter of WG 28 final report
(revised from the version originally developed at the WG 28 meeting at PICES-2012 in Hiroshima)

General Outline

Chapter 1. Introduction (Co-Chairs: Takahashi/Perry)
- Background to the WG
- ToR/Objectives
- Brief overview of the issue of multiple activities/stressors on marine ecosystems
  - *e.g*., use of the phrase "activities/stressors (or "pressures") to indicate both natural and anthropogenic pressures, and that not all of these are always "bad" for the ecosystem. Define what is a "bad" ecosystem? – *e.g*., different objectives for ecosystem states, what is "bad" varies for fishers *vs* conservationists. Perhaps recommend the broader concept of retaining the natural resilience of ecosystems?
  - Include definitions for "stressors". Note the issue that information to construct indicators is often available at multiple but different time and space scales, *etc*.
  - Brief literature review of problems of multiple and cumulative stressors in marine systems – *e.g*., the norm, but difficult to assess more than 2–3 stressors at one time
    - presentation by Dr. Coté in Session S8 later in this PICES meeting provides an excellent overview and access to key literature.
    - include reference to climate change and fishing issues (*e.g*., age structures are truncated and this can create problems with resilience to climate change).
    - two general types of approaches:
      - mesocosm experiments,
      - whole ecosystem studies and statistical methods.
- Organization and guide to report contents

Chapter 2. Multiple stressors on North Pacific marine ecosystems (Perry, Takahashi, Samhouri, Zhang, Lee, Martone, others welcome!)
- Frameworks linking pressures to impacts and changes in North Pacific marine ecosystems (*e.g*., PICES Session S10 at 2012 Annual Meeting in Hiroshima)
  - brief review of potential frameworks that could be used to link activities and stressors to ecosystem responses,
  - assessment of their applicability to North Pacific marine ecosystems,
  - recommendations for applications.
  - *e.g*.,
    - Pathways of Effects
    - Driver-Pressure-States-Impact-Response models,
    - simulation and other analytical modeling approaches, *e.g*., Ecopath with Ecosim,
    - probabilistic (Bayesian) networks,
    - Integrated Ecosystem Analyses,
    - IFRAME, INVEST,
    - others?
- Multiple pressures on North Pacific marine ecosystems
  - identification of the spatial (and temporal, where possible) extent of important activities and stressors in North Pacific marine ecosystems,
  - identify habitats and general locations (if possible) where multiple stressors overlap,
  - identify trends in these activities/stressors if possible,
  - use existing literature as a starting point, but also build on own analyses.
- Sub-sections of this chapter for each PICES country, preferably using a common approach (???), plus a synthesis section. Or perhaps these might be included in the case studies?

Chapter 3 Ecosystem Indicators for multiple stressors (Boldt, Samhouri, Itoh, Yoshie, Chung, Martone, others?)

- A. Chapter Introduction
  - Identify need to include indicators of multiple stressors when evaluating the state of marine ecosystems.
  - Purposes of chapter:
    - review existing indicators,
    - review potential sources of data available from national and international programs,
    - indicator-selection criteria, and
    - approaches for evaluating indicators.
- B. Review of indicators in literature
  - General definition of indicators
  - General categories of indicators:
    - Human, biological (including trophodynamics), environmental, socio-economic-political,
    - State and trend,
    - Fulton (2003): strong, intermediate, and weak indicators.
  - Examples of indicators:
    - PICES Scientific Report No. 37:
      - Relative biomass, *e.g.*, top predators,
      - Biomass ratios, *e.g.*, Piscivore:planktivore,
      - Habitat-forming taxa, *e.g.*, proportional area covered by epifauna,
      - Community size spectra slopes,
      - Taxonomic diversity (richness),
      - Total fishery removals,
      - Maximum (or mean) length of species in catch,
      - Size-at-maturity,
      - Trophic level or trophic spectrum of the catch,
      - Biophysical characteristics, *e.g.*, temperature, chlorophyll a.
    - IndiSeas1 (focused on effects of fishing):
      - Mean length,
      - Trophic level of landed catch,
      - Proportion under/ moderately exploited species,
      - Proportion predatory fish,
      - Mean life span,
      - 1/CV biomass,
      - Biomass of surveyed species,
      - 1/landings/biomass.
    - IndiSeas2 (in addition to IndiSeas1 indicators; expanded to include effects of environment and indicators of human dimensions)
    - Environmental indicators: SST, Chl-*a*, global and regional climate
    - Human dimensions indicators:
      - Effectiveness, efficiency and fairness of fisheries management and quality of governance,
      - Contribution of fisheries to food provision, economic and social well being,
      - Well being and resilience of fisher communities.
    - Biodiversity indicators:
      - Mean intrinsic vulnerability index of fish catch,
      - Trophic level of the community,
      - Mixed trophic index (TL $\geq$ 3.25),
      - Proportion of exploited species with declining biomass,
      - Relative abundance of flagship species,
      - Discards/landings.
- C. Indicator Selection Criteria
  - Rice and Rochet (2005) 8-step process for selecting a suite of ecosystem indicators:
    - Step 1 determine user needs,
    - Step 2 develop list of candidate indicators,
    - Step 3 determine screening criteria,
    - Step 4 score candidate indicators against screening criteria,

        - Step 5 summarise scoring results,
        - Step 6 decide how many indicators are needed,
        - Step 7 make final selection,
        - Step 8 report on chosen suite of indicators.
    - PICES 2011 FUTURE workshop criteria (each criterion should be weighted for relevance to end user identified):
        - available regularly and in a timely manner,
        - available as a time series,
        - statistical properties are understood and provided,
        - related to attribute either empirically or theoretically,
        - specific to attribute,
        - spatial and temporal scales of indicator appropriate to attribute,
        - responsive (sensitive to perturbation),
        - relevant to objective,
        - understandable by target audience,
        - provides a basis for comparison between ecosystems.
- D. Indicators of ecosystem responses to multiple stressors
    - Approaches:
        - Halpern *et al*. (2007, 2008, 2009), Teck *et al*. (2010) – cumulative impact scores,
        - Samhouri and Levin (2012).
        - IndiSeas2 exploring approaches to integrating/combining indicators (Shin *et al*., 2012):
            - scoring approach to aggregate all indicators into a single indicator,
            - multidimensional approach,
            - multi-criteria decision analysis.
        - Ban:
            - Data-based: Meta-analysis,
            - Expert-based elicitation,
            - Combined above, spatial: Regional mapping, GIS approaches,
            - Experimental,
            - Model-based.
        - Evaluation of indicators to identify vulnerable ecosystem components
            - despite pros and cons of each approach there is a need to use multiple approaches (expert elicitation, model-based simulation, and empirical analysis) to identify and evaluate critical multiple stressors of North Pacific marine ecosystems and indicators to assess their impacts.

Chapter 4. Case Studies
- Coastal systems (using Strait of Georgia, Canada, Puget Sound (US), Seto Inland Sea (Japan)
    - *e.g*., Perry *et al*. S8 presentation (but at the moment development of Indicators is lacking)
- Possibly: Sea of Okhotsk, Bering Sea (?Lukyanova, Kullik, Zador?)

Chapter 5. Conclusions and recommendations (drafted by Co-Chairs but developed by all WG 28 members)

Appendices
1. Terms of Reference
2. Membership
3. Reports of sessions held by WG 28

etc.