Appendix 1

Membership of Working Group on *Ecosystem-based Management and its Application to the North Pacific* (WG 19)

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Appendix 2

Template for Ecosystem-based Fishery Management Country Profiles of Ocean Management Activities

1. Fishery Management	- General approach to management for target species	
	- For general approach or a representative selection of species/groups	- Ecological properties of the species (*e.g.*, where on r-K spectrum; top predator, intermediate predator–prey, prey species)
		- Level of natural variability (*e.g.*, 'usual' level of interannual recruitment variability → highly variable recruitment interannually → episodic recruitment and regime shifts)
		- Planned management responses (control rules and recovery rules and targets)
		- Level of information/uncertainty (elaborate as necessary)
		- Reference points (target, limit and trigger if used)
	- General approach to management for non-target/bycatch	
	- For general approach or a representative selection of species/groups	- Ecological properties of the species or groups
		- Level of natural variability
		- Planned management responses (control rules, recovery rules and targets)
		- Level of information/uncertainty (elaborate as necessary)
		- Reference points (target, limit and trigger if used)
2. Management of Threatened or Protected Species and Communities	- General approach to management of threatened or protected species/communities	
	- For general approach or a representative selection of species/communities	- Ecological properties of the species or groups
		- Level of natural variability
		- Planned management responses (control rules, recovery rules and targets)
		- Level of information/uncertainty (elaborate as necessary)
		- Reference points (target, limit and trigger, if used)

3. Habitat Management	- General approach to management of habitats	
	- For general approach or a representative selection of habitats	- Ecological properties of the habitats
		- Level of natural variability
		- Planned management responses (control rules, recovery rules and targets)
		- Level of information/uncertainty (elaborate as necessary)
		- Reference points (target, limit and trigger, if used)
4. Community/Trophic Structure Management	- General approach to management of food webs in general and of direct feeding interactions (predator–prey relationships involving the target species) specifically.	
	- For direct feeding interactions (*e.g.*, predator–prey relationships) that directly involve the target or other highly valued species	- Ecological properties involved
		- Level of natural variability
		- Planned management responses (control rules, recovery rules and targets)
		- Level of information/uncertainty (elaborate as necessary)
		- Reference points (target, limit and trigger if used)
5. Management of Physical Environment (including Freshwater Discharge from Land)	- General approach to management of the physical environment	
	- For general approach or a representative selection of issues	- General properties of the aspect of the physical environment at issue (*e.g.*, fragility/robustness and reversibility /irreversibility of fishery effects)
		- Level of natural variability
		- Planned management responses (control rules, recovery rules and targets)
		- Level of information/uncertainty (elaborate as necessary)
		- Reference points (target, limit and trigger, if used)
6. Management of Contaminants and Pollutants	- General approach to management of contaminants and pollutants	
	- For general approach or a representative selection of issues	- General properties of the aspect of contaminants, pollutants at issue (*e.g.*, toxicity and reversibility/ irreversibility of effects)
		- Level of annual/seasonal variability
		- Planned management responses (control rules, recovery rules and targets)
		- Level of information/uncertainty (elaborate as necessary)
		- Reference points (target, limit and trigger, if used)

	- Socio-economic considerations	- Size of local population and growth rate
		- Size of population dependent on the activity being considered
		- Cultural, social and economic values/importance of the activity
7. Management of Aquaculture	- Ecological properties of species	
	- Level of harvest variability	
	- Planned management responses	
	- Level of information/uncertainty	
8. Management of Enhancement Activities	- General properties of the enhancement activities (*e.g.*, stocking or releasing of fry/juveniles, establishing artificial reefs, making seaweed beds, *etc.*)	
	- Ecological properties of stocking species	
	- Planned management responses	
	- Level of information/uncertainty	

Appendix 3

Terminology

The ecosystem literature is rich with definitions and terms. The Canadian National Workshop on "Objectives and indicators for ecosystem-based management" (February 27–March 2, 2001, Sidney, B.C. Canada) spent considerable time discussing and debating those related to the ecosystem-level objectives (Jamieson *et al.,* 2001; see section 2.2). The terms and definitions given in the table below are based upon those currently in use in the literature as well as a few new ones added at the workshop.

Term	Definition
Characteristic	Some property of the ecosystem, separate from our measurement of it (*e.g.*, absolute biomass or recruitment measures for a population)
Delphic analysis	The Delphi Method is based on a structured process for collecting and distilling knowledge from a group of experts by means of a series of questionnaires interspersed with controlled opinion feedback.
Ecosystem	The spatial unit and its organisms and natural processes (and cycles) that is being studied or managed
Ecosystem-based management	A strategic approach to managing human activities that seeks to ensure through collaborative stewardship the coexistence of healthy, fully functioning ecosystems and human communities [towards maintaining long-term system sustainability] by integrating ecological, economic, social, institutional and technological considerations
Indicator (attribute)	Quantity that can be measured and be used to track changes over time with respect to an operational objective. Measurable part or process (property) of a system (*e.g.*, average weight of age 5 individuals of a species)
Metric	Indicator empirically shown to change in value along a gradient of human influence (*e.g.*, a population's biomass as a result of fishing activity; number of introduced (exotic) feral species)
Multimetric index	A number that integrates several metrics to indicate a "condition" factor
Reference point	Value of an indicator corresponding to a management target or threshold
Target reference point	An indicator reference point that is trying to be achieved (*e.g.*, an estimated biomass of 30,000 t)
Limit reference point	An indicator reference point that if crossed results in the implementation of a management action (*e.g.*, if the estimated biomass falls below 10,000 t, the fishery is closed)
Conceptual objective	General statements that are uniformly accepted by all stakeholders as desirable. They are specific enough that everyone will interpret them the same way, but do not specify how they will be measured.
Operational objective	Objective that has a direct and practical interpretation in the context of (fisheries, habitat) management and against which performance can be evaluated quantitatively. A specific statement that consists of a verb (*e.g.*, maintain), a specific measurable indicator (*e.g.*, estimated biomass), and a reference point (*e.g.*, 50,000 t), thus allowing an action statement for management (*e.g.*, maintain estimated biomass of a given forage species greater than 20,000 t biomass).

Reference

Jamieson, G., O'Boyle, R., Arbour, J., Cobb, D., Courtenay, S., Gregory, R., Levings, C., Munro, J., Perry, I. and Vandermeulen, H. 2001. Proceedings of the National Workshop on Objectives and Indicators For Ecosystem-based Management, Sidney, British Columbia, February 27–March 2, 2001. CSAS Proc. Ser. 2001/09.

Appendix 4

Department of Fisheries and Oceans Ecosystem Overview and Assessment (EOA) Report Format

Standard Table of Contents

GENERAL INFORMATION

7. **Physical Oceanography (models)**
    a. Freshwater inputs
    b. Sea level and Tides
    c. Water Masses and Currents
    d. Stratification and Mixing (Fronts, Gyres and Upwellings)
    e. Waves and Turbulence
    f. Ice (Permanent and Seasonal Coverage)
    g. Underwater Sound – Sources and propagation

8. **Physical-Chemical Properties of Seawater**
    a. Temperature, Salinity and Water Density
    b. Dissolved Oxygen – Areas of Hypoxia
    c. Suspended Matter – Light Availability
    d. Organic Carbon (DOC/POC)
    e. Nutrients – Flux and Budgets
    f. Biogeochemistry (Dissolved Trace-Metals and Natural Hydrocarbons)

Part C – BIOLOGICAL SYSTEM

9. **Flora and Fauna**
    a. Planktonic Communities
        i. Bacterioplankton
        ii. Phyto- and Zooplankton
        iii. Ichtyoplankton
    b. Benthic Communities
        i. Microalgae
        ii. Macrophytes
        iii. Infauna
        iv. Invertebrates
            a. Commercial Species
            b. Non-Commercial Key Species
        v. Ground Fish
            a. Commercial Species
            b. Non-Commercial Key Species
    c. Pelagic Communities
        i. Invertebrates
        ii. Marine Turtles
        iii. Pelagic Fish
            a. Commercial Species
            b. Non-Commercial Key Species
        iv. Marine Mammals
        v. Sea Birds

10. **Habitat Use and Functional Areas**
    a. Mating / Spawning / Breeding Areas
    b. Rearing Areas
    c. Foraging / Feeding Areas
    d. Migration Routes
    e. Critical Habitats (under SARA)

Part D – ECOSYSTEM DESCRIPTION

11. How does the ecosystem work? Ecosystem Relationships
  a. Physical-Biological Linkages
      i. Influence of physical factors on biology and species distributions
      ii. Nutrient Cycles, Blooms, Upwellings
  b. Biological Interactions
      i. Functional Processes
      ii. Food Web and Trophic Structure
  c. Natural Variability – Seasonal, Inter-Annual and Long-Term Changes
  d. Resilience of the Ecosystem

VOLUME TWO.   ASSESSMENT AND CONCLUSIONS

PART E – ECOLOGICAL ASSESSMENT

12. Areas of Concern (maps)
  a. Ecologically and Biologically Significant Areas (EBSAs)
  b. Conservation Areas (MPAs, NMCAs, Wildlife Conservation Areas, *etc.*)
  c. Heavily Impacted Areas (*e.g.* 'hot spots' of contaminants, habitat degradation)
  d. Ocean Space Uses (Fishing zones, Oil & Gas Licenses, Aquaculture sites, Corridors, *etc.*)

13. Impacting Activities and Stressors
  a. Major Human Activities of Concern
      i. Land-Based Activities
      ii. Harvesting of Renewable Resources
      iii. Extraction of Non-renewable Resources
      iv. Transportation and Communications
      v. Recreational Activities
      vi. Other Sea-Based Activities
  b. Anticipated / Emerging Activities
  c. Global Stressors (regional focus)
      i. Global Warming and Climate Change
      ii. Ozone and UV Radiations
      iii. Long-Range Transport of Pollutants
      iv. Aquatic Invasive Species

14. Threats and Impacts on Ecosystem Properties and Components
      – Cumulative Impacts
  a. Biodiversity and Species at Risk
  b. Productivity and Use of Oceans Resources
  c. Water/Sediment, Habitat and Biota Quality
  d. Integrity of Coastal Landscapes and Bottomscapes
  e. Cumulative impacts/effects

PART F – CONCLUSIONS AND RECOMMENDATIONS

15. Uncertainties, Unknowns and Limits of Science Support

16. Recommendations to Science Managers
  a. Identification of Knowledge Gaps *(may be discussed in appropriate sections above)*
  b. Monitoring and Research Needs

17. Recommendations to the Integrated Management
   a. Summary of the Major Environmental Issues and Concerns for the Study area
   b. Identification of Priority Areas and Actions Needed
       i.   In the short-term (1 year)
       ii. In the medium term (2-5 years)
       iii. In the long term (> 5 years)
   c. Best Practices – Examples of Interest

CITED REFERENCES
(Or may be listed at the end of each corresponding sections)

RESOURCES AND EXPERTISE
- List of regional experts in fields of expertise
- List of ongoing initiatives in topics of interest

Selected Bibliography and Web Resources

ANNEXES
- Glossary (technical terms used in the report)
- List of acronyms
- Supporting Technical Documents *(if needed)*

IMPORTANT NOTICE

How to use this standard Table of Content

The EOA Protocol is under development; it will give explanations on the content of each chapter and section proposed in the Standard ToC. In the interim, the aim of this standard ToC is to provide EOA project coordinators and authors with a guidance to organize the information in order to describe ecosystem features and discuss environmental issues that may be observed in all Canada's Oceans and regions. It must be noted that not all sections of the standard ToC may be necessary, according to the study area. Only those relevant to Ecosystem-Based Management should be detailed and discussed in the EOA for IM purposes. On the other hand, only overall chapters and sections are mentioned in the Standard ToC. Authors may want to re-organize the proposed chapters or add new sections to highlight specific features and/or regional issues that are considered important for meeting IM needs in the study area / at the regional scale.

Additional sub-divisions can be added into a given chapter/section if necessary.

Appendix 5

WG 19 Annual Reports

PICES Fourteenth Annual Meeting
September 29–October 9, 2005
Vladivostok, Russia

2005 Report of Working Group on
Ecosystem-based Management Science and its Application to the North Pacific

Working Group (WG 19) on *Ecosystem-based management science and its application to the North Pacific* held its first meeting from September 28-30, 2005. The WG 19 Co-Chairmen, Drs. Glen Jamieson and Chang-Ik Zhang, welcomed the participants (*WG 19 Endnote 1*) and reviewed the agenda for the meeting (*WG 19 Endnote 2*). Ms. Patricia Livingston, the third WG 19 Co-Chairman, was unable to attend due to travel interruptions enroute to Vladivostok.

Making terms of reference useful to PICES (Agenda Item 2)

There seems to be a significant difference between regions: Japan, China, and Korea have relatively perturbed ecosystems, and much of the national emphasis is on fisheries and aquaculture; on the other hand, Russia, Canada, and the United States seem to emphasize maintaining less-impacted, historical ecosystem characteristics. Valuable perspectives were offered from other parts of the world (*e.g.*, ICES, Australia).

WG 19 proposes to produce a brochure on ecosystem-based management (EBM), following the template of the well-received approach used by the PICES Study Group on *Fisheries and Ecosystem Responses to Recent Regime Shifts.* The brochure would be an executive summary of the final report of the Working Group and would focus on (1) the need for EBM, (2) objectives for EBM, (3) consequences of not moving to EBM, and (4) research that is needed to move towards EBM.

Revision of ocean management reporting format (Agenda Item 3)

The draft management plan was reviewed and streamlined to increase the focus on the general characteristics at the eco-region level. For each section, a list of questions was prepared for members from each country to answer about the status of management in their respective jurisdictions (*WG 19 Endnote 3*).

National marine ecosystem monitoring approaches, plans and issues (Agenda Item 4)

All member countries represented at Vladivostok gave overviews of their existing ecosystem monitoring approaches (neither China nor Japan sent Working Group members to the meeting). Monitoring approaches exist in each country, although each identified many data gaps, difficulty with data accessibility, and a lack of integration among monitoring programs. Dr. Elizabeth Fulton summarized the Australian approach to EBM-based monitoring. Some member nations have monitoring programs, though not necessarily organized in an EBM conceptual framework.

WG 19 proposes to establish a standardized format for reporting monitoring in each country, focusing on biological monitoring, physical monitoring, human influences, modeling, and ecosystem status reporting (*WG 19 Endnote 4*).

Overview of the 2004 IOC/SCOR symposium on "Quantitative ecosystem indicators for fisheries management" (Agenda Item 6)

Dr. Ian Perry provided a summary of a symposium that was held from March 31 – April 3, 2004, in Paris, France. Selected papers from the symposium were published in the *ICES Journal of Marine Science* (2005, Vol. 62, No. 3). The symposium had two major themes: (1) to provide an overview of the range of indicators of exploitation and state of ecosystems developed for fisheries management; and (2) to examine scientific basis for incorporating indicators into ecosystem-based fisheries management (EBFM). Over 100 indicators were proposed, and some included reference points or reference directions. All papers advocated multiple indicators, and most indicators were derived from

fisheries-independent surveys. The symposium did not achieve consensus on which indicators to use, but the general consensus was that the identification of indicators is an important task but it is work in progress.

Dr. Perry described the properties of good indicators, an eight-step procedure for identifying them, how to determine screening criteria, and the general approaches used in applying them (empirical *vs*. theoretical, which seem to converge on which indicators are strongest, according to ICES symposium papers by Drs. Jason Link and Elizabeth Fulton).

Dr. Fulton noted that indicators based on data from fishery-independent surveys are not available in all parts of the world because countries cannot afford them. Models and empirical studies suggest that restricting the choice of indicators to fishery-dependent data can result in incorrect conclusions being drawn from the indicator data. Therefore, priority should be placed on the use of fishery-independent data. There is optimism that this can be done, even in developing countries and new fisheries, because of increased capabilities of remote sensing and the power of coarse scale indicators (*e.g.*, body size, abundance of all individuals in a particular functional group) that may be relatively easy to monitor.

Discussion on eco-regions (Agenda Item 7)

WG 19 discussed how to define eco-regions, based largely on the Canadian experience. The "eco-region" definition includes a mixture of geological, biological and physical parameters. Eco-region boundaries tend to be fuzzy, not sharp, and indicate areas of commonality.

All countries reported on progress with eco-regional delineation. Canada has progressed farthest. Delineation of eco-regions is in progress in the United States and Russia. Korea has begun consideration of formal eco-regional delineation. All participants agreed that it would be beneficial to have regional plans that span national boundaries because many of the eco-regions in the North Pacific are trans-boundary or in international waters.

Dr. Fulton discussed the Australian approach to bio-regionalization, a hierarchical approach that is

defined at large scale by information on circulation and temperature, and adds in finer scale, ecological processes as you move down the 5-level hierarchy.

To consider the scientific requirements for eco-region identification and review the existing Large Marine Ecosystem boundaries in the PICES area, WG 19 proposes to convene a 1-day MEQ/FIS Topic Session on "*Criteria relevant to the determination of unit eco-regions for ecosystem-based management in the PICES area*" at PICES XV. Travel funds are requested for 1 invited speaker to attend the session.

NPRB/PICES Workshop on ecosystem indicators for the Bering Sea (Agenda Item 8)

Dr. Perry informed about a project that was funded by the North Pacific Research Board to integrate ecological indicators in the North Pacific, with an emphasis on the Bering Sea. Four activities were identified for a workshop to be held May 31 – June 2, 2006, in Seattle:
1. Involve Bering Sea and international communities in developing a set of operational objectives for southeastern Bering Sea ecosystem;
2. Evaluate the NOAA/Fisheries "*Ecosystem Considerations*" chapter that is prepared annually for the North Pacific Fishery Management Council and the PICES North Pacific Ecosystem Status Report, with the goal of integrating the results;
3. Investigate methodologies to monitor system-wide structural ecosystem changes within the marine ecosystem;
4. Identify steps in valuating indicator performance that improve the monitoring network, and integration into predictive models.

Findings from this workshop are important for identifying criteria for ecosystem indicators.

Action items to be completed prior to the next WG 19 meeting (Agenda Item 9)

1. Compile national and international (*e.g.*, PICES, LMEs, "Sea Around Us" project (D. Pauly), Longhurst) approaches (maps, processes used to identify area) to establishing science-based eco-regions, and compare these to existing or planned "management" regions.

Gather together all delineated areas (*e.g.*, fishery statistical areas, LOMAS, management areas, *etc*.) and digitize for GIS display. Identify areas of cooperation/collaboration between adjacent countries to jointly evaluate cross-jurisdictional areas with the goal of trying to establish common eco-regions. These deliberations may be useful in updates of the North pacific Ecosystem Status Report.
- Lead – all countries
- Submission deadline – January 1, 2006
- Product – summary GIS chart and report; G. Jamieson and I. Perry for Canada; D. Fluharty and J. Stein for US; by July 1, 2006.

2. Consider a theoretical evaluation of the consequences of an artificial boundary that splits an ecological process and how that could affect management.
- Lead – C. Harvey and E. Fulton (ghost collaborator)
- Deadline – July 1, 2006
- Product – report and presentation at next meeting, as well as a paper to be published in peer-reviewed literature.

3. Each country will complete at least one Ocean management activity report. The intent is to show the process and framework that each country is using to implement an ecosystem approach to management. In selecting a region, consider regions where there is more than one significant management issue (*e.g.*, fishing and oil and gas exploration).
   a. Leads – All WG members
   b. Deadline – June 1, 2006
   c. Product – reports

4. Describe national ecosystem monitoring approaches relevant to the eco-regions considered in #3 (above). Monitoring activities should be grouped by category.
- Lead – all countries
- Deadline – June 1 2006
- Product – reports

5. Summarize the findings from the 2004 symposium on "*Quantitative ecosystem indicators for fisheries management*"
- Lead – I. Perry and P. Livingston (with assistance from E. Fulton)

- Deadline – January 1, 2006
- Product – reports

6. Summarize findings from the upcoming PICES/NPRB workshop on the framework and criteria for identifying ecosystem indicators. Invite members of MONITOR to WG 19 meetings.
- Lead – WG members that participate in the workshop
- Deadline – October 2006, next WG 19 meeting
- Product – preliminary report

7. Hold a mini-symposium at PICES XVI on "*Comparative analysis of frameworks to develop EBM and research needed to move towards implementation of EBM*" to build on products arising from the PICES/NPRB Bering Sea Indicators workshop. Each country would present their perspective. Invited speakers will address issues such as case studies, lessons learned, indicators, *etc*. WG 19 should invite participation by other PICES Committees (*e.g.*, MONITOR) and WGs/Sections. Consider "over-arching" questions such as the following (also proposed bases for a brochure-type publication):
- scientific need for EBM and consequences of not moving to EBM,
- objectives for EBM,
- ways to move towards EBM,
- research needs to move towards EBM.

Co-Chairmen to present brochure concept to parent PICES Committees in 2006.

8. Next meetings:
- A 3-day PICES/NPRB Workshop on "*Integration of ecological indicators for the North Pacific with emphasis on the Bering Sea*" to be held May 31-June 2, 2006, in Seattle, U.S.A.;
- A 3-day WG 19 meeting prior to PICES XV (October 2006, Yokohama, Japan);
- A 1-day MEQ/FIS Topic Session on "*Criteria relevant to the determination of unit eco-regions for ecosystem-based management in the PICES area*" at PICES XV.

WG 19 Endnote 1

Participation list

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Christopher Harvey (U.S.A.)
Glen Jamieson (Canada, Co-Chairman)
Jae-Bong Lee (Korea)
R. Ian Perry (Canada)
Vladimir Radchenko (Russia)
Inja Yeon (Korea)
Chang-Ik Zhang (Korea, Co-Chairman)

<u>Observers</u>

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Robin Brown (Canada)
Elizabeth Fulton (Australia)
Melissa Haltuch (U.S.A.)
Yukimasa Ishida (Japan)
Tokimasa Kobayashi (Japan)
Phillip Mundy (U.S.A.)
Hak-Gyoon Kim (Korea)
Darlene L. Smith (Canada)
John E. Stein (U.S.A.)

WG 19 Endnote 2

WG 19 meeting agenda

<u>Wednesday, September 28</u>
1. Welcome and introductions
2. Review terms of reference
3. Revision of ocean management reporting format
4. National marine ecosystem monitoring approaches, plans, and issues

<u>Thursday, September 29</u>
5. Continue descriptions of relevant national marine ecosystem monitoring approaches, plans and issues
6. Overview of the 2004 IOC/SCOR symposium on "*Quantitative ecosystem indicators for fisheries management*"

7. Review existing definitions of "eco-regions" and identify criteria that could be used for defining ecological boundaries in the PICES area

<u>Friday, September 30</u>
8. Discuss ideas for a PICES/NPRB workshop on ecosystem indicators for the Bering Sea planned (May-June 2006) and an inter-sessional workshop to be held in Year 2 or 3 of the WG's mandate
9. Discuss objectives, site and date for the next WG 19 meeting

WG 19 Endnote 3

Revised ocean management reporting format

<u>Ocean management activities</u>
▪ Eco-region where defined or geographic location (*e.g.*, Korean portion of Yellow Sea);
▪ General description of oceanographic and biological setting; if appropriate, start with PICES North Pacific Ecosystem Status Report for the description of regions;
▪ Relevant management plan, policy, legislation (please provide copies of these or a source, such as a website or a contact point, so that we can obtain copies);
▪ General form of management or any other general comments on the management regime;

▪ What are overall ecosystem-based management objectives?
▪ How will these objectives be achieved?
▪ What is the timeframe to implement these objectives and meet goals?

<u>Fishery management</u>
▪ Management objectives for targeted and non-targeted species in fisheries;
▪ How is the ecosystem taken into consideration when managing fisheries?
▪ How selective is the gear (*e.g.*, bottom trawl; mid water trawl; purse seine; other gear, such

as long line and trap; gillnet) for the target species?

- Fishery gear targets certain sizes or life-history stage(s);
- Is fishery spatially concentrated, or not?
- Is fishery year round, or not?
- Are certain geographic areas excluded from the fishery? Explain reason for the exclusion.
- Are there catch limits on non-target species?
- Is the catch of non-target species recorded and accounted for?
- What is the environmental variability (*e.g.*, physical disturbance regime; El Niño, typhoon, changes in strength of currents) and how do species respond, if known?
- What is the spatial distribution of the fishery compared to the distribution of the target species?

Management of threatened or protected species and communities
- General approach to designation (legal/regulatory framework), management and recovery of threatened or protected species/communities (describe ecological properties of the species or groups that makes them vulnerable and needing protection);
- Is there legislation for designating species at risk?
- How are threatened species identified, and are there timeframes for developing recovery plans?
- Are recovery thresholds identified above which a species no longer needs legal protection?

Habitat management (conservation/restoration)
- General approach to management of habitats; this includes biological habitat, such as corals, sea-grass beds, *etc*., as well as physical habitat (describe ecological properties of the habitat that makes it significant.);
- Are specific habitats designated for protection, and what legislation allows for the designation?
- Are there monitoring and inventory activities in place?
- Are there restoration plans or activities underway?
- Are there ecologically or biologically significant habitat types/areas that can be identified and are they given special protection, and are there standards (*e.g.*, no activities allowed or just limitation of human activities in the habitat) for the level of protection?

Community/trophic structure management
- Are the characteristics of the community altered by human activities (*e.g.*, eutrophication, pollution, species introductions, sedimentation, altered coastal circulation, dredging and filling, altered hydrography of rivers, fishing, *etc.*)?
- Are management activities affecting food-webs or do existing food web perturbations constrain moving to a desired state.
- Does specific legislation address issues relevant to food webs?
- Are there monitoring and inventory activities in place?
- Are there restoration plans or activities underway?
- Are there ecologically or biologically significant species interactions that can be identified and are they given special consideration, and are there standards (*e.g.*, ballast water, coastal development, water quality, *etc.*) for the level of protection?

Management of contaminants and pollutants
- General approach to management of ecosystem-wide effects of contaminants and pollutants;
- Does specific legislation address issues relevant to contaminants?
- Are there monitoring and inventory activities and standards in place?
- Are there restoration plans or activities underway?
- Which aspects of the ecosystem are being most affected by the effects of contaminants?

Management of aquaculture
- General properties of the aquaculture activities (*e.g.*, stocking or releasing of seed/fry/juvenile, production of individuals in contained environments);
- Do specific regulations address issues relevant to species selection, scale of the operation, spatial distribution, and environmental impacts of activities?
- Are there monitoring and inventory activities in place?
- Are there mitigation plans or activities underway?
- Are there significant ecological and biological interactions that can be identified and are they given special consideration?

Management of enhancement activities (species and habitat)

- General properties of the enhancement activities (*e.g.*, stocking or releasing of fry/juvenile, putting in artificial reefs, making seaweed beds, *etc.*);
- Do specific regulations address issues relevant to species selection, scale of the operation, spatial distribution, and environmental impacts of activities?
- Are there monitoring and inventory activities in place?
- Are there mitigation plans or activities underway?
- Are there significant ecological and biological interactions that can be identified and are they given special consideration?

WG 19 Endnote 4
Standardized format for reporting national monitoring

- Habitat classification (biogeographic zone)
- Biodiversity
- Species population abundance (fish, HABs, *etc.*)
- Species spatial distribution and movements (migration routes) – ecologically and biologically significant areas
- Temporal changes (cycles and trends) in physical environment
- Human influences
  - o Pollution level, sedimentation, exotics, habitat alterations
  - o Spatial locations (*e.g.*, vessel location monitoring (VMS))
- Modeling, predictions and forecasting (identification of key indicators or gaps in knowledge)
- Ecosystem status reporting (state of ocean report); planning for reporting
- Level of integration, monitoring systems and data management and access

WG 19 Endnote 5
Proposal for a 1-day MEQ/FIS Topic Session at PICES XV on "*Criteria relevant to the determination of unit eco-regions for ecosystem-based management in the PICES area*"

The management of human activities that impact ocean ecosystems requires planning and engagement of stakeholders to meet the objectives of ecosystem-based management, which in turn requires identification of areas to determine which stakeholders need to be involved in each specific process. Area boundaries are typically based upon science (*i.e.* eco-regions), human community (*i.e.* coastal community composition), administrative (*i.e.* historical resource management areas) and international considerations (*i.e.* transboundary issues). This session will consider the science requirements for eco-region identification in the PICES area, and we solicit presentations that: 1) highlight national or regional experiences or frameworks in place for delineating marine sub-regions or eco-regions; 2) demonstrate the use of a variety of physical and/or biological criteria for region identification; or 3) explain the specific management purposes behind various sub-regional identification schemes. Session discussion will involve participants in reviewing the existing Large Marine Ecosystem boundaries of the PICES area and developing recommendations for criteria to be used in sub-regional identification in the North Pacific.

Recommended convenors: Glen Jamieson (Canada), Patricia Livingston (U.S.A.) and Chang-Ik Zhang (Korea).

PICES Fourteenth Annual Meeting Topic Session Summary

MEQ/FIS Topic Session (S8)
Ecosystem indicators and models

Co-convenors: Glen Jamieson (Canada), Xian-Shi Jin (China), Pat Livingston (U.S.A.), Tokio Wada (Japan), Vladimir Radchenko (Russia) and Chang-Ik Zhang (Korea)

Background

Ecosystem-based management (EBM) of resources will require ways to monitor current conditions and predict future states. Ecosystem indicators are single variables that reflect the status of broad suites of management activities or environmental conditions, and their assessment is key to monitoring the achievement of EBM. Predictive ecosystem models can be used to hypothesize the responses of an ecosystem to management actions, to assess the sensitivities of indicators, and to highlight gaps in current knowledge. This session brought experts together to identify criteria for suitable indicators and the utilities of predictive models, and to present candidates of indicators and models that are actively in use in PICES areas.

Summary of presentations

Thirteen of 15 scheduled oral papers were presented plus several posters. Presentations included reviews of indicators in simulation models that attempted to describe key elements of entire ecosystems, and the ecosystem behavior that might result from perturbation, indicators relative to describing the consequences of fishing and/or environmental features in particular, modeling of specific ecosystem energy pathways, approaches to the identification of indicators that track ecosystem characteristic shifts, identification of important spatial areas where monitoring activities might most cost-effectively be focused, and the utility of different bioindicators for monitoring specific impacts. Given this diversity of papers, discussion was wide-ranging and reflected the challenges in trying to identify relevant, cost-effective and conceptually easily explainable potential indicators for evaluation of success in achieving EBM.

List of papers

Oral presentations
Elizabeth A. <u>Fulton</u>, Michael Fuller and Anthony D.M. Smith
Management strategy evaluation and indicators for ecosystem-based fisheries management

Gordon H. <u>Kruse</u>, Patricia A. Livingston and Glen S. Jamieson
Evolution of ecosystem-based fishery management

Sang Cheol <u>Yoon</u> and Chang Ik Zhang
A comprehensive ecosystem-based approach to management of fisheries resources in Korea

James E. Overland, J. Boldt, J. Grebmeier, J. Helle, P.J. Stabeno and M. <u>Wang</u>
Multiple indicators track major ecosystem shifts in the Bering Sea

Michio J. <u>Kishi</u>, Ippo Nakajima and Yasuko Kamezawa
Fish growth comparisons around Japan using NEMURO.FISH

Vladimir I. <u>Zvalinsky</u>
Ecosystem parameters and stability: Theoretical considerations

Glen <u>Jamieson</u> and Cathryn Clarke
Identification of ecologically and biologically significant areas in Pacific Canada

Chuan-Lin <u>Huo</u>, Geng-Chen Han, Ju-Ying Wang and Dao-Ming Guan
EROD as bioindicator for monitoring of marine contaminants along the Dalian coast

Sun-Kil <u>Lee</u>, Jae Bong Lee, Chang-Ik Zhang and Dong Woo Lee
Comparisons in ecosystem effects of fishing in Korean waters

Zhenyong Wang, Hao Wei and Zuowei Zhang
Application of modified NEMURO Model to Jiaozhou Bay

Thomas C. Wainwright, James J. Ruzicka and William T. Peterson
A biological production index for the northern California Current

Jie Li, Zengmao Wu and Xiaofang Wan
Modelling study of the new production and the microbial food loop impact in the Yellow Sea Cold Water Mass

Chris J. Harvey, Isaac C. Kaplan, Emily J. Brand, Elizabeth A. Fulton, Anthony D.M. Smith, Albert J. Hermann, M. Elizabeth Clarke and Phillip S. Levin
A spatially explicit ecosystem model to examine the effects of fisheries management alternatives in the California Current

Posters

Young-Min Choi, Kwang-Ho Choi, Yeong-Seop Kim, Jung Hwa Choi and Jong-Bin Kim
Ecosystem structure and fisheries resources status in the southern part of Korean waters

Jae Bong Lee, Chang-Ik Zhang and Dong Woo Lee
Ecosystem indicators for the recruitment of pelagic fish around Korean waters

PICES Fifteenth Annual Meeting
October 13–22, 2006
Yokohama, Japan

2006 Report of Working Group on
Ecosystem-based Management Science and its Application to the North Pacific

The Working Group (WG 19) on *Ecosystem-based management science and its application to the North Pacific* held its second meeting from October 13–14, 2006, under the co-chairmanship of Drs. Glen Jamieson and Chang-Ik Zhang, and Ms. Patricia Livingston. Dr. Christopher Harvey served as rapporteur. A list of participants and the meeting agenda can be found in *WG 19 Endnotes 1* and *2*.

Review of national/international approaches to establishing science-based eco-regions (Agenda Item 2)

Dr. Ian Perry reviewed the definitions of North Pacific ecosystems put forth by PICES and other researchers and institutions, the different management zones defined by member nations, and how closely ecosystem boundaries and management boundaries matched one another. He concluded that:

- Ecosystem boundaries are often difficult to define due to the lack of fixed geography and due to long-term variability in non-static boundary-forming processes;
- The Large Marine Ecosystems (LMEs) as defined by Sherman appear to be the most useful conceptualization of ecosystems for PICES member countries;
- Management boundaries are generally consistent and complementary between nations, although perhaps less so in the Bering Sea and in the western Pacific;
- It will be difficult to change existing statistical areas due to the historic value and inertia placed upon their usage, so PICES must build on historical context rather than trying to change it;
- Management areas are generally much smaller than LMEs, but the management areas can generally be aggregated to reasonably approximate LMEs.

Theoretical evaluation of the consequences of an artificial boundary (Agenda Item 3)

Drs. Harvey and Elizabeth Fulton provided an update on efforts to use Atlantis, a spatially explicit marine ecosystem modeling software, to examine how different management strategies on either side of a jurisdictional boundary (*e.g*., a national border) affect cross-border eco-systems. Harvey and colleagues are still in the process of completing an Atlantis model of the northern California Current, and therefore have yet to finish this task. It will be done by next year's Annual Meeting, either using the northern California Current model or one of Fulton's models for Australia.

National ocean management activity reports (Agenda Item 4)

Each member country outlined the processes and frameworks they are using to implement ecosystem-based management (EBM). A common problem among member countries is that the elements of EBM are often handled by different government agencies (for example, fisheries are managed by one ministry and environmental monitoring by another), and that there is often very little communication and collaboration between those agencies.

As it was noted last year, there are different conceptual frameworks among member countries. In Canada, Russia and the United States, EBM is mainly directed at maintaining or restoring ecosystems to relatively pristine status, while in China, Japan and Korea, EBM is described in the context of resource enhancement. In addition, there is a need for greater coordination and integration of management efforts, both within individual nations and between nations for resources that inhabit multi-national waters. As within nations, different aspects of EBM are handled by different agencies or ministries, frameworks may not exist for coordinating those activities. Across nations, all

PICES member countries manage resources that move into other EEZs (Exclusive Economic Zones), and the Working Group encourages PICES to support the development of regional management plans in these multi-national areas.

Two other concerns were raised by WG 19 on this agenda item. Firstly, certain words (*e.g.*, "ecosystem", "integrative") have different meanings and applications among different member countries, and a glossary of terms with agreed-upon definitions should be a part of the WG 19 final report. Secondly, written volumes describing marine eco-regions and science supporting EBM are crucial and should be living, evolving documents. However, they can grow very large and thus inaccessible to readers who need the information that they contain.

National ecosystem monitoring approaches (Agenda Item 5)

WG 19 members described highlights of their national monitoring plans. Each nation has devoted considerable resources to monitoring programs; Russia and Korea, in particular, have developed long time series and broad spatial coverage of a wide range of oceanographic and biological variables. Emerging issues that different nations are encountering include:

- the need to better define ecosystem objectives, so that monitoring programs can be used most effectively in management;
- the difficulty of getting managers, who are often in different agencies or ministries, to use monitoring data in decision-making;
- maintaining funding for monitoring programs.

Summaries of recent scientific meetings on ecosystem indicators (Agenda Items 6 and 7)

Two recent scientific meetings on ecosystem indicators were reviewed. Drs. Perry and Fulton revisited the 2004 Paris Symposium on "*Quantitative ecosystem indicators for fisheries management*", which was described at last year's WG 19 meeting. They broadened the discussion to include new thinking on indicators. Dr. Fulton stressed the value that several "types" of indicators have had in monitoring ecosystem change. They include: relative biomasses, biomass ratios (*e.g.*, piscivores to planktivores), size spectra, maximum fish length, total fishery removals (or some other

total human impact), size at maturity, biodiversity, and biophysical variables (*e.g.*, Chl-*a*). These can be rapidly measured and do not require special expertise or modeling to quantify. She has concluded that monitoring pelagic ecosystems requires fewer total indicators, but signal detection is slow. By contrast, demersal systems require more indicators but signal detection is rapid.

Dr. Perry described the Bering Sea Ecosystem Indicators project, a PICES effort funded by NPRB to define objectives, a monitoring program, and effective indicators for managing the southeastern Bering Sea. The process featured pre-workshops with diverse experts and stakeholders to maximize participation. These meetings were preparatory to the PICES/NPRB Indicators workshop convened on June 1-3, 2006, in Seattle, U.S.A. The project has produced recommendations concerning ecosystem objectives, socio-economic objectives, and communication objectives for better disseminating the project's work within PICES, to the broader scientific community, and to the public. The final report will be published as *PICES Scientific Report No. 33* by the end of this year. It will include three white papers developed for the workshop (on "*Operational objectives for the southeastern Bering Sea*" by Gordon Kruse and Diana Evans, on "*Toward ecosystem-based management of the oceans: A perspective for fisheries in the Bering Sea*" by Andrea Belgrano, Jennifer Boldt, Patricia Livingston and Jeffrey M. Napp, and on "*Ecological indicators: Software development*" by Sergei N. Rodionov) and a summary of workshop discussions and recommendations. Outcomes of the workshop have been used by NPRB in developing an integrated ecosystem research plan for the Bering Sea.

It was recommended that WG 19 should focus not on choosing specific indicators, but rather on developing a scientific process by which proper indicators are defined for a given ecosystem, such that the process can be readily developed and implemented in an EBM framework.

Content of the WG 19 final report (Agenda Item 8)

The final WG 19 report, due prior to the 2008 PICES Annual Meeting, will include a general introduction, national definitions of EBM, and a glossary listing and defining key terms. It will then

summarize activities toward meeting the WG 19 Terms of Reference (TOR). Reporting plans for TORs are detailed below:

TOR #1:   Describe and implement a standard reporting format for EBM in each PICES country. The report will include: (1) national definitions of EBM;   (2) national objectives for EBM;   (3) descriptions of how objectives are made operational in each country;   (4) reports on national ocean management activities;   and (5) a synthesis that describes similarities and differences among national approaches. *The Working Group no longer feels it is practical to create a standard reporting format because it would be prohibitively labor-intensive, so this aspect of the term of reference will not be considered further.*

TOR#2: Review existing definitions of eco-regions and identify criteria used for defining ecological boundaries.   The report will include national identification criteria as presented at the PICES XV MEQ/FIS workshop (W3) on "*Criteria relevant to the determination of unit eco-regions for ecosystem-based management in the PICES area*", with particular attention to how national definitions compare with other ecosystem definitions (*e.g.*, LMEs).   The brief report of the workshop is included in the *Session Summaries* chapter of this Annual Report.

TOR #3:   Evaluate indicators from the 2004 Symposium on "*Quantitative ecosystem indicators for fisheries management*".   The report will present the WG 19 recommendations for types of indicators (and not specific indicators) that have been analyzed in publications generated since the 2004 symposium. *The Working Group feels that this term should be broaden to include and integrate findings from the NPRB-funded PICES Bering Sea Ecosystem Indicators project into the final report.*

TOR #4:   Describe relevant national marine ecosystem monitoring approaches, plans, and models for predicting human and environmental influences on ecosystems.   The WG is concerned that much of this Term of Reference has already been addressed, in the *PICES Scientific Report No. 18* on "*Impact of climate variability on observation and prediction of ecosystem and biodiversity changes in the North Pacific*" (2001). *The Working Group proposes to change this TOR to: Determine if national monitoring data currently being*

collected are sufficient to allow calculations of key indicators.   Each nation will summarize the monitoring approaches in one ecosystem or eco-region that are most representative of their implementation of EBM.   Tentatively, those case studies will be: the Kuroshio Current (Japan), the Yellow Sea (Korea), the Okhotsk Sea (Russia), the Pacific North Coast (Canada), and the Bering Sea (U.S.A.).   Key indicators will be calculated for each system and data gaps will be identified.

TOR #5:   Hold an inter-sessional workshop that addresses the status and progress of EBM science efforts in the PICES region.   For the purposes of the final report, we will summarize the content of a 1-day FIS/MEQ workshop on "*Comparative analysis of frameworks to develop an ecosystem-based approach to management and research needed for implementation*" proposed for PICES XVI in Victoria, Canada.

In addition, WG 19 will create an 8- to 10-page brochure that is essentially an Executive Summary of the final report. It will be published in 2008, with the foreseen target audience to be determined later. We hope that the brochure will be translated into the languages of all PICES member countries.

Planning for PICES XVI (Agenda Item 9)

WG 19 proposes a 1-day FIS/MEQ workshop "*Comparative analysis of frameworks to develop an ecosystem-based approach to management and research needed for implementation*" to be convened at PICES XVI (*WG 19 Endnote 3*).

The structure of the workshop would be:
▪ a keynote talk summarizing activities of the Working Group;
▪ invited talks from other PICES Working Groups and committees (*e.g.*, MONITOR, TCODE, or parent committees) that describe EBM-related tools and themes developed by other groups in PICES;
▪ invited talks from representatives of external institutions (*e.g.*, FAO) that describe EBM-related tools and themes developed outside of PICES;
▪ an invited talk on the constraints to implementation of EBM;
▪ an invited talk on governance issues and difficulties related to EBM;

- An invited talk on socio-economic issues related to EBM; and
- Contributed talks solicited through the general abstract submission process.

In the evening following the workshop, WG 19 would convene for 2 hours to discuss the content of the workshop and incorporate it into the final report.

The desired outcomes of this workshop are:
- to fulfill the Terms of Reference of WG 19;
- to promote general discussion on objectives, practices, and implementation of EBM in PICES member countries; and
- To generate papers for a special issue or theme section of a prominent marine science journal, such as *Marine Ecology Progress Series* or *Progress in Oceanography*.

WG 19 Endnote 1

Participation list

Members

Elena Dulepova (Russia)
David Fluharty (U.S.A.)
Christopher Harvey (U.S.A.)
Oleg Ivanov (Russia)
Glen Jamieson (Canada, Co-Chairman)
Tatsu Kishida (Japan)
Jae-Bong Lee (Korea)
Patricia Livingston (U.S.A., Co-Chairman)
R. Ian Perry (Canada)

Vladimir Radchenko (Russia)
Inja Yeon (Korea)
Chang-Ik Zhang (Korea, Co-Chairman)

Observers

Robin M. Brown (Canada)
K. Alexandra Curtis (U.S.A.)
Elizabeth Fulton (Australia)
Henry Lee (U.S.A.)
Jacob Schweigert (Canada)

WG 19 Endnote 2

WG 19 meeting agenda

October 13
1. Welcome and introductions
2. Review of national and international approaches (maps, processes used to identify area) to establishing science-based eco-regions, and compare these to existing or planned "management" regions
3. Theoretical evaluation of the consequences of an artificial boundary that splits an ecological process and how that could affect management
4. National ocean management activity reports: the process and framework that each country is using to implement an ecosystem approach to

management
5. National ecosystem monitoring approaches relevant to the eco-regions considered above

October 14
6. Findings from the 2004 Paris symposium on "*Quantitative ecosystem indicators for fisheries management*"
7. Findings from the NPRB-funded PICES Bering Sea Ecosystem Indicators project
8. Content of the WG 19 final report
9. Planning for PICES XVI

WG 19 Endnote 3

Proposal for a 1-day FIS/MEQ workshop at PICES XVI on
"*Comparative analysis of frameworks to develop an ecosystem-based approach to management and research needed for implementation*"

An ecosystem-based approach to management (EBM) is an integrated approach to management of land, water, and living resources that promotes

conservation and sustainable use over a broad range of human activities in an ecosystem. Implementation of an EBM for marine ecosystems

in the North Pacific Ocean requires a number of steps and activities. An explicit framework that outlines the objectives, legal mandates, and institutional roles and responsibilities is essential. Data requirements and analytical tools need to be developed. This workshop invites papers to: 1) highlight existing national and international frameworks for implementation of an ecosystem approach to management; 2) outline the data requirements for such an approach; 3) describe the analytical tools being developed; 4) show the progress in communicating results of EBM activities; and 5) discuss outstanding research gaps for making progress. The workshop will be organized to allow time for keynote summaries of

PICES Working Group 19 results, invited contributions from other PICES groups, insights by other organizations involved in providing integrated ecosystem advice, talks on governance issues and difficulties, socioeconomic issues, *etc*. During a discussion period, participants are welcome to advise the convenors on the desirability of publishing the results of the workshop in a leading primary scientific journal.

Recommended convenors: Glen Jamieson (Canada), Patricia Livingston (U.S.A.) and Chang-Ik Zhang (Korea).

PICES Fifteenth Annual Meeting Workshop Summary

MEQ/FIS Workshop (W3)
Criteria relevant to the determination of unit eco-regions for ecosystem-based management in the PICES area

Convenors: Glen Jamieson (Canada), Patricia Livingston (U.S.A.) and Chang Ik Zhang (Korea)

Background

The management of human activities that affect ocean ecosystems requires planning and the engagement of stakeholders to meet the objectives of ecosystem-based management. This, in turn, requires identification of areas to determine which stakeholders must be involved in each specific process. Area boundaries are typically based upon science (*i.e*., eco-regions), human community (*i.e*., coastal community composition), administrative (*i.e*., historical resource management areas) and international considerations (*i.e*., transboundary issues). This workshop considered the science requirements for eco-region identification in the PICES area, and presentations were solicited to: 1) highlight national or regional experiences or frameworks for delineating marine sub-regions or eco-regions; 2) demonstrate the use of a variety of physical and/or biological criteria for region identification; or 3) explain the specific management purposes behind various sub-regional identification schemes. Discussion involved participants in reviewing the existing Large Marine Ecosystem boundaries of the PICES area and in developing recommendations for criteria to be used in sub-regional identification in the North Pacific.

Summary of presentations

The workshop had 11 presentations, 2 of which were invited, that focused on the science requirements for eco-region identification in the PICES area. Presentations highlighted national or regional experiences or frameworks in place for delineating marine sub-regions or eco-regions (Jamieson, Lee *et. al*.); demonstrated the use of a variety of physical and/or biological criteria for region identification (Fluharty, Harvey *et al*., Shtrik, Sydeman *et al*.); and/or explained the specific management purposes behind various existing sub-regional identify-cation schemes (Kishida, Livingston and Piatt, Seki and Makaiau). Invited speakers discussed: 1) a hierarchical classification scheme that has been successfully applied across multiple scales and in many system types and whose output is becoming an accepted component of management support packages – both as maps for use in defining coherent management areas, but also as part of ecosystem-level modeling tools (Fulton), and 2) issues associated with reconciling overlapping biogeochemical and fisheries-based ecosystem typologies, and the mesh of fisheries management and reporting areas which may, or may not, in turn be related to marine ecosystem

typologies (Perry). The workshop concluded with a plenary discussion of issues raised from the presentations with respect to criteria for ecoregion determination.

List of papers

Oral presentations

Elizabeth Fulton, Vincent Lyne and Donna Hayes   (Invited)
Bioregionalisation and ecosystem-based management in Australia

Glen S. Jamieson
Canada's ecoregion determination approach

Jae Bong Lee, Chang Ik Zhang, Dong Woo Lee, Jong Hwa Park and Jong Hee Lee
Marine sub-regions determined with physical and biological criteria in Korean waters

Chris J. Harvey, Isaac C. Kaplan and Phillip S. Levin
Selecting model domains and boundaries in ecosystem modeling of the U.S. West Coast: Process determines scale

David L. Fluharty
Aligning institutions with ecosystems for marine science

Patricia A. Livingston and John F. Piatt
Progress in U.S. ecoregion definitions for ocean ecosystems and an Alaskan example

R. Ian Perry   (Invited)
Ecosystem typologies in the North Pacific – A useful concept for ecosystem-based management?

Michael P. Seki and Jarad Makaiau
Archipelagic fishery ecosystem plans for the U.S. central and western Pacific islands

William J. Sydeman, Sonia D. Batten, Michael Henry, Chris Rintoul, David W. Welch, Ken H. Morgan and K. David Hyrenbach
Meso-marine ecosystems of the North Pacific: Application to ecosystem-based management

Vadim A. Shtrik
Use of the classification and structure of coastal zone macro-vegetation for global and local eco-regional identification of coastal areas in the North Pacific

Tatsu Kishida
Physical and biological criteria for region identification around Japan

PICES Sixteenth Annual Meeting
October 26–November 5, 2007
Victoria, Canada

2007 Report of Working Group on
Ecosystem-based Management Science and its Application to the North Pacific

The Working Group on *Ecosystem-based Management Science and its Application to the North Pacific* (hereafter WG 19) held its third meeting on October 27–28, 2007, under the co-chairmanship of Drs. Glen Jamieson and Chang-Ik Zhang, and Ms. Patricia Livingston. A list of participants and meeting agenda can be found in *WG 19 Endnotes 1* and *2*.

Description and implementation of a standard reporting format for EBM initiatives (Agenda Item 2)

Descriptions received from member countries were disparate and are being compiled into a summary. Still missing is a contribution from China. WG 19 discussed a conceptual spectrum of the ecosystem-based management (EBM) from single species fishery management to integrated (multi-sectoral) marine management and talked about trying to display national situations on the spectrum. Lists of government agencies involved in implementing EBM are being assembled.

Participants from each country were asked to provide Dr. David Fluharty a few paragraphs which outline where each nation is located on the Ecosystem Approach to Management (EAM) spectrum (*sensu* Sainsbury slide), including endangered species legislation, marine protected areas (MPA), or heritage site designations.

Dr. Fluharty discussed the possibility of incorporating a list of treaties dealing with transboundary stock management into the report. This document could be enhanced by adding aquaculture activities and their management. Categories in the report are expected to include: (1) definitions, (2) objectives, (3) legislation and agencies with marine management authority, (4) environmental assessment requirements in decision making, and (5) endangered species protection, marine sanctuaries, national heritage or other MPA designation processes. Target date for

completion of this chapter of the WG 19 final report is the end of December 2007.

Definitions of "eco-regions" and criteria for defining ecological boundaries relevant to PICES (Agenda Item 3)

Dr. Christopher Harvey gave an update of the "eco-region" chapter of the WG 19 final report. Currently, the discussion section needs more work and regional figures are not yet in a common format. There was discussion about the World Wildlife Fund MEOW (Marine Ecosystems of the World) initiative and how this might overlap with PICES efforts to define eco-regions. It was determined that governments of member countries are pursuing individual definitions and frameworks for eco-regions, a situation that must be highlighted. It is not clear whether MEOW's system will be adopted, but national efforts could be compared with their regions. Some details and refinement of the discussion have to be finalized, but this chapter of the report is virtually complete, although lacking a contribution from China.

Dr. Elizabeth Fulton presented a report on the consequences of ocean management scenarios that ignore eco-region boundaries in favour of national boundaries. An artificial national boundary was generated between States in an existing model of southeast Australian waters, creating two artificial Exclusive Economic Zones (EEZs). Different management scenarios (loosely based on the range of management methods existing in the PICES region) were implemented, with contrasting options within these two EEZs. This meant that there were two management regions that spanned parts of a single eco-region – with some but not all species moving across the border between the two quasi-nations. Results for a range of indicators (drawn from the list constructed by Perry *et al.*) were presented. This gave insight into the state of the system overall and the relative performance of the management methods. Results included:

- different levels of production with different management approaches (although this result might not occur in regions with a dominant signal from upwelling);
- less biomass in forage groups if target species were managed sustainably and higher trophic levels were conserved;
- any kind of management helps maintain target species biomass (*vs.* an unconstrained baseline scenario);
- for species with even moderate degrees of mobility (or more), effective management in one "nation" subsidizes catches and biomass taken by the other, but is still beneficial as it also raises overall system state;
- top predators benefit from more prey but this signal can be diffused by large scale (including seasonal) movements following rich prey sources/locations;
- cephalopods dropped in biomass slightly because of increase in top predators;
- habitat has the potential to benefit from management, but success is not a given (it is sensitive to the magnitude and specific implementation and types of management);
- from an EBM perspective, management in one region is helpful but perhaps not as effective as if management was coordinated across the regions.

One question that has not been addressed in this modeling work to date is whether the benefits seen from implementing effective management in one nation's waters, even if the neighbouring country is not being as efficient, are cost-effective. This research will be targeted for publication by Drs. Fulton and Harvey in the peer reviewed literature, however, some illustrative examples and results will be incorporated in the WG 19 final report to highlight ecosystem issues arising from differential management across boundaries.

Evaluation of indicators and summary of monitoring efforts (Agenda Items 4 and 5)

An overview of the indicators chapter of the WG 19 final report was provided, and discussion points were outlined and agreed upon. The next step was for each member country to suggest whether the indicators listed in Table 2 of the chapter had been calculated yet for a particular region in each nation and whether there are data available to do so. Dr. Perry will coordinate this

effort. Tables from some countries were finished at the meeting, but others will need input from national experts. Most indicators were related to effects of fishing and not to the broader types of impacts from other marine sectors. The participants expanded the third recommendation in the chapter to explore the development and use of socio-economic indicators. There was discussion about social indicators such as the spatial distribution and numbers of jobs. Those data are difficult to obtain in some countries. ICES examples in that regard can be found in the 2006 Report of the Ecosystem Effects of Fishing (Sections 4.2–4.4, pp. 92–106, Tables 4.2.4, 4.4.3). Indicator availability tables from each country will be completed by the end of December 2007 and will be added to this chapter of the report.

FIS/MEQ workshop at PICES XVI (Agenda Item 6)

A full report of the FIS/MEQ workshop on "*Comparative analysis of frameworks to develop ecosystem-based approach to management and research needed for implementation*" (W3) can be found in the *Session Summaries* chapter of this Annual Report. The workshop made progress in highlighting issues related to the implementation of EBM in PICES member countries. It was clear from the presentations that member countries are in different stages of EBM implementation. Some are still working on incorporating an ecosystem approach to fisheries management, while others have national legislation that provides a mechanism for implementing cross-sectoral approaches to the management of marine activities to ensure environmental protection. The degree of advancement might be related partly to the nature of the different human pressures being exerted on the marine environment. Even some of the countries that appeared to be more advanced in their implementation mentioned problems in actually making cross-sectoral management work in marine ecosystems. Overarching legislation that requires action may be needed. It was clear that more than one agency was involved in EBM activities in each country, and a challenge is to get agencies to work together in implementation. It was noted that the legislation that typically led to cross-sectoral implementation was some form of endangered species legislation.

Data requirements for EBM were discussed. The

Australian experience demonstrated that implementation could involve both highly quantitative approaches and models if data are available, but could also include methods to evaluate ecosystem status and potential impacts in qualitative ways. The ICES experience exhibited how highly-evolved data gathering for EBM advice could be, although it was noted that highly-evolved advice did not necessarily translate into the political will to follow such advice. MONITOR outlined some of the data requirements that would necessitate its involvement and that of all of the PICES Committees. The workshop noted particularly the lack of socio-economic data to assist in decision-making in an EBM context.

Analytical tools are being developed to aid in EBM, and these include the highly structured risk assessment framework of Australia that allows for both quantitative and qualitative evaluation of risks, and determinations of when action is needed. The MODEL Task Team described a suite of modeling tools that might be used to understand impacts of climate variability on marine ecosystems. Models such as ATLANTIS can help in the evaluation of management strategies, and these seem to be important tools to further decision-making.

Communicating the results of EBM activities is ongoing in member countries. Some are using highly-structured reporting instruments such as ecosystem assessment documents. The ICES advisory structure communicates EBM advice in a tactical way that is highly evolved, although its success in implementing EBM might not be so advanced. Reporting of ecosystem status is crucial but it was recognized that identification and reporting of ecosystem pressures and ecosystem responses to management are significant pieces in conveying EBM progress. Communicating measures of human health was noted to be essential in this regard. The role of PICES in communicating EBM was seen to be more of a strategic one. There is a variety of potential scales useful in reporting results.

A major outstanding research gap is the need for social science indicators and information. The advancement of risk assessment frameworks and tools seemed particularly important. Perhaps Working Groups on *Human Dimensions of Implementing EBM* or *Evaluation of Risk Assessment Tools and Frameworks* might be worthwhile to consider in the future.

WG 19 final report and 2008 inter-sessional meeting planning (Agenda Item 7)

National submissions of the above material are due to January 1, 2008, after which the lead authors and Co-Chairmen will begin merging the data into a final report. A major gap is a lack of Chinese submissions and lack of participation from this country to date. Options relating to finalization of the WG 19 report are thus:
▪ Get Chinese participation in an inter-sessional meeting in February 2008 (options Seattle or China);
▪ Extend the Working Group for one more year and meet with Chinese scientists at the next PICES Annual Meeting in Dalian;
▪ Finalize the report without Chinese input.

WG 19 hopes to have a draft of the final report by late January to send to the Chinese prior to the inter-sessional meeting, so they can see what contribution is desired from them.

After the meeting adjourned, it was realized that WG 19 originally intended to publish a brochure on EBM in 2008 but this topic was not discussed at the meeting. In hindsight, such a publication would have been premature as the final report has yet to be written. WG 19 still plans to produce a brochure (the concept was approved by Science Board last year), but after the final report is complete. Its contents would be a subset of information compiled in the final report. Discussion of contents of the brochure will be conducted either via email, at the inter-sessional meeting, or at next year's Annual Meeting.

Structure and content of North Pacific Ecosystem Status Report and EBM-related topics for inclusion (Agenda Item 8)

An incremental improvement version of the 2004 pilot report is being recommended by Science Board (*SG-ESR Endnote 2*). WG 19 suggests enhancing the next report with information on pollution and socio-economics. The discussion focused on the need to identify key pressures in each region, and on how should indicators on status and trends describing human well-being be determined. Further discussion on these topics will be required.

Establishing a PICES Study Group on *Indicators of Human Well-being: Benefits, Health* is recommended to assist in this effort. Terms of reference for this group might include:

1. Identify potential indicators of human well-being and human impacts in relation to PICES marine ecosystem status and trends. Evaluate the Millennium Ecosystem Report Indicators for their appropriateness.
2. How might these measures be quantified and standardized across member countries? Are the data available to quantify these?
3. How can these measures be used in ecosystem models and management strategy evaluation frameworks?
4. Identify longer-term issues that might be covered by a Working Group on this topic (governance structures for implementation, *etc.*).

Membership for this Study Group should consist of qualified social scientists, primarily those with strong economics background, with an understanding of natural sciences, particularly marine science, who are working on questions relating to marine ecosystem approaches and management issues.

Comments on FUTURE (Agenda Item 9)

The participants evaluated a draft Science Plan for a new PICES integrative scientific program on *Forecasting and Understanding Trends, Uncertainties and Responses of North Pacific Marine Ecosystems* (FUTURE) in the context of advancing science and communication in support of EBM. The communications aspect of this program is very important and should be discussed and outlined more clearly with a strategic view of identifying the audiences and appropriate methods of communication. The status and trends information is newsworthy and needs communication.

Models are important to project future ecosystem states, and the program has a heavy emphasis on that aspect. WG 19 members thought that the deliverables for the program also have to include status and trend indicators and an improved, coordinated monitoring system to support indicator data requirements. Society needs to hear about human health, food security, role of climate, and potential for unanticipated ecosystem change.

WG 19 Endnote 1

Participation list

Members

Elena Dulepova (Russia)
David Fluharty (U.S.A.)
Christopher Harvey (U.S.A.)
Glen Jamieson (Canada, Co-Chairman)
Jae-Bong Lee (Korea)
Patricia Livingston (U.S.A., Co-Chairman)
Mitsutaku Makino (Japan)
R. Ian Perry (Canada)
Vladimir Radchenko (Russia)
In-Ja Yeon (Korea)
Chang-Ik Zhang (Korea)

Observers

Elizabeth Fulton (Australia)
Xuewu Guo (PICES Secretariat)
Woo-Seok Gwak (Korea)
Oleg Katugin (Russia)
Kenji Konishi (Japan)
Skip McKinnell (PICES Secretariat)
Thomas Okey (Canada)
Jake Rice (Canada)
John Stein (U.S.A.)
Mikhail Stepanenko (Russia)
Zhaohui Xhang (China)
Mingyuan Zhu (China)

WG 19 Endnote 2

WG 19 meeting agenda

October 27, 2007

1. Welcome and introductions
2. National definitions of EBM, making sure to

expand beyond EBFM and list agencies that are involved in broader sectors, other than fisheries. Brief description of each country's ocean management report contents

3. National reports: Review national definitions of "eco-regions" and identify criteria that could be used for defining ecological boundaries relevant to PICES
4. Evaluation of the indicators from the 2004 Symposium on "*Quantitative ecosystem indicators for fisheries management*" for usefulness and application to EBM in the North Pacific, but broaden the terms of reference to encompass not just Paris symposium, but also NPRB indicators project and the types of indicators summarized by Elizabeth Fulton
5. National reports on monitoring efforts that address the types of indicators described in item 4 above, as well as identify gaps. Member countries will focus on an eco-region that is most representative of their EBM efforts

October 28, 2007

6. Discuss content of FIS/MEQ Workshop on "*Comparative analysis of frameworks to develop an ecosystem-based approach to management and research needed for implementation*" (W3) at PICES XVI and incorporate into the report
7. Initiate discussion of structure of final report, deliverables and time frames; Planning for a 2008 inter-sessional meeting
8. Advice on structure and content of the North Pacific Ecosystem Status Report; suggest EBM-related topics for inclusion in the report
9. Discuss next major PICES scientific program, FUTURE, and provide comments

PICES Sixteenth Annual Meeting Workshop Summary

FIS/MEQ Workshop (W3)
Comparative analysis of frameworks to develop an ecosystem-based approach to management and research needed for implementation

Co-Convenors: Glen Jamieson (Canada), Patricia Livingston (U.S.A.) and Chang-Ik Zhang (Korea)

Background

An ecosystem-based approach to management (EBM) is an integrated approach to management of land, water, and living resources that promotes conservation and sustainable use over a broad range of human activities in an ecosystem. Implementation of an EBM for marine ecosystems in the North Pacific Ocean requires a number of steps and activities. An explicit framework that outlines the objectives, legal mandates, and institutional roles and responsibilities is essential. Data requirements and analytical tools need to be developed. This workshop invited papers to: 1) highlight existing national and international frameworks for implementation of an ecosystem approach to management; 2) outline the data requirements for such an approach; 3) describe the analytical tools being developed; 4) show the progress in communicating results of EBM activities; and 5) discuss outstanding research gaps for making progress. The workshop was organized to allow time for keynote summaries of PICES Working Group 19 results, invited contributions from other PICES groups, insights by other organizations involved in providing integrated ecosystem advice, talks on governance issues and difficulties, socioeconomic issues, *etc*. During a discussion period, participants were welcomed to advise the convenors on the desirability of publishing the results of the workshop in a leading primary scientific journal.

Summary of presentations

The workshop made progress in highlighting issues related to the implementation of EBM in PICES member countries. It was clear from the presentations that member countries are in different stages of implementation with respect to EBM. Some countries are still working on incorporating an ecosystem approach to fisheries management while others have national legislation that provides a mechanism for implementing a cross-sectoral approach to the management of marine activities to ensure environmental protection. The degree of advancement might be partly related to the nature of the different human pressures being exerted on the marine environment. Even where some countries

appeared to be more advanced in their implementation, there were problems in actually making cross-sectoral management work in marine ecosystems. The need for overarching legislation that requires action may be needed. It was clear that more than one agency was involved in EBM activities in each country and a challenge is to get agencies to work together in implementation. It was also noted that the main type of legislation that forced cross-sectoral implementation was species-at-risk legislation.

Data requirements for EBM were discussed to some extent. The Australian experience demonstrated that implementation could involve both highly quantitative approaches and models if data are available but the framework could also include methods to evaluate ecosystem status and potential impacts even in qualitative ways. The ICES experience demonstrated how highly evolved data gathering for EBM advice could be, although it was noted that highly evolved advice did not necessarily translate into the political will to follow such advice. The Technical Committee on Monitoring outlined some of the data requirements that would require its involvement along with the involvement of all the PICES committees. The workshop particularly noted the lack of socio-economic data to aid in decision-making in an EBM context.

Analytical tools are being developed to aid in establishing EBM frameworks. Highly structured risk assessment frameworks in Australia allow both quantitative and qualitative evaluation of risks and definitions of when actions are needed. The

MODEL Task Team described a suite of modeling tools that might be used to understand impacts of climate variability on marine ecosystems. Models, such as Atlantis, to aid in the evaluation of management strategies seem to be important tools to help EBM decision-making.

Communicating the results of EBM activities is ongoing in member countries. Some are using highly structured reporting instruments such as ecosystem assessment documents. ICES advisory structure for communicating EBM advice in a tactical way is highly evolved although reporting its success in implementing EBM might not be so advanced. Reporting of ecosystem status is important but it was recognized that identification and reporting of ecosystem pressures and ecosystem responses to management are important pieces of communication of EBM progress. Communicating measures of human health was noted to be important in this regard. The PICES role in communicating EBM was seen to be more of a strategic one. There seemed to be a variety of scales that are potentially useful for reporting results.

A major outstanding research gap is the need for social science indicators and information. The advancement of risk assessment frameworks and tools seemed particularly important. Perhaps working groups on the human dimensions of implementing EBM or evaluation of risk assessment tools and frameworks might be important to consider in the future.

List of papers

Oral presentations

R. Ian Perry, William R. Crawford and Alan F. Sinclair
Comparative analysis of Canadian Pacific North Coast and Strait of Georgia marine ecosystems

Phil R. Mundy
Data requirements for implementing an ecosystem approach to management from a PICES perspective

Jake Rice
Ecosystem approaches to management – Where to start?

Mitsutaku Makino and Tatsu Kishida
Ecosystem-based management in Japan: Its status and challenges

Vladimir I. Radchenko
Ecosystem-based principles in the contemporary fisheries management on the Russian Far East

Jake Rice
ICES frameworks and processes for science advice in an ecosystem approach

Glen S. Jamieson
Integrated management in Canada's Pacific North Coast: Challenges in determining ecological objectives

Bernard A. Megrey, Michio J. Kishi, Shin-ichi Ito, Kenneth A. Rose, Francisco E. Werner and members of the MODEL Task Team and the NEMURO Mafia
Modeling multi-trophic level marine ecosystems using the NEMURO family of models: Climate change applications in the boreal North Pacific and scientific potential for ecosystem-based management

Chang Ik Zhang, Suam Kim, Donald Gunderson, Jae Bong Lee, Inja Yeon, Hee Won Park and Jong Hee Lee
Progress in the development of an ecosystem-based approach to assess and manage fisheries resources in Korea

David L. Fluharty
Realizing ecosystem based management through integrated ecosystem assessment and regional collaboration in the United States

Keith Sainsbury (Invited)
Sustainable use of marine ecosystems – The search for practical ways to support and implement ecosystem-based fisheries management and regional development

Inja Yeon, H.J. Whang, M.H. Shon, Y.J. Im, J.G. Myoung and WWF YSEPP project partners
Yellow Sea marine ecoregion for implementation of ecosystem-based management in marine capture fisheries

PICES Seventeenth Annual Meeting
October 24–November 2, 2008
Dalian, People's Republic of China

2008 Report of Working Group on
Ecosystem-based Management Science and its Application to the North Pacific

The Working Group on *Ecosystem-based Management Science and its Application to the North Pacific* (hereafter WG 19) held its final meeting on October 26, 2008, under the co-chairmanship of Drs. Glen Jamieson, Chang-Ik Zhang, and Ms. Patricia Livingston. A list of participants and the meeting agenda can be found in *WG19 Endnotes 1* and *2*. *WG19 Endnote 3* contains the draft Executive Summary of the PICES Scientific Report currently being finalized.   This Executive Summary contains the main recommendations of Working Group 19 at the conclusion of its work.

AGENDA ITEM 2
Discussion of Final Report

The primary item on the agenda involved discussion of the completeness of the final report and the recommendations of the Working Group. Status of the brochure was also discussed.

AGENDA ITEMS 3 AND 6
Description and implementation of a standard reporting format for EBM initiatives

Working Group members went over the country profile format and Ecosystem Approach to Management (EAM) typology contributions. Canada and Korea have newer contributions that need to be incorporated into the document. Each country should look to make sure its contribution is still accurate after English language editing. Also, WG 19 needs to decide if the country contributions should be made comparable in terms of length. Some contributions are longer than others. The Ecosystem-based Management (EBM) matrix that depicts each country's progress was not filled out by each country. Should this matrix still be shown? Members commented that it is difficult to report on a national basis because there are regional differences in implementation. There are several issues that are not in the table at present. For example, offshore wave energy generation, tourism and sportfishing are not outlined. Mariculture may need to identify intertidal, pen culture, and onshore locations of the activity. The text will be modified to describe the typology and sectors as examples. Offshore wave energy generation could be identified as an emerging issue in the text. Regional implementation of EBM should consider the most important sectors in a particular area. Another aspect is evaluating the social cost of EBM implementation. Dr. Mitsutaku Makino will provide a paragraph about this. Japan will contribute an example for one prefecture. WG 19 members from China and Russia will be contacted to see if they are able to contribute a national example to this table. Contributions will need to be made before the end of the year.

The Working Group consulted with Dr. Skip McKinnell about how to format the report with respect to location of references, appendices, and section formatting. For now, each section will have its own specific recommendations and the executive summary will provide a roll-up of all the recommendations from each section. Order of sections was discussed. EAM typologies and country profiles will come first. An ecoregion approach would then logically follow. Consistency in the names of countries needs to be checked and terms of reference need to be verified because they were modified later. Dr. Zhang will review the section on monitoring to see if anything could be added.

AGENDA ITEM 4
Discussion of recommendations

The relationship of PULSE (see *WG 19 Endnote 3*) to other potential task teams of FUTURE was discussed and more members were nominated. A potential Study Group or Working Group on *Indicators of Well-being* was mentioned. The Working Group recommended that the Convenors of Topic Session on "*Connecting the human and natural dimensions of marine ecosystems and marine management in the PICES context*" (S12) bring up this proposed group in the discussion part of their session. Potential members of the study group/working group could be some of the people presenting at S12. WG 19 members thought that this should be a study group initially to help focus the work and refine membership for a follow-on working group. A topic session for next year on spatial planning was discussed, and it was suggested that it be sponsored by MEQ and FIS.

AGENDA ITEM 5
Ecologically and biologically sensitive international marine areas in the North Pacific

Drs. Akihiko Yatsu and Jake Rice presented information on the current status of a Regional Fisheries Management Organization (RFMO) in international waters in the North Pacific and a joint Convention on Biological Diversity-International Union for Conservation of Nature (CBD-IUCN) effort that are both considering to look at the application of criteria for designating vulnerable marine ecosystems (VMEs) in North Pacific international waters. It appears that the RFMO is still being developed, and likely would not be able to initiate studies until the fall, 2009, at the earliest, while the CBD meeting to review progress on using the criteria in evaluation of VMEs will be in early fall, 2009. It was suggested by Dr. Rice that PICES might therefore be interested in considering addressing the usefulness of the criteria in the spring, 2009. WG 19 did not have any comment about PICES' possible role but agreed that species do not recognize national borders and EBM must extend to international waters. The proposed designation of VMEs in international waters would be a necessary step in the long-term achievement of EBM in the entire North Pacific.

AGENDA ITEM 7
Brochure

The brochure format was discussed. A figure depicting the differences between single sector management, ecosystem-based fishery management and multisector integrated managed was suggested. The terms EBM should be consistently used throughout the brochure although some mention could be made of the other terms that are in use. There was also support for translating into languages of the PICES member nations and making those available on the PICES website. There was some discussion on the possible perspectives and recommendations of the PICES Study Group on *Communications* about this brochure. Members were tasked with looking at various sections and provide edited text.

WG 19 Endnote 1

Participation list

Members

David Fluharty (U.S.A.)
Glen Jamieson (Canada, Co-Chairman)
Patricia Livingston (U.S.A., Co-Chairman)
Mitsutaku Makino (Japan)
In-Ja Yeon (Korea)
Chang-Ik Zhang (Korea, Co-Chairman)

Observers

Evgeny Barabanshchikov (Russia)
Ingrid Burgetz (Canada)
Oleg Katugin (Russia)
Skip McKinnell (PICES Secretariat)
Thomas Okey (Canada)
Jake Rice (Canada)
Steve Rumrill (U.S.A.)
Yasunori Sakurai (Japan)
Akihiko Yatsu (Japan)

WG 19 Endnote 2
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Working Group 19 meeting agenda
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1. Welcome and Introductions (Co-chairs)
2. Discussion of completeness of final report, deliverables and timeframe
3. Report by each country: Describe and implement a standard reporting format for EBM initiatives (including more than fishery management) in each PICES country, including a listing of the ecosystem based management objectives of each country. Summary of compilation progress: Dave Fluharty
4. Discussion of recommendations – PULSE and SG on *Indicators of Human Well-Being: Benefits and Health*
5. Presentation by Jake Rice on SG on *Ecologically and biologically sensitive international marine areas in the North Pacific*
6. Overall review of final report
7. Discussion of brochure

WG 19 Endnote 3
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Looking beyond WG-19
</div>

We discussed how the findings and work of WG 19 could best be integrated and built upon within PICES in the years ahead, particularly within the context of the FUTURE program. Development of ecosystem-based management is still very much in its early stages in each of the PICES countries, and so we recommend that PICES continue to actively monitor progress into the foreseeable future. To provide a long-term forum for this process, we concluded that WG 19 might most appropriately evolve into a Task Team rather than a Section because Task Teams report to Science Board and are more broadly distributed across all of PICES, rather than simply reporting to one or two committees. We suggest that the Task Team's emphasis be on developing an integrative, science-based, ecosystem-scale understanding of the human dimension (across a diversity of sectors) in FUTURE, and suggest it be called *"PICES Understanding, Linking and Synthesis of Ecosystems"* (PULSE). A draft proposal for this Task Team with a basic background statement, terms of reference and suggested co-chairs and members is:

Objective

To monitor and synthesize regional and basin-wide ecosystem-based management (EBM) studies and initiatives (ecosystem health) and to provide a forum for the integration of FUTURE-related EBM practices and their implementation.

Draft Terms of Reference

1. The PULSE Task Team is the scientific body responsible for the promotion, coordination, integration and synthesis of research activities related to the implementation of EBM among PICES member nations. This goal would be accomplished by convening meetings, periodic scientific symposia or workshops, or by distributing information designed to foster cooperation and integration among existing or developing PICES programs, and possibly between and/or within member nations;

2. The PULSE Task Team will provide the scientific body to identify and improve indicators to measure progress in the achievement of EBM. It will provide the forum to discuss the needs, impacts and responses of coastal communities in a changing marine environment, and to enhance the use of this information by governments and society at large. It will provide a forum for the connection of ecosystem monitoring and status reporting of both environmental and social indicators (through linkage with MONITOR), and the subsequent implementation and adaptation of EBM;

3. Scientific collaboration and coordination with other international agencies, bodies and societies that are engaged in either EBM or human activities that are relevant to the achievement of EBM will be undertaken. This will engage expertise not previously active in PICES, such as social-scientists and policy makers;

4. The PULSE Task Team will encourage establishment of other component activities, such as developing the basis for coupled human science-natural science models, and emerging approaches as needed to facilitate synthesis of the FUTURE Program.

Suggested members

We are seeking a structure that will ensure core connection with PICES Committees, key expertise from the various disciplines involved in studying ecosystem approaches to management, and national representation. We advocate a nomination process that will closely connect the Task Team to PICES Scientific Committees, such as ensuring that a member or designate from each of the Committees, and perhaps from the current Study Group on *Communications* is in PULSE. There is also perhaps merit in having member participation form different sectors besides fishing (*e.g.*, mariculture, *etc.*) and ecoregions.

1. *Suggested Co-chairs:* Mitsutaku Makino (Japan) and Gordon Kruse (U.S.A.)

2. Suggested members:
Janelle Curtis (Canada)
David Fluharty (U.S.A., SG-Communications)
Chris Harvey (U.S.A.)
Glen Jamieson (Canada, MEQ)
Xianshi Jin (China)
Patricia Livingston (U.S.A.)
Ian Perry (Canada)
Vladimir Radchenko (Russia, BIO)
In-Ja Yeon (Korea)
Chang-Ik Zhang (Korea, FIS)

EBM in International Waters

In the above, all details and discussion presented have been focused on initiatives being undertaken within the Exclusive Economic Zones of the PICES member countries, and while significant progress is being made in these regions to address issued relates to EBM, the reality is that many species have spatial distributions in the Pacific Ocean that extend well beyond national jurisdictions. For these species, effective EBM can only be realised if national efforts to achieve EBM are harmonised with similar national efforts in shared national ecoregions and with multinational efforts in international waters. To this end, many of the initiatives to determine appropriate EBM steps in national waters, such as identifying ecoregions (spatial areas with a basically similar mix of species and environment) and within them, ecologically and biologically significant areas and species, need to be undertaken in offshore international waters of the PICES region.

PICES Seventeenth Annual Meeting Topic Session Summary

MEQ Topic Session (S12)
Connecting the human and natural dimensions of marine ecosystems and marine management in the PICES context

Co-Convenors: David L. Fluharty (USA), Mitsutaku Makino (Japan), R. Ian Perry (Canada) and Chang-Ik Zhang (Korea)

A complete definition of marine ecosystems includes the human components. Consideration of ecosystem-based management, at least within the natural sciences, usually leaves out the human dimensions, or includes it only as fishing effort. For ecosystem-based management to succeed, however, humans need to be included. This session builds on the Science Board Symposium of 2003 titled *"Human dimensions of ecosystem variability"*. Human relationships and how humans interact with the ocean have been changing in nature and strength over time. Natural variability in marine systems can be large, but so are socio-economic pressures and considerations relating to marine environments. Determining appropriate socio-economic indicators to complement indicators of natural climate variability, *e.g.* for ecosystem-based management, is an ongoing challenge. This session will address these interactions between natural and socio-economic issues in the context of ecosystem-based management. Specifically, it will consider: (1) What are the criteria to determine relevant socio-economic indicators of human well-being related to marine issues for PICES member countries? (2) What are appropriate indicators to monitor changes in management objectives and human well-being relevant to changing ecosystem structure and production? (3) How might decisions that are made to enhance human well-being likely to impact (positively or negatively) the nature and functions of marine ecosystems? This session theme will continue to explore the many ways that humans interact with marine ecosystems and the scientific efforts to quantify and predict human impacts on the dynamics of such systems.

List of papers

Oral presentations
Mitsutaku Makino and Hiroshi Horikawa
Social-ecological conditions of fisheries and management by ITQs: A global review

Lawrence C. Hamilton (Invited)
Ecosystem, fishery and social changes in western Alaska

Chang Seung and Chang-Ik Zhang
Socio-economic indicators used in ecosystem-based assessment for the eastern Bering Sea trawl fishery

Peter S. Ross, T. Child and N. Turner
Caught in the crossfire: Environmental contaminants in Pacific food webs and implications for coastal First Nations

David L. Fluharty
Developing and using social science information in marine management processes in the United States

Hee Won Park, Chang-Ik Zhang and Jae Bong Lee
A comparative study on the structure and function of Korean marine ranching ecosystems

Shang Chen, Jian Liu, Tao Xia and Qixiang Wang
Change of ecosystem services of the Yellow River Delta Wetland, China

Olga N. Lukyanova and Ludmila V. Nigmatulina
The value of ecosystem services of Peter the Great Bay (Japan/East Sea)

Samuel G. Pooley, Ian Perry and Mitsutaku Makino
Socio-economic considerations of ecosystem approaches to fisheries management

Zhifeng Zhang
Effects of dredging on internal release of phosphate from marine sediments in Dalian Bay

Poster presentations

Jingfeng <u>Fan</u>, Hongxia Ming, Lijun Wu, Yubo Liang and Jiping Chen
Detection of human enteric viruses in shellfish in China

Peter M. <u>Zhadan</u> and Marina A. Vaschenko
Does pollution change the reproductive strategy of the sea urchin?

Natalia M. <u>Aminina</u> and Lidia T. Kovekovdova
Brown algae metabolism in polluted environments

Zhen <u>Wang</u>, Xindong Ma, Zhongsheng Lin, Guangshui Na, Qiang Wang and Ziwei Yao
Occurrence and congener specific distribution of polybrominated diphenyl ethers in sediments and mussels from the Bo Sea, China

Guangshui <u>Na</u>, Qiang Wang, Zhen Wang, Hongxia Li, Shilan Zhao, Tong Chen, Zhongsheng Lin and Ziwei Yao
Pharmaceuticals and Cersonal Care Products (PPCPs) in some river and sewage water of Dalian, China

Li <u>Zheng</u>, Xuezheng Lin, Zhisong Cui, Frank S.C. Lee and Xiaoru Wang
Phylogenetic analysis of indigenous marine bacteria with the ability to degrade oil pollutants in Bohai Bay

Liping <u>Jiao</u>, Liqi Chen, Yuanhui Zhang, Gene J. Zheng, Tu Binh Minh and Paul K.S. Lam
Polycyclic aromatic hydrocarbons in remote lake and coastal sediments from Svalbard, Norway: Levels, sources and fluxes

Qixiang <u>Wang</u>, Shang Chen and Xuexi Tang
Preliminary assessment of ecosystem services of the Yellow Sea

Petr V. <u>Lushvin</u>
The impact of anthropogenic activity (regime of hydroelectric power stations and technological explosions) on behaviour and reproduction of fish and crustaceans

Zhang Hongliang, Leng Yu, Xu Zijun and Li Jiye
Research on the generating and vanishing process of *Enteromorpha* bloom and the environmental controlling factors

Zhou Yan-Rong Zhang Wei Tang Wei Zhao Bei andYang Dong-Fang
Analysis of nutrients and organic pollution in Shuangdao Bay

Ji-Ye Li, Xiu-Qin Sun, Feng-Rong Zheng and Lin-Hua Hao
Screen and effect analysis of immunostimulants for sea cucumber, *Apostichopus japonicus*

Wang <u>Xinping</u>, Sun Peiyan, Zhou Qing, Li Mei, Cao Lixin and Zhao Yuhui
Compounds concentration analysis of oil and its application in oil spill identification

Appendix 6

PICES Press Article

The new PICES Working Group on Ecosystem-based management

Glen Jamieson
Pacific Biological Station
Fisheries & Oceans Canada
Hammond Bay Road, Nanaimo, B.C.,
Canada. V8T 6N7
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Dr. Glen Jamieson is a research scientist at the Pacific Biological Station (Fisheries & Oceans Canada) who has 18 years' experience in shellfish stock assessment. His research and provision of scientific advice is currently centered in four general areas: 1) research in support of the establishment of marine protected areas (MPAs) and ecosystem-based management in British Columbia; 2) development of appropriate steward-ship and monitoring protocols; 3) evaluation of the population dynamics and responses of selected species, focusing on relatively sedentary species such as benthic invertebrates, rockfish, and lingcod; and 4) investigation and monitoring of the presence and impacts of exotic species. Glen is a member of the PICES MEQ Committee and the Chairman of the Study Group on Ecosystem-based management science and its application to the North Pacific.

Since the industrial revolution, man's impact on the oceans has increased dramatically, this being especially true in recent years. In near-shore coastal areas, human population growth has led to increasing pollution and habitat modification. Fishing effects have become increasingly severe, with many, if not most, traditionally harvested populations now either fully exploited or over-fished (Garcia and Moreno, 2003). Thus far, management of these activities has been primarily sector-focused. For instance, fisheries have generally been managed in isolation of the effects of other influencing factors, and have targeted commercially important species, without explicit consideration of non-commercial species and broader ecosystem impacts. However, there is now an increasing international awareness of the cumulative impacts of sector-based activities on the ecosystem (Jennings and Kaiser, 1998; Kaiser and De Groot, 2000), and the need to take a more holistic or ecosystem-based management (EBM) approach (Anon., 1999; Kabuta and Laane, 2003; Link, 2002) to ensure the sustainability of marine ecosystems. Globally, there is an emerging paradigm shift in our approach to ocean management and usage (Sinclair and Valdimarsson, 2003).

In response to the increasing awareness to look at cumulative environmental impacts, in October 2003, the PICES Science Board established, under the direction of the Fishery Science (FIS) and Marine Environmental Quality (MEQ) Committees, the Study Group on *Ecosystem-based management science and its application to the North Pacific*, with the following terms of reference:
1) Review and describe existing and anticipated ecosystem-based management initiatives in PICES member nations and the scientific bases for them;
2) Identify emerging scientific issues related to the

implementation of ecosystem-based management; and
3) Develop recommendations for a Working Group to focus on one or more of the issues identified.

The first Study Group task was to reach a common understanding of what the terms ecosystem and ecosystem-based management meant. The following definitions were agreed to:

Ecosystem: The spatial unit and its organisms and natural processes (and cycles) that is being studied or managed.

Ecosystem-based management: A strategic approach to managing human activities that seeks to ensure through collaborative stewardship the coexistence of healthy, fully functioning ecosystems and human communities [towards maintaining long-term system sustainability] by integrating ecological, economic, social, institutional and technological considerations.

Representatives from each country then submitted a summary of their country's approach to EBM, and it became immediately obvious that challenges were different between China, Japan and Korea *vs.* Russia, Canada and the United States. The greater coastal populations in the former three countries, coupled with their much longer history of full exploitation of most harvestable renewable resources, meant that EBM was, initially at least, focused on 1) minimising existing impacts, 2) rebuilding depleted stocks to more acceptable levels, and 3) in near-shore areas in particular, minimising widespread impacts in the marine environment from land runoff from both industrial and urban developments. In contrast, in the latter three countries, human coastal populations and development were generally much less, with fishing impacts and offshore oil and gas

development identified as the major impacts. In many instances, relatively unimpacted, pristine habitat and biological communities still existed, and so the challenges there were often how to maintain them while permitting appropriate new economic activity to occur.

When the Study Group met at PICES XIII (Honolulu, October 2004), there was much discussion around three issues:
1) What would be an appropriate standard format to document environmental impacts and initiatives to minimise them;
2) How could the PICES region be subdivided into what the Study Group termed eco-regions; and
3) What indicators would be most appropriate to evaluate progress in achieving EBM.

While it is recognised that many human activities impact the marine environment (*e.g*., fishing, mariculture, oil and gas exploration and development, pollution from land-based activities, disruption of freshwater discharges by urbanisation, *etc*.), the most comprehensive databases (*e.g*., target species landings, bycatch and discard characteristics, habitat disruption, *etc*.) as to how these impacts are affecting marine ecosystems are related to fishing activities. Hence, much initial reporting of ecosystem impacts is likely to be focused on documenting and addressing fishery impacts. Alternate reporting formats may need to be assessed or developed that capture the ecosystem effects resulting from other human activities, and that describe how these ecosystem effects are being monitored. Ecosystem parameters already, or potentially, being monitored may capture environmental change, without linking this change back to the specific human activity, or activities, that in fact might be causing the change (*e.g*. increasing sea water temperature may be the result of many causes, some of which relate to human activities). In some cases, additional research may then be required to determine linkages. It was thus proposed by the Study Group that a standardised reporting framework that describes human activity impacts be progressively applied to all fisheries in PICES member countries, and that the adopted reporting framework be robust enough to address an increasing number of environmental and other requirements imposed by legislation, certification schemes, and consumer and community demands.

Eco-regions have been defined by Canada as "*a part of a larger marine area (eco-province) characterized by continental shelf-scale regions that reflect regional variations in salinity, marine flora and fauna, and productivity*". Biological communities between each region are somewhat different, but within a region, they are generally similar, at least on the large scale. There would obviously be differences between habitats (*e.g*., estuarine, rocky, soft substrate, *etc*.) within an eco-region, but overall, the same mix of species could be expected to occur. EBM approaches within an eco-region should thus strive to

achieve the same broad conceptual objectives of trying to preserve the natural species mix, proportions across trophic levels, water quality, and so on. Since some eco-regions might transgress national boundaries, this might mean that different countries would be trying to address the same ecological objectives in their own waters within the same eco-region. The Study Group thus indicated that it would be of value to have a collective evaluation of where different eco-region boundaries are located.

It was generally agreed that while achievement of EBM was a common objective, only through monitoring could the level of progress be actually measured. For cost-effectiveness, existing monitored parameters should be first assessed as to their utility here, but it was recognised that new parameters, many associated with non-commercial species, will also have to be monitored. Different national approaches to achieving such monitoring were briefly discussed, mostly in the context of initiatives to develop a process to determine an optimal mix of parameters to monitor.

In finalising its report, the Study Group made the recommendation to its two parent Committees, FIS and MEQ, to establish a Working Group on *Ecosystem-based management*, with a 3-year duration and the following terms of reference:

- Describe and implement a standard reporting format for EBM initiatives (including more than fishery management) in each PICES country, including a listing of the ecosystem-based management objectives of each country;
- Describe relevant national marine ecosystem monitoring approaches and plans and types of models for predicting human and environmental influences on ecosystems. Identify key information gaps and research and implementation challenges;
- Evaluate the indicators from the 2004 Symposium on "Quantitative Ecosystem Indicators for Fisheries Management" for usefulness and application to the North Pacific;
- Review existing definitions of "eco-regions" and identify criteria that could be used for defining ecological boundaries relevant to PICES;
- Hold an inter-sessional workshop that addresses the status and progress of EBM science efforts in the PICES region, with the deliverable being either a special journal issue or a review article; and
- Recommend to PICES further issues and activities that address the achievement of EBM in the Pacific.

The parent Committees and Science Board accepted these recommendations, and the proposed Working Group on *Ecosystem-based management science and its application to the North Pacific* was established in October 2004. The Science Board also suggested that the full report of the Study Group be published as soon as possible in the PICES Scientific Report Series.