

Ecosystem-level Indicators and Assessments Discussion Outline

Day 1: 15:30-17:00

Workshop Objective

Identify ecosystem-level indicators of status and change, including but not limited to fisheries-based indicators;

- defining the objective for indicator usage (within context of FUTURE?)
- framework for identifying indicators
- how to measure the indicators (linked to uncertainty theme of Day 2)

Elements from the Presentations for Discussion

1. Common to most presentations, suggested indicators are measuring ecosystem status or trends; most are linked to management decision-making.
 - this introduces the element of policy or decision-making which is outside of PICES' traditional area of expertise
- **Q1:** What is PICES' objective for selecting and measuring ecosystem indicators?
 - will it be used solely for "North Pacific Ecosystem Status and Trends Report"?
 - will it be used by any member countries for ecosystem assessments, with national implications for management?
 - will it incorporate "Human Dimensions"?
 - will it link to PICES' communication strategy (SOFE)?
2. Several frameworks for selecting ecosystem indicators have been presented and discussed;
 - what (if any) are the common elements to these frameworks?
 - can we select one existing framework, a combination of existing frameworks, or do we need to develop a PICES'-specific framework?
- **Q2:** What approach or framework should PICES' adopt for indicator selection?
 - how can this be handled, e.g. within a WG or with national programs, or FUTURE workshop or decided at this workshop
3. Common to several presentations, is the use of ecosystem models to 1) select indicators, or 2) forecast indicator response to change.
- **Q3:** Within PICES', are there existing PICES' models that we need to use to test indicator performance or to augment indicator selection? Do we need to place research emphasis on developing models to do so?
 - how can this be handled (e.g. within a WG or FUTURE workshop)?

Ecosystem Resilience and FUTURE Science Workplan Discussion Outline
Day 2: 9:30-10:30

Workshop Objective

Identify means of determining ecosystem resilience or vulnerability.

Elements from the Presentation for Discussion

1. Additional discussion as required of the Invited Speaker's conclusions and recommendations.

2. What can we infer from a lack of Contributed Papers that dealt with this theme?

➤ **Q1:** Is the concept of ecosystem resilience (and vulnerability) well understood?

- what are the mechanisms behind resilience? Do we understand them? Can we forecast them?
- are resilience and vulnerability opposite characteristics of one another? i.e. if an ecosystem is highly resilient is it automatically less vulnerable than other ecosystems?

3. Given the absence of resilience research in PICES to date and some obstacles identified in the presentation:

➤ **Q2:** Can we address this using key questions contained in the FUTURE Science Plan?

1. What determines an ecosystem's intrinsic **resilience** and **vulnerability** to natural and anthropogenic forcing?

- 1.1. What are the important physical, chemical and biological processes that underlie the structure and function of ecosystems?
- 1.2. How might changing physical, chemical and biological processes cause alterations to ecosystem structure and function?
- 1.3. How do changes in ecosystem structure¹ affect the relationships between ecosystem components²?
- 1.4. How might changes in ecosystem structure and function affect an ecosystem's **resilience** or **vulnerability** to natural and anthropogenic forcing?
- 1.5. What thresholds, buffers and amplifiers are associated with maintaining ecosystem **resilience**?
- 1.6. What do the answers to the above sub-questions imply about the ability to predict future states of ecosystems and how they might respond to natural and anthropogenic forcing?

- can it be accomplished in the next 10 years?
- what specific research can PICES' endorse to accomplish this task?

4. If multiple steady-states are possible for ecosystems, then should we decide an ecosystem is not resilient if stressors force the system to change from a 'desirable' state (e.g. lots of food fish) to an 'undesirable' state (e.g. lots of jellyfish)?

➤ **Q3:** To what degree is the concept of ecosystem resilience reliant on human perception of desirable ecosystem states? To what degree is the concept of ecosystem resilience reliant on observational time-series?

- is our expectation of ecosystem state framed by what we have observed historically (generally less than 100 years)?
- can we remove these biases?

Indicator Uncertainty and Measuring Reference Levels Discussion Outline

Day 1: 15:20-17:00

Workshop Objective

Identify methods to characterize uncertainty in these indicators;

- how to communicate the uncertainty
- how to assess status relative to reference points and to make regional comparisons given uncertainty

Elements from the Presentations for Discussion

1. The Invited Speaker outlined the multiple types of uncertainty and methods for estimating (from simple to complex) them.
 - **Q1:** What method(s) should PICES employ for estimating indicator uncertainty?
 - is there a minimum standard for PICES to accept?
 - should we develop a framework?
 - e.g. if the indicator is derived from stock assessment models then uncertainty must be conveyed as confidence interval; if the indicator is derived from an ecosystem model then it report error structure
 - do we need to simply require that any computation of an indicator to be used by PICES must have some measure of error, and always report this error?
2. The importance of uncertainty is relevant when reference points are defined or forecasting is made.
 - **Q2:** Do we need to identify reference levels for each indicator?
 - how will we accomplish this (does it require consensus among PICES' regions)?
 - do we need to define broad ecosystem-wide reference points for ones that integrate several indices
3. Some indicators do not necessarily retain the attributes of underlying processes when downscaled or upscaled between regional- or basin scales and local-scales.
 - this has implications if in Day 1, one of our objectives is to make regional comparisons as suggested within FUTURE
 - will this require a different suite of indicators that are not necessarily selected through a framework linked to objectives we identified in Day 1?
 - **Q3:** Should we consider two (or more) different suites of indicators to deal with PICES' multiple objectives?
4. Communication of states and forecasts with associated uncertainty to the community outside of PICES will in some cases require a more qualitative approach.
 - **Q4:** Is it possible to communicate indicator and forecast uncertainty in a qualitative manner akin to report cards?
 - a report card requires definition of relative status (e.g. healthy, cautious, critical), which may be difficult to define or reach consensus on
 - can we provide direction to SOFE to develop the visual nature of the report card?