

Report of FUTURE Evaluation Panel

Introduction

Over a three-year period PICES developed the ten-year FUTURE Science Plan and Implementation Plan, which were adopted in 2009. As 2014 is the midpoint in the lifespan of FUTURE, PICES appointed an Evaluation Panel to review progress towards the FUTURE goals. Members of the Evaluation Panel are listed in Annex 1 to this report.

The Evaluation Panel was not given detailed Terms of Reference. Rather it was encouraged to look broadly and constructively at the progress that has been made towards the goals of FUTURE over the past five years. The overarching science questions and their sub-questions in the Research Themes of the FUTURE Science Plan, and the Anticipated Benefits in the Plan, were key considerations in the evaluation of progress. Both of these are copied in Annex 2 of this report. Particularly where shortcomings or slow progress were found, the Evaluation Panel was encouraged to identify key impediments and propose actions that might address them. The Evaluation Panel considered both organizational changes for FUTURE and new or modified actions by the Expert Groups and members of PICES, when seeking pathways to address impediments to progress on FUTURE goals.

The main sources of information used by the Evaluation Panel included:

- A substantial number of background documents provided on-line before the meeting, including the Science Plan, Implementation Plan, Terms of Reference and Annual Reports of Expert Groups;
- Presentations and discussions throughout the week of Workshops and Scientific Sessions at the April 2014 PICES FUTURE Open Science Meeting;
- Meetings with current and often previous Chairs of the FUTURE Advisory Panels, many Chairs of PICES Expert Groups and Committees, and prominent individuals in the PICES community¹;
- Experience with similar marine science organizations with major international science programs.

The Evaluation Panel would like to acknowledge and sincerely thank all these individuals, and particularly the PICES Secretariat, for their consistently open and helpful attitude during all our interactions, and their willingness to provide information we needed for our review.

Our report commences with an overview of the PICES FUTURE science program, which has achieved a great deal of excellent science and strengthened collaborations in its first five years. Section 1 then discusses how well FUTURE has positioned PICES science in the international

¹ These included the Chairs of each FUTURE Advisory Panel (COVE, AICE, SOFE), Chairs of Working Group 28 (Development of Ecosystem Indicators to Characterize Ecosystem Responses to Multiple Stressors), members of S-HD (Section on Human Dimensions), Chair of S-CCME (Section on Climate Change Effects on Marine Ecosystems), Science Board Committee Chairs (MEQ, MONITOR, BIO, FIS), and the current and previous Chairs of Science Board that have been responsible for the oversight of FUTURE.

marine science landscape. Section 2 reviews the value that FUTURE has added to the contributions of individual scientists and national research projects under the FUTURE umbrella. Section 3 looks more critically at the mid-point progress of the three main parts of FUTURE: ocean-climate forecasting (guided by COVE Advisory Panel), coastal pressures and cumulative impacts (guided by AICE Advisory Panel), and communications and outreach (guided by SOFE Advisory Panel), and actions needed to accelerate progress where necessary. Section 4 looks critically at the organizational structure of FUTURE and PICES, and structural changes we considered necessary to achieve the full potential of FUTURE. Section 5 concludes with some specific follow-on actions regarding review and updating of the FUTURE Implementation Plan.

The overall impressions of the Evaluation Panel are that the PICES community is not as aware of the FUTURE Science Plan and work related to FUTURE as they should be, if FUTURE is to be the flagship science program of PICES. It appears as if FUTURE has not achieved a high profile within PICES. For example, the Chairs of Working Group 28 (Development of Ecosystem Indicators to Characterize Ecosystem Responses to Multiple Stressors) were unaware that the AICE Advisory Panel had been instrumental in establishing WG 28, and since its inception there has been no structured communication between that Working Group and AICE. At least one Committee Chair was unaware that Science Board served as the Scientific Steering Committee for FUTURE. One of the roles of FUTURE is to integrate the PICES work relevant to its Science Plan, and the Evaluation Panel heard a number of times that the lack of horizontal communication between Expert Groups impeded this integration. The Evaluation Panel noted that gaps in participation by some areas of expertise and countries at the 2014 PICES FUTURE Open Science Meeting could reflect a lack of necessary priority being given to FUTURE in those areas and countries, in addition to increasing logistical challenges for meeting travel in some member countries.

Those observations notwithstanding, the workshops, plenaries, and sessions of the Open Science Meeting did provide concrete examples of progress made in achieving one of the Anticipated Benefits of the FUTURE Science Plan: increased participation in PICES of younger scientists and a greater role for social scientists, including economists. There were several early career scientists in attendance from physical, biological, and ecological disciplines, suggesting that FUTURE science is relevant to their research. Several of the themes for workshops and sessions involved the social sciences and the engagement of the public (W2, S3 and S8), each attracting presenters and participants new to PICES. These developments impressed the Evaluation Panel that some progress is being made on the inclusion of human dimensions into the work of FUTURE. The Evaluation Panel fully encourages its continued progression.

Based on the mix of workshops and sessions at the FUTURE Open Science Meeting, as well as the attendance by a number of young scientists and scientists who were new to PICES, it seems clear that the basic paradigm that drives FUTURE is being implemented, perhaps slowly, but surely.

1. FUTURE and International Science Progress/Identity

Over its 20+ years of history, PICES has developed an international profile based on the quality of its science, its clear geographical focus, and its desire to collaborate with like-minded organizations and international initiatives. The footprint of PICES is now globally recognized, and the need for alliances with similar organizations and research initiatives is no longer driven by the need to be recognized but by the benefits that these relationships bring to fulfill PICES and FUTURE objectives.

In this context the relationship between PICES and ICES has matured and become very strong, institutionally and operationally. An example of this is the arrangement between PICES Science Board (SB) and the ICES Science Committee (SCICOM) to co-sponsor and fund theme sessions in each other's Annual Science Conferences. However, FUTURE, as the flagship science initiative of PICES, has perhaps not benefitted from this relationship to the extent it could have. The Evaluation Panel believes that this arrangement could be better utilized to underpin and showcase the delivery of FUTURE objectives.

The Evaluation Panel considers that there may be only two formal examples clearly demonstrating that FUTURE has helped connect North Pacific marine science to global science. The first would be the Joint ICES-PICES Section (Strategic Initiative, in ICES language) on Climate Change Effects on Marine Ecosystems (S-CCME) established in October 2011 and scheduled to run through 2020. This initiative has been very successful in coordinating northern hemisphere research efforts in the area of climate change and marine ecosystems, providing a very significant exposure to FUTURE. For the second, PICES and ICES collectively nominated authors to the IPCC Assessment Report 5, and this resulted in appointments of a number of scientists who have been veteran members of the two organizations. It was the first time that regional organizations (and even more than collective efforts of two organizations) exerted influence on IPCC authorship.

Notwithstanding the above contribution of FUTURE to the international reputation of PICES science, FUTURE has not achieved the prominence that the Climate Change and Carrying Capacity (CCCC) program, the previous flagship program of PICES, enjoyed. The PICES CCCC benefitted from national funding for GLOBEC programs in several PICES countries and from international coordination via International GLOBEC. The CCCC program played a strong role in coordinating regional GLOBEC efforts, increasing the international exposure and relevance of PICES. There is not a similar relationship between FUTURE and IMBER, for reasons that are complex despite the existing joint memberships of individuals in PICES and IMBER structures. FUTURE was not designed as part of larger program (as CCCC was designed to be nested within GLOBEC), IMBER does not encompass all of FUTURE the way that CCCC as a whole mapped well onto GLOBEC, and neither IMBER nor other international programs have the resources and traction with all Parties to PICES the way that GLOBEC had through national commitments and directed funding. For these reasons it is difficult to pursue FUTURE implementation in the same way CCCC was implemented. This said, connections between IMBER and FUTURE should be strengthened when appropriate, for example in the area of social-ecological research, where some clear synergies can be fostered.

It is also worth noting that FUTURE, through Working Group 27 (North Pacific Climate Variability and Change) and Working Group 29 (Regional Climate Modeling), has strong links with the international CLIVAR program. These links should be nurtured as tactical linkage to CLIVAR provides PICES with additional credibility in the climate change and climate variability research area, and strategically such linkage ensures that the climate aspects of FUTURE are delivered in partnership.

Beyond these linkages largely related to the ocean-climate forecasting aspects of FUTURE, there is little evidence that FUTURE has, as yet, added an identity to PICES at the international marine science stage. PICES itself is well recognized in the global marine science landscape, particularly through its intergovernmental status. It is noteworthy that PICES was asked to organize the North Pacific coordinating workshop for the UN World Ocean Assessment. This is more significant than may otherwise appear, as the UN Regular Process conducting the assessment has been designed by its UN oversight bodies to be nationally and not regionally driven. PICES as a whole also benefits from its commonalities and institutional coordination arrangements with ICES, like the regular early career scientists conferences and topical international symposia. However there is little evidence that these arrangements are used for the benefit of FUTURE or by FUTURE to enhance the international image of PICES.

In fact, despite being designed as a holistic research initiative, FUTURE is not widely known outside PICES and may not even be dominant in the thinking of many scientists within PICES. The ocean-climate forecasting part of FUTURE is highly respected internationally, and has given PICES visibility beyond the actual participants in PICES. For the communications and outreach part of FUTURE, work organized around SOFE has gotten PICES science products to a somewhat wider audience of various stakeholders around the North Pacific, but not beyond.

FUTURE should be the flagship of PICES. Failure to showcase its achievements as opportunities to cement the stature of PICES at the global marine science stage could have deleterious effects. The value of PICES goes beyond its regional coordination status; FUTURE should help to reflect the excellence of PICES science broadly. FUTURE certainly has the potential to fill this role but it must be considered in the international outreach that is conducted by the individual projects associated with it. There needs to be a decision if the outreach is to focus on the North Pacific nations of PICES or more widely, and if the latter how to allocate communications and outreach efforts within and beyond the PICES members.

At this time it is not clear to the Evaluation Panel what the key audiences are for FUTURE communications efforts. Bearing in mind that many organizations world-wide are grappling with how to showcase and communicate scientific achievements, the Evaluation Panel suggests that FUTURE focuses particular attention on activities that generate research impact for FUTURE, PICES and its members, as discussed in Section 3, and not on communication in its broader sense. In this context, FUTURE could be more relevant in at least two ways. One way would be to act as a clearinghouse for operational products that would garner international recognition. Another product could be related to the content of the North Pacific Ecosystem Status Report (NPESR) and the manner and frequency at which the NPESR is produced.

2. FUTURE and PICES Member States

Like several other aspects of FUTURE, the added value to the science being done by PICES members is not the same for the three elements of FUTURE: ocean-climate forecasting, the communications and outreach, and the coastal pressures and cumulative impacts. As explained below, there are already clear benefits being received from some aspects of FUTURE, and in many ways this is already adding value to the work of individual scientists and investments of member countries. The realization of the full potential of FUTURE is not assured however, unless some problems identified in the progress reported in Section 3 are addressed effectively, including making some structural changes as discussed in section 4.

The work done for ocean-climate forecasting is inherently collaborative, large-scale science, and much of the work to this point has been possible only because of the multi-national and multi-disciplinary interactions of the PICES science community. However, just as the NEMURO modelling did not specifically come about because of CCCC, the collaborating scientists in the ocean-climate forecasting work of FUTURE did not come together because of FUTURE. However, in FUTURE as in CCCC, the synergistic efforts of individual scientists benefitted greatly from opportunities it presented. With FUTURE as the structuring framework for these opportunities to collaborate, the contributing scientists, and their host institutions and countries, have obtained significant added value from FUTURE.

The picture is slightly different with the communications and outreach work of FUTURE. There are examples of many FUTURE-related projects on coastal pressures and occasionally climate-forecasting questions which have included products consistent with the communications and outreach aspects of FUTURE. Although these are providing benefits, most are better presented as “local accomplishments” and not as PICES-scale products. Nevertheless they have received significant added value from FUTURE, both through receiving greater impetus from FUTURE to produce a broad range of products rather than exclusively papers for scientific audiences, and through sharing experience and building capacity for communicating in a broader range of ways and with more diverse audiences. However, to this point there have been few PICES-scale communications products from FUTURE that provide clear benefits. Reasons for this are discussed in Section 3, and if issues raised there are addressed, there is confidence that significant added value to PICES members could be enjoyed from this aspect of FUTURE as well, because the planning for such products has been excellent.

With regard to the *coastal pressures and cumulative impacts* elements within the FUTURE framework, few direct benefits have been realized to this point. Section 3 will again discuss reasons for slow progress, but it should be noted that the added value of nesting such work in an international science program like FUTURE may be inherently more difficult to document than the added value of the *ocean-climate forecasting* or *communications and outreach* elements of FUTURE. In direct contrast to the inherently international scale of much of the ocean-climate forecasting work in FUTURE, much of the work on coastal pressures and cumulative impacts is inherently national and subnational in scale. The added value potentially

provided by PICES and FUTURE would be in improved efficiencies of inherently local studies. If issues discussed in Section 3 are addressed, potential added value from FUTURE could be expected in at least three aspects of these coastal issues. The class of benefits would be

- extraction of lessons learned from replicates of local-scale assessments of impacts of individual pressures;
- building on the first, identification of best practices for how to quantify a pressure and its impacts and how to assess interactions and cumulative effects, so scientists working on common pressures or assessment issues would not have to reinvent solutions to each local occurrence.
- providing an expert forum for quality assurance on individual national or sub-national scale studies of pressures, impacts and cumulative effects assessments.

There are examples of some of these benefits from past PICES work, such as with alien invasive species. However the coastal pressures and cumulative impacts element of FUTURE has had such trouble attracting critical mass that these potential added values are rarely being realized, and even where limited successes in the three types of benefits are found, they have not been produced under the FUTURE framework.

Despite the shortcomings in providing direct value added by some parts of FUTURE, at least to this point, the Evaluation Panel has noted that throughout this Open Science Meeting, many talks either acknowledged the FUTURE vision in their wrap-up slides and/or it was clear to the Evaluation Panel that the work fit into the FUTURE vision statement. Many talks, including a number from participants new to PICES, also demonstrated some knowledge of the FUTURE program, showing that it has influenced thinking and problem formation at the scale of individual researchers.

This influence on thinking and planning by the science community demonstrates an important class of benefits from FUTURE, beyond specific science or communications products from specific research projects, whether the projects themselves are small-scale and individual or large-scale and highly collaborative. FUTURE is providing a place for collaboration and building of an interdisciplinary community, which is beneficial to scientists within the PICES member countries. It is also providing a focus for work by giving it a higher priority at scientist or institutional level. There is real value added from serving as a forum for such collaboration and building of community. Through such linkages the individual scientists become better at their work, receive constructive challenge and exposure to a greater diversity of scientific perspectives on a problem, and have opportunities to place their own research in much larger contexts of the experience of other researchers working on similar problems elsewhere.

3. Mid-term Progress Report on FUTURE Science Plan

The FUTURE Science Plan includes a series of specific science questions in the Research Themes. As with the value added from FUTURE (Section 2), progress on the questions is quite different for the three elements of FUTURE. Progress is excellent on work related to the ocean-climate forecasting elements of FUTURE, quite spotty on the work related to communications and

outreach elements, and even more mixed, often slow or disappointing, for the work on coastal pressures and cumulative impacts elements. These situations, contributing factors, implications, and some potential remedies, when needed, are discussed below.

3a. Ocean - Climate Forecasting work under the COVE Advisory Panel

PICES' work related to ocean-climate forecasting elements of the FUTURE Science Plan is well developed and underway. This is in part due to the momentum of previous work under CCCC that has been carried through to Working Group 27 and Working Group 29, both of which are conducting work relevant to this element of FUTURE. Although the CCCC modelling was primarily backward-looking, that work set a clear foundation for the forward-looking focus of FUTURE modelling. Additionally, these Working Groups are based in natural sciences and the mandate for these sciences in the FUTURE Science Plan is very clear. Working Group 27 has updated the synthesis of climate processes in the North Pacific and has identified the climate forcing functions that are relevant to specific North Pacific ecosystems. The Working Group has also interpreted the IPCC 5th Assessment Report projections in the context of North Pacific climate dynamics. Working Group 29 has completed a comprehensive review of existing, and developed new, Regional Climate Models in the North Pacific and assessed their potential and performance for downscaling. The Working Group will produce bias maps for outlooks and a forecast map that can be applied to regional ecosystem modeling studies. Overall, the ocean-climate forecasting work conducted is highly respected internationally, and has contributed to PICES international recognition.

The next phase for ocean-climate forecasting work should be to integrate with the biological and social sciences Expert Groups of PICES. For example, coordination with Working Group 29 and S-CCME would facilitate integration of Working Group 29 forecasts into S-CCME efforts to forecast climate change impacts on commercial fisheries. There also is a need in FUTURE science for 1-3 year and 5-10 year forecasts of climate and ocean modeling in addition to the current 50-100 year projections. Such forecasts, although challenging scientifically, would assist FUTURE with exploring and eventually forecasting ecosystem responses to ENSO and decadal climate events.

One of the challenges for ocean-climate forecasting work is the attraction of young scientists to PICES from the natural sciences. The Evaluation Panel heard from the COVE Advisory Panel Chair that young scientists in this field are focused mainly on research within their discipline in order to produce publications that are supportive of securing first-time jobs. Inter-disciplinary research in the natural sciences is often a focus for later career scientists.

3b. Communications and Outreach work under the SOFE Advisory Panel

The Evaluation Panel found that good planning for some science communications products with potentially broad audiences has been completed. However, the SOFE Advisory Panel and FUTURE have no internal mechanisms to implement this planning, so action on the plans depends on individuals and other components of the PICES organization. So far uptake of

FUTURE guidance by the other parts of PICES, and action on intersessional work, has been uneven and unsystematic. This has meant that on the positive side, a number of project-scale cases are available, where the communications and outreach part of work under various aspects of FUTURE, and PICES more generally, effectively reached a wider range of audiences. On the other hand, plans by the SOFE Advisory Panel for several intermediate and long-term communications and outreach products have made slow progress in implementation. Some of these products are directly linked to FUTURE, some are for PICES more generally (such as the next NPESR), but all require contributions from many cooperating expert sources. However, no mechanism for systematically delivering those products within PICES has been identified. Some individuals, PICES groups, and/or countries have completed their parts of these larger initiatives, whereas others have not. If the products are not filled out by supporting contributions from all the necessary PICES parties, not only will potential benefits of these more ambitious communications products not be realized, but efforts of participants that did contribute risk being dissipated.

The above recognizes two issues that make difficult the delivery of the communications and outreach elements of FUTURE. First, communication and outreach are tasks that straddle FUTURE and PICES, without sufficiently clear division of what fall under the Secretariat and under FUTURE implementation. Second, it is not clear whom the parts of FUTURE need to communicate and outreach to, as the client focus would determine the type of action followed. In order to facilitate the work currently allocated to the SOFE Advisory Panel the Evaluation Panel suggests that FUTURE give priority to research impact activities, rather than communication and outreach in their broader sense. Research impact is defined as the demonstrable contribution that research makes to the economy, society, culture, public policy or services, health, the environment or quality of life, beyond academia. The measurement of impact, as opposed to generic communication and outreach, has become a dominant measure of success in research-based organizations. It is not enough just to focus on activities and outputs that promote impact on scientific peers, such as staging a conference or publishing a report. PICES and FUTURE must be able to provide evidence of research impact, for example, that research results have been taken up and used by policy makers and practitioners, and/or led to improvements in services or businesses in its member countries. This transition demands a much clearer commitment by PICES members, both as institutions and as individuals, to the research impacts aspects of FUTURE.

Potential Actions regarding the work currently under SOFE Advisory Panel:

One necessary measure is a much clearer commitment by PICES members, both as institutions and as individuals, to the communications and outreach elements of FUTURE. Even if individuals vary in their motivation and aptitude for communicating science to diverse audiences, if PICES and FUTURE are going to have these more ambitious products, there has to at least be a sense of responsibility of all associated with PICES to provide the necessary information within their expertise in a timely manner.

To strengthen the necessary commitments, the Evaluation Panel **RECOMMENDS** that the other parts of PICES (Committees, Working Groups etc.) review plans of the SOFE Advisory Panel (or

its institutional successor) at their group meetings, assign explicit responsibility for delivery of specified science inputs to specified deadlines, and establish follow-up mechanisms to ensure the responsibilities are met. This measure is intended to facilitate the greater accountability for supporting FUTURE communications products.

Additional actions are needed, though, for the communications and outreach parts of FUTURE to realize their full potential. Correspondingly, the Evaluation Panel **RECOMMENDS** that members of the SOFE Advisory Panel (or its institutional successor) and other Expert Groups work together to more systematically identify who are the target audiences for various types of information and products, and the nature of products best suited for those audiences.

The Evaluation Panel also **RECOMMENDS** that the communications and outreach part of FUTURE itself review the impact of various types of information, packaged and delivered in various ways. In the FUTURE context, one way “impact” can occur is when the products increase awareness of PICES and FUTURE science in the wider community of stakeholders and general public. This type of impact, of a more informed citizenry, does have benefits, but often in the longer term and indirectly. It is also the type of impact referenced most often in the presentations at the relevant sessions of this Open Science Meeting. More attention is needed to products with more direct impact, however; products for governments and regulatory agencies that inform them of important science issues that they should be considering in their work. There is sometimes concern that such products may politicize science, particularly in organizations where member Parties may have different processes and cultures for how science experts communicate with the public and decision-makers on high-profile topics. Fortunately, there is extensive experience and guidance on how science products can be developed and delivered to be “policy relevant without being policy prescriptive” to use a phrase well established in the IPCC and World Ocean Assessment processes, where such guidance can be found. The communications and outreach elements of FUTURE can serve a vital role in ensuring the work of FUTURE has full benefit, by helping the science results to bring important marine issues onto the agendas of appropriate agencies, and by informing the discussion within these agencies about the likelihood of various outcomes under different policy and management scenarios.

The experience of several scientists associated with FUTURE in the IPCC 5th Assessment Report is a valuable resource on which to strengthen this role. However, in the modern world many new modes of communication are emerging, often built around social media. Engagement of younger scientists, who often may be more familiar with the new tools, will also be necessary for FUTURE communications and outreach to fully deliver its role. And of course the intent is to communicate the science progress of FUTURE broadly. Hence solid and on-going communication with the other parts of FUTURE remains essential. The Evaluation Panel is satisfied this is well understood by those who have been directly engaged in the SOFE Advisory Panel, but the organization of FUTURE activities needs to facilitate continuing two-way communication between those focused on communications and outreach as an activity and the rest of FUTURE (See Section 4).

3c. Coastal Pressures and Cumulative Impact Assessments under the AICE Advisory Panel

The Evaluation Panel concludes that the least progress has been made on the FUTURE goals related to coastal pressures and cumulative impacts. The challenges were inherently large because there is such a wide range of anthropogenic pressures and many are expressed on local scales (although often with many replications of the pressures at various coastal sites around the North Pacific). Significant progress at the PICES scale on such problems would require both a clearly defined role for FUTURE and the AICE Advisory Panel (or its institutional successor), and ongoing strong engagement by a large number of experts.

Although the FUTURE Science Plan and Implementation Plan lack detail about what exact role should be filled by the coastal pressures and cumulative impact work, and particularly what activities should be undertaken by that part of FUTURE, the existing AICE Advisory Panel leadership communicated a vision of a realistic role in facilitating progress on the coastal aspects of FUTURE, with two central themes. First, they see the value of the coastal part of FUTURE as a forum where countries could share experiences with evaluating the impacts of individual pressures on coastal ecosystems, and develop best practices for such assessments and for planning the shared knowledge of potential impacts. Second they see the value of coastal FUTURE groups for developing and testing methods for integrated assessments of cumulative impacts of multiple stressors. These are good foundations for the coastal pressures and cumulative assessments aspects of FUTURE. However, more action is needed to build on this foundation.

For the latter role, in fact, Working Group 28 has devoted substantial effort to evaluating methods for cumulative impact assessments. In setting up its interviews, however, the Evaluation Panel was somewhat surprised to hear that Working Group 28 did not see any particular linkage nor accountability to the AICE Advisory Panel, so this progress was made with little direct connection to FUTURE. With regard to best practices for evaluating impacts of individual pressures on coastal systems, to this point the AICE Advisory Panel has been able to provide little coordination, because it has no Working Groups it can direct, and participation at its meeting has been minimal. It is impossible to fill a coordination role effectively when neither direct nor indirect pathways to the expert communities are working effectively, and groups that are working effectively feel no accountability to the AICE Advisory Panel. Consequently the lack of progress on the coastal elements of FUTURE, although concerning, is understandable.

Potential actions regarding work currently under AICE Advisory Panel:

Several actions are needed if the coastal component of FUTURE is to be delivered. Two are institutional, and if both are not addressed, the other actions will be able to achieve little.

Above all, the Evaluation Panel **RECOMMENDS** that PICES countries and experts need to greatly increase their investment in the PICES activities related to coastal pressures and cumulative assessments. The Evaluation Panel is satisfied that at the national and subnational level of all members, there is substantial work being done on coastal issues. However if the people doing

the work do not come to PICES meetings, and attend relevant activities at the meetings, experiences cannot be shared effectively and planning cannot be coordinated well for added value of coordinated work. In addition, the Evaluation Panel **RECOMMENDS** that a greater accountability be established for all the expert groups of PICES addressing coastal issues, relative to the specific FUTURE Science Plan and Implementation Plan. This greater accountability is likely to require structural changes in FUTURE and PICES, as discussed in Section 4.

If the critical mass and accountability issues are addressed, then AICE (or its institutional successor) can plan and implement work on coastal issues more effectively. The Evaluation Panel sees two urgent priorities to address in this planning and subsequent implementation, and two other valuable actions that could be addressed once the priority needs are being addressed.

First, the Evaluation Panel **RECOMMENDS** that the AICE Advisory Panel (or its institutional successor) work with Working Group 28 participants, to see the degree to which that Working Group has successfully identified best practices for cumulative impact assessments, systematized them into operational frameworks, and made these frameworks available to practitioners around the North Pacific. If this review concludes the job is complete to the extent possible with existing knowledge, then this aspect of the FUTURE coastal component gets marked down as complete, and focus shifts elsewhere. If progress has been made but work remains, the Evaluation Panel **RECOMMENDS** that a 5 year plan for completing that work within the FUTURE framework should be developed.

Second, the Evaluation Panel **RECOMMENDS** that the AICE Advisory Panel (or its institutional replacement) work with all members of PICES to identify one or two coastal pressures of interest to all members, and make those selected pressures its priority at least for the next few years. Several candidate themes were discussed by the Evaluation Panel, including acidification, hypoxia, oil spills, and chemical pollution. However, the Evaluation Panel concluded that it lacked both the coastal knowledge and the mandate to pick the most promising themes, and rather encourage PICES and FUTURE to make these thematic choices as quickly as possible, so there is adequate time to plan, implement, and synthesize results of focused multi-national comparative activities within the lifespan of FUTURE.

Two other activities are also encouraged. First, one of the overarching goals of FUTURE was to strengthen the human dimensions aspects of PICES science. It was clear to the Evaluation Panel throughout the Workshops and Science Sessions at the 2014 FUTURE Open Science Meeting that there has been a growing engagement of social scientists in PICES work and the appetite for such engagement can be found in every part of the FUTURE science activities. However, there is an impression that to this point the engagement of experts in the human dimensions aspects of FUTURE science has been largely opportunistic (although often very effective when it has happened). It appears that there may now be a crucial mass of such expertise interested in FUTURE and PICES activities. This input is crucial to the coastal elements of FUTURE, and the Evaluation Panel **RECOMMENDS** that more systematic planning be undertaken to identify what

human dimensions aspects are priorities for FUTURE coastal themes, and how the appropriate expertise will be attracted and structured.

Second, a core part of FUTURE is forecasting. The Evaluation Panel has seen little evidence of any discussion of how to include more forecasting within the coastal component of FUTURE, although the relevance of forecasting to coastal issues is just as high as the relevance of forecasting to offshore climate issues. The forecasting of coastal components may pose different challenges and need different tools (e.g. probably finer spatial resolution, more attention to dispersion processes and land-based inputs, etc.), but that is all the more reason to strengthen communication between the PICES forecasting community and the PICES coastal expert community.

4. Governance Structure

Upon reflection of the above points, the Evaluation Panel suggests a number of changes to the governance structure of the FUTURE program.

Key elements of a successful interdisciplinary, multinational research program include a clear commitment of resources, scientific and institutional leadership, and accountability for delivery of products and impacts, and participants with enough time to devote to providing the leadership that is required for a complex research program. Resources need to be available within countries to enable research relevant to the program to be undertaken, to allow scientists involved in the research to engage in effective collaboration with peers from other disciplines and nations, to travel to PICES annual and expert meetings, and to support the oversight of the program. The majority of international interdisciplinary programs, such as FUTURE, are dependent on a large number of participants who are able to dedicate significant amounts of their time to provide the leadership, coordination, and delivery required by the program.

The current governance structure of the FUTURE program was designed to ensure that the program was well embedded in the structure of PICES. This was to enable the program to take advantage of the existing PICES organizational structure and to ensure that the PICES Science Board had a very good overview of FUTURE activities and progress. In the current governance structure the Chair of the Science Board is also the Chair of the Scientific Steering Committee for FUTURE and the Science Board acts as the Scientific Steering Committee for FUTURE. There are also three Advisory Panels, COVE, AICE and SOFE, which provide guidance on the scientific direction and implementation of FUTURE to the Science Board. The chairs of these Advisory Panels are members of the Science Board, sharing one vote on it. The work of FUTURE is expected to be conducted by the Science Board Committees and their related Expert Groups.

The current governance structure for FUTURE has not been shown to be fully effective in providing leadership, scientific oversight and coordination for the program for a wide range of reasons. The Advisory Panel chairs were to lead FUTURE, but were not empowered to do so since they could only advise and not implement; the Science Board did have the authority to implement but did not ensure delivery of FUTURE activities for the AICE and SOFE Advisory Panels and did not hold the Committees accountable for lack of progress; the Governing

Council did not hold Science Board accountable for lack of progress on the implementation of FUTURE.

All of these factors led to a lack of institutional leadership, accountability and ownership, scientific oversight, and commitment to the program in some areas. In addition, the Science Board Chair and members have significant calls on their time to support the wider activities of the Science Board making it difficult for them to dedicate enough time for either meetings or intersessional activities focused solely on FUTURE. These shortcomings in governance will become a more severe problem as the program matures and moves towards the synthesis of the activities which are needed to enable the program to reach its full potential.

The Evaluation Panel **RECOMMENDS** a change to the governance structure of FUTURE which we believe will provide improved scientific oversight, coordination, leadership, and accountability for the program while ensuring that the program remains embedded in the structure of PICES. Embedding FUTURE in PICES should enable the program to take advantage of the PICES organizational structure and ensure that the PICES Science Board retains oversight of all PICES science programs.

The Evaluation Panel **RECOMMENDS** the establishment of the FUTURE Scientific Steering Committee (SSC) with a separate Chair supported by two Vice-Chairs. These individuals, committed to FUTURE, would be members of the Science Board. Between these three leadership positions there would be clear representation of the major elements of FUTURE; ocean-climate forecasting, coastal pressures and cumulative impact assessments, and communication and outreach. The SSC membership should include two representatives from each member country, stratified to ensure that there is at least one member from each Committee, and a balance across the three elements of FUTURE. If necessary to achieve the complex balance of countries, scientific disciplines, and aspects of FUTURE, additional members might be appointed on an as needed basis, and following full official practices. In the formation of the SSC, the inclusion of early career scientists should also be considered.

The Committee representatives on the FUTURE SSC would be charged with ensuring clear and effective communication between their Committee and related Expert Groups and the FUTURE SSC. The FUTURE SSC members would also be charged with ensuring that there is effective communication of all FUTURE activities to their national science communities. The FUTURE SSC will keep under review the Terms of Reference of existing Expert Groups, where necessary frame new Terms of Reference related to FUTURE activities for these Expert Groups, and where appropriate propose new groups, working through Science Board. The FUTURE SSC Chairs and Vice-Chairs would take all recommendations from FUTURE SSC to the Science Board for discussion and implementation.

FUTURE SSC members from the Committees would report annually to the FUTURE SSC on progress on relevant Terms of Reference. The FUTURE SSC would consider progress and make recommendations to address opportunities or impediments to progress as per the preceding paragraph. The Science Board would report annually to the Governing Council on the progress and status of the FUTURE program. This report should be prepared jointly by the Chair of

Science Board and the Chair of FUTURE SSC. Although in the short-term the FUTURE SSC is not expected to directly oversee Expert Groups, there might be a need for Expert Groups reporting directly to the FUTURE SSC for specific synthesis activities that are required at the later stage of the FUTURE program.

The responsibilities of the Scientific Steering Committee for FUTURE are outlined below as a draft Terms of Reference:

1. To provide leadership and scientific direction to FUTURE and its structures in implementing its Science and Implementation Plans.
2. To work with PICES Scientific Committees, Working Groups, Study Groups, Sections and the FUTURE Advisory Panels to ensure collective and integrated delivery of FUTURE.
3. To integrate, promote and stimulate national activities around the vision statement of FUTURE.
4. To identify and facilitate interactions with national/international research programs from which FUTURE could benefit.
5. To ensure that FUTURE research and products translate into high level impacts for PICES and its member countries
6. To facilitate the engagement of a wider range of scientific expertise, including early career scientists and social scientists, in FUTURE activities.

Given that the FUTURE program only has five more years in its lifespan, in order for the FUTURE program to fully benefit from these changes, they would need to be implemented by the end of 2014. The Evaluation Panel notes that there may be administrative impediments, but **RECOMMENDS** that these changes be implemented as swiftly as possible.

5. Other Issues

The FUTURE Implementation Plan for the FUTURE Science Program will need to be reviewed and updated by the FUTURE SSC in 2015. This review will need to include a review of the science questions for FUTURE to ensure they are all still relevant, the accountabilities for delivering FUTURE given the new governance structure for FUTURE, and a clear way forward for the synthesis of the FUTURE program. We recommend that this report be widely circulated across the PICES community, both to inform that review, and more generally to ensure that the background to the recommendations is fully understood and to facilitate collective and synergistic solutions at all levels.

ANNEX 1 Evaluation Panel Members

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Annex 2 Specific Questions and sub-questions related to Research Themes, and Anticipated Benefits, from the FUTURE Science Plan

FUTURE is organized around three research themes that are best characterized as key questions. Each of the key questions has a list of more specific questions that define an approach to address a research theme.

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 structure² affect the relationships between ecosystem components³?
 - 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?
2. How do ecosystems respond to natural and anthropogenic forcing, and how might they change in the future?
 - 2.1. How have the important physical, chemical and biological processes changed, how are they changing, and how might they change as a result of climate change and human activities?
 - 2.2. What factors might be mediating changes in the physical, chemical and biological processes?
 - 2.3. How does physical forcing, including climate variability and climate change, affect the processes underlying ecosystem structure and function?
 - 2.4. How do human uses of marine resources affect the processes underlying ecosystem structure and function?
 - 2.5. How are human uses of marine resources affected by changes in ecosystem structure and function?
 - 2.6. How can understanding of these ecosystem processes and relationships, as addressed in the preceding sub-questions, be used to forecast ecosystem response?
 - 2.7. What are the consequences of projected climate changes for the ecosystems and their goods and Services?
3. How do human activities affect coastal ecosystems and how are societies affected by changes in these ecosystems?
 - 3.1. What are the dominant anthropogenic pressures in coastal marine ecosystems and how are they changing?
 - 3.2. How are these anthropogenic pressures and climate forcings, including sea level rise, affecting nearshore and coastal ecosystems and their interactions with offshore and terrestrial systems?
 - 3.3. How do multiple anthropogenic stressors interact to alter the structure and function of the systems, and what are the cumulative effects?
 - 3.4. What will be the consequences of projected coastal ecosystem changes and what is the predictability and uncertainty of forecasted changes?
 - 3.5. How can we effectively use our understanding of coastal ecosystem processes and mechanisms to identify the nature and causes of ecosystem changes and to develop strategies for sustainable use?

² Such as species composition, population structure and dynamics, *etc.*

³ Such as species interactions, habitat usage, biological rates and biological diversity.

The scientific research, communication and outreach that occur during the 10-year life of FUTURE will increase understanding of the processes and mechanisms regulating ecosystems of the North Pacific and provide a sound scientific basis for developing scenarios of ecosystem response to climate change and other human-use influences. The anticipated benefits and products will include:

- Increased understanding of physical, chemical and biological linkages and ecosystem responses to anthropogenic and climate forcings;
- Coordinated monitoring and descriptions of the current state of ecosystems;
- Forecasts of future states of North Pacific marine ecosystems and their associated uncertainty;
- Better quantitative and qualitative forecasts, with specified uncertainty, of ecosystem responses to climate change and increasing human influence;
- IPCC-like reports on responses of North Pacific ecosystems to climate change;
- An improved scientific basis for managing coastal ecosystems to sustain ecosystem services and to mitigate various environmental problems;
- Quantification of the benefits and risks associated with different management strategies;
- Region-specific assessments of topical issues (*e.g.*, harmful algal blooms, eutrophication, native and alien species range changes, anoxia, and ocean acidification);
- Increased data sharing, access and dissemination with a focus on coordination and metadata.
- Increased marine science capabilities in PICES member countries;
- Increased participation in PICES of younger scientists and a greater role for social and economic scientists;
- Increased public awareness of the ecosystem changes in the North Pacific.

FUTURE will improve understanding of the North Pacific Ocean, including its climate, biological processes and human communities, and will enhance wise use of this information by governments and society at large.