

## Marine Environmental Committee in review

**Richard F. Addison<sup>1\*</sup>, John E. Stein<sup>2</sup> and Alexander V. Tkalin<sup>3</sup>**

<sup>1</sup> Institute of Ocean Sciences, Sidney, B.C., Canada V8L 4B2. E-mail: AddisonR@pac.dfo-mpo.gc.ca

<sup>2</sup> Northwest Fisheries Science Center, National Marine Fisheries Service, NOAA, Seattle, WA 98112, U.S.A. E-mail: John.E.Stein@noaa.gov

<sup>3</sup> UNDP Tumen River Project, 3-1-52 Tayuan Diplomatic Compound, 1 Xindong Road, Chaoyang District, Beijing, People's Republic of China 100600. E-mail: atkalin@public.un.org.cn

\* Present address: 121 Graham Dr., Saltspring Is., B.C., Canada. V8K 1J5

### The history of MEQ and its Working Groups

The North Pacific Marine Science Organization — PICES — was envisaged as long ago as the late 1970s, and an organizational structure was negotiated in 1987. The first scientific plans for the Marine Environmental Quality Committee (MEQ) were outlined at a PICES Scientific Workshop held in December 1991, in Seattle. In a review of that workshop, presented at the PICES First Annual Meeting (PICES I) in 1992, Dr. Usha Varanasi from the U.S.A. identified five research issues of importance:

- nutrient loading and eutrophication,
- chronic and persistent chemical pollutants (all high priority issues and of lower priority),
- the role of the North Pacific in waste disposal,
- large scale environmental impacts, and
- biological community impacts due to exploitation.

Following discussions at PICES I (Victoria, Canada), the MEQ report to the PICES Science Board re-cast these priorities identifying two topics as being particularly important:

- harmful algal blooms (HAB), and
- chemical and biological contaminants.

However, the discussions at PICES I had obviously ranged fairly widely. It was recognized, for example, that the focus of most member countries was on coastal rather than “open ocean” pollution. This issue of whether MEQ should focus its efforts within PICES on coastal or on open ocean is not fully resolved even now. There was also some discussion about need for calibration of environmental assessments under the heading of “common assessment

methodology”. It had been suggested that MEQ should select:

- suitable species for monitoring of the status and trends in fate and effects of chemical contaminants in the North Pacific, and
- a suite of chemicals or other environmental pollution-related phenomena for the open ocean that would be related to effects on indicator species.

The Committee recommended that a scientific session of MEQ at the next Annual Meeting should focus on “Assessment techniques and methodology in MEQ”, with an emphasis on two main issues: HAB and chemical and biological contaminants. Partly in response to these discussions, the PICES Governing Council established a Working Group 2 (WG 2) to formulate approaches to the “Development of common assessment methodology for marine pollution” under the auspices of MEQ.

The “science” activities of MEQ began seriously at PICES II (Seattle, U.S.A.) in 1993, with WG 2's first meeting. Background papers had been solicited from all member countries (at that time, Canada, Japan, People's Republic of China, and U.S.A.), summarising their concerns about marine pollution. “Pollution” had been interpreted to cover a wide range of stresses, not just chemical contamination, but also pathogens, HABs, etc. As noted above, most countries focussed on coastal rather than open ocean concerns, because the coastal zone is where many human activities have their most direct impact. The reports noted that the chemicals of concern were persistent organic pollutants (*e.g.*, PCBs, DDTs, dioxins), metals, oil-related compounds (*e.g.*, polynuclear aromatic

hydrocarbons, PAH) and radionuclides, but there was a growing interest in eutrophication and harmful algal blooms.

WG 2 recommended that PICES:

- organize a session to review approaches to assessing the impact of stressors at the ecosystem level, and
- sponsor a practical workshop to address some of these issues.

This recommendation was endorsed by MEQ at PICES II. The approach proposed was to convene a session at PICES III (Nemuro, Japan) to discuss how to measure biological impacts, and to outline the organization of the practical workshop. This was also endorsed by MEQ but with much discussion about where a workshop should (or could) be held, and what problems it would address. Ideally, MEQ would look for a site to hold the workshop where problems existed that were of interest to all member countries. Site selection was important because the location for the workshop needed: (1) to afford the opportunity to have maximum participation by scientists from member countries, (2) have been studied previously so that selection of actual sampling sites would afford the types of samples necessary to test and compare different biological and chemical assessment techniques. The latter was critical, because the longer-term goal was to work towards harmonization of assessment methodologies used by PICES member countries. Harmonization is a key factor in improving inter-comparability among studies. Without the ability to use results from multiple studies with a known degree of confidence, scientists are severely limited in making trans-Pacific assessments of the status and trends in chemical contaminant levels in marine biota, much less assessments of relative magnitudes of biological effects in indicator species.

The MEQ session at PICES III had as its theme “Interdisciplinary methodology to better assess and predict the impact of pollutants on structure and function of marine ecosystems”; 11 papers were presented on various approaches to the subject. Many of these focused on the relationship between the presence of contaminants and their effects on organisms at the biochemical, or whole organism, level or on communities. There was

general agreement that chemical analyses and biological effects measurements were each valuable by themselves, but were of considerably more value when combined. A future practical workshop should build upon this theme, and ideally should be held in the western Pacific area. Also at PICES III there was considerable discussion around the issue of the scale at which MEQ should focus with regard to human impacts to marine environmental quality. The discussion centered on the question of what stressors could have the biggest impact on the ecological processes of the North Pacific? The discussion ranged from changes in hydrologic regimes of rivers and their consequences to coastal areas, to climate change and long-range transport of pollutants. The international Arctic Monitoring and Assessment Program (AMAP) was providing solid evidence that long-range transport of certain persistent organic pollutants (“POPs”) was the major source of these contaminants to Arctic ecosystems. In addition, there was preliminary evidence of a trans-Pacific transport (west to east) of pollutants associated with combustion of fossil fuels (*e.g.*, NO<sub>x</sub> and SO<sub>x</sub>), and that they could be affecting relatively pristine forest ecosystems of the Pacific Northwest.

One consequence of these two issues was a major change in the direction of WG 2. Whereas previously it had focused on “development of common assessment methodology”, WG 2 now proposed to amend its terms of reference to (a) draft a work plan for a workshop in the East China Sea area (probably focusing on the impact of the Three Gorges project); and (b) to put the workshop in place by 1997. The Three Gorges Project would lead to a major change in the sediment budget to the South China Sea; the impact could be substantial. While this project could have considerable ecological impact on marine waters of the PICES region, conducting a scientific study related to the project was felt by many to be very challenging. Perhaps more than for any other committee in PICES, MEQ, through its scientific work, most directly addresses issues that are controversial and can bring attention to the ecological impacts of human actions. MEQ endorsed this proposal while recognizing the challenges, and WG 2 was re-cast as WG 8 with essentially those terms of reference.

Qingdao, People's Republic of China, was the site for PICES IV. At this meeting, WG 8 consulted with its Chinese members on the feasibility of using the Three Gorges Project as the focus of the workshop. It was concluded that it could be a very lengthy process to get the necessary approvals for a workshop with such a focus. Consequently, WG 8 and MEQ accepted an offer from the Academia Sinica Institute of Oceanology at Qingdao to base the workshop there, with Jiaozhou Bay as the study area, and the focus would be chemical contaminants. Jiaozhou Bay was attractive scientifically, because the Academia Sinica had already accumulated a large body of "baseline" data on the Bay, and good laboratory facilities were available at the Institute of Oceanology. MEQ fully supported this initiative. Throughout the following year, a considerable body of data pertaining to Jiaozhou Bay was assembled (and in some cases translated) and refinements to the operational plan for the practical workshop were developed.

The MEQ scientific session at PICES IV on "Sources, transport and impact of chemical contaminants" provided further background and suggestions for approaches to be used at the practical workshop.

Since one of the first decisions by MEQ was to focus on HABs in addition to chemical pollution, MEQ decided that it should not focus exclusively on the practical workshop. The Committee recommended that PICES V should include a joint session with BIO on HABs as a means to initiate activity on this subject. There was growing evidence that the frequency of HABs appeared to be increasing worldwide and to be having significant ecological (mass die-offs) and economic (depressed shellfish harvests) impacts.

During 1996, there was extensive work by WG 8 on refining plans for the practical workshop, and a detailed work plan with cost estimates was presented to MEQ, approved, and sent to the Science Board at PICES V in Nanaimo, Canada. The workshop was envisaged as involving 2-4 scientists from each member country (now six, since Republic of Korea and Russia had joined PICES), and a detailed list of samples (sediment, water and biota), and analyses (chemical and

biological) to be carried out was provided. Since Jiaozhou Bay is a fairly heavily industrialised system, a "reference" site at nearby Laoshan Bay would also be analysed. The workshop was finally scheduled for 2-3 weeks during spring or summer of 1997 (June to October). This was a major step forward for MEQ to bring together what would be the first collaborative scientific effort involving practical field studies by a PICES Scientific Committee.

On the advice of our Chinese scientific colleagues, two formal requests were made to the appropriate Chinese authorities to hold the workshop in Qingdao. However, a formal reply was not forthcoming in time to hold the workshop in 1997, and it had to be postponed for at least a year. At PICES VI (Pusan, Republic of Korea) it was agreed that if no formal approval could be obtained by January 1998 from Chinese authorities to hold the workshop in summer 1998, an alternative study site would be chosen. The general logistic considerations would still apply, but we would clearly have to assemble "background" information about the chemical, physical and biological oceanography of the new site.

In addition to dealing with the planning of the practical workshop, MEQ sponsored a session on "Processes of contaminant cycling" which focussed primarily on processes occurring in the coastal zone; many examples of these processes were based on data from Masan and Chinhae Bays. MEQ also concluded that a new priority area that deserved attention was the issue of aquaculture or mariculture. With the decline in wild fish landings and an increasing global demand for seafood, the culture of fish and shellfish will likely continue to expand and would become a larger portion of the economic base of the seafood industry worldwide. Associated with this growth are increasing concerns about deleterious ecological effects from increased eutrophication and habitat degradation, about antibiotics as a potential chemical pollutants, and about escaped cultured (often "exotic") species.

In early 1998, a reply was received from the Chinese authorities stating that it would not be possible to host the practical workshop at

Qingdao. In light of this decision, and given the amount of work that had gone into planning the workshop, much of the discussion at PICES VII (Fairbanks, U.S.A.) centred on the issue of finding an alternative study area for the workshop. Vancouver Harbour, British Columbia, Canada, was chosen. There were a number of practical reasons for the choice, such as the availability of laboratory facilities at the West Vancouver Laboratory of Canada's Department of Fisheries and Oceans, the availability of appropriate "background" information, and other logistical considerations, which would allow the workshop to proceed without undue delay. This proposal was approved by both MEQ and the Governing Council, and WG 8 revised its work plans accordingly.

The focus of the MEQ sessions at PICES VII was on "Contaminants in high trophic level biota -- linkages between individual and population responses" (jointly sponsored with BIO) and "Science and technology for environmentally sustainable mariculture". This second session indicated a shift in emphasis away from chemical contaminant issues and towards the more biological aspects of marine environmental quality. The recognition of HABs as an area needing additional attention had matured with the establishment of specific national research initiatives (*e.g.*, US ECOHAB), as well as internationally through GEOHAB. These programs were providing support to a number of scientists, which increased the likelihood that they could participate in a PICES-directed effort that would likely significantly improve understanding of HAB events and their ecological impacts.

1999 was a special year in the history of MEQ, because the practical workshop was held in the spring at Vancouver. A full report of the workshop and the data collected are available as PICES Scientific Report No. 16. Briefly, 24 scientists from all PICES member countries participated making a range of measurements including chemical, biochemical, pathological, physiological, anatomical and ecological analyses in Vancouver Harbour over a period of about two weeks. Although the raw data are in the PICES Scientific Report, a more valuable product, in the sense of highlighting internationally PICES' (and

MEQ's) environmental studies, is the selection of refereed papers that will appear as a special issue of *Marine Environmental Research*. (At the time of writing, these are being refereed.)

At PICES VIII (Vladivostok, Russia), two sessions were organized by MEQ, one comprising 12 papers on "Ecological impacts of oil spills" (which attracted overflow attendance) and a second (jointly with BIO) on "Coastal eutrophication, phytoplankton dynamics and harmful algal blooms". Following these meetings, and discussions within the Committee, MEQ decided to recommend the formation of a Working Group on "Ecology of harmful algal blooms in the North Pacific" (WG 15); this was approved by the Governing Council.

At PICES IX (Hakodate, Japan), MEQ held topic sessions on "Science and technology for environmentally sustainable mariculture: impacts and mitigation in coastal areas" and on "Environmental assessment of Vancouver Harbour: results of an international workshop". The quality of the results presented at the last session encouraged planning for a peer-reviewed publication mentioned above.

With the completion of the practical workshop, MEQ turned its attention to the implementation of its Strategic Plan. This identifies several main issues for the next few years:

- coastal pollution/eutrophication and phytoplankton dynamics;
- ecological impact of oil and other chemical spills;
- science and technology for mariculture;
- impacts of climate change on coastal systems;
- biological and physical transport of anthropogenic substances in the North Pacific;
- diseases and their relationship to pollution.

MEQ also recognizes the need to pursue opportunities to work within a broader international framework, *e.g.*, through GOOS, ICES, AMAP, GIWA or a combination of groups.

### **A broad retrospective view**

The foregoing has summarized in some detail MEQ activities over the last decade or so, and it is

worth stepping back from this and considering the general evolution of the MEQ programme. PICES' original remit to MEQ was essentially to harmonize approaches to the assessment of pollution by developing a "...common assessment methodology...". It is worth asking if MEQ has reached this objective.

As background, we can consider pollution as one kind of environmental change, which results from a range of "forcing functions"; some of these are natural (such as climate change, perhaps) and some are anthropogenic (introduction of contaminants, over-fishing, habitat destruction). And of course, some of these forcing functions interact among themselves. Their net effects cause changes in the structure and/or function of ecosystems, and it is these changes which we want to record, to relate to causes and, ultimately, to manage. However, at present we are limited in the measurements we can make to indicate ecosystem changes: we can routinely measure the distribution of chemicals in various ecosystem compartments and we can, in a few cases, measure some functional or structural changes in specific ecosystem compartments. These are, however, only "snapshots" of aspects of ecosystem structure and/or function.

Within this generalized conceptual framework, MEQ has gone some way to harmonizing its approaches to assessing pollution. Most countries rely on similar approaches (specifically, contaminant monitoring by analytical chemistry); some extend this to biological effects measurements, which complement the chemical data. Through sessions at the Annual Meetings, MEQ has encouraged discussion of these approaches, and most importantly at the Vancouver workshop, PICES scientists have been able to work together in applying a variety of assessment methods and in seeing their value and relevance. This is not to say that all PICES countries will adopt methods used at Vancouver, but the "hands-on" experience of working collaboratively using these techniques must lead eventually to a better mutual understanding of their value.

In addition to the technical and scientific difficulties of harmonizing approaches to

assessing marine pollution, it is worth noting that there are contextual factors of scale, of political objectives, and of technical expertise and economic capacity which govern the evolution of the MEQ programme. As we have noted above, there always has been an element of conflict between PICES' broad --- almost hemispheric --- view of the North Pacific, and individual member nations' focus on local or regional pollution issues. The difference is one of geographic scale: the North Pacific as a system functions on scales of thousands of kilometers, whereas most pollution concerns of member nations (and the programmes to deal with these concerns) occupy scales of tens to hundreds of kilometers. But this difference in geographic scale has implications for the temporal scales on which we operate: changes in ecosystem processes in the North Pacific are likely to occur (or be detected) over intervals of decades, while coastal or regional pollution studies often focus on questions (*e.g.*, about regulation of pollutants) which may be answered (at least, resource managers *hope* they can be answered) over periods of years. MEQ has always been aware of these differences in perspective but national priorities and the practicalities of science funding have probably led us to emphasize local and regional approaches rather than hemispheric ones. This is not to say that MEQ does not recognize the importance, of long-range atmospheric transport of pollutants from industrialized to less contaminated regions (indeed, we have tried to address that issue in previous sessions); rather, our national concerns with local or immediate problems have often pushed these less urgent issues to the background. Only time will tell whether this has been a wise strategy.

"Scale" in the perspective of PICES (as compared to that of its members) also provides a context within which to compare PICES and ICES. PICES structure was modelled largely on ICES, but the geographic scale on which the two organizations operate are quite different. Although Canada and U.S.A. are members of ICES, in the context of MEQ, ICES is much more of a regional organization (Canada and U.S.A. contribute extensively to the "research" aspects of MEQ in ICES, but are involved much less in regulatory affairs). But because ICES is largely an organization of states in close proximity to each

other (around the North Sea and the Baltic) pollution concerns or events on scales of tens to hundreds of kilometers have international implications that are virtually absent from PICES. It is therefore not surprising that the ICES Advisory Committee on the Marine Environment has a supra-national advisory role which seems to lead to international co-ordination (within ICES) in dealing with some aspects of marine pollution. Within PICES, there seems to have been no need (so far) for such a PICES-wide group which works towards “managing” the North Pacific; instead, member states have often developed bi-lateral structures to address local or regional pollution issues over scales of tens to hundreds of kilometers. Some examples include the Canada – U.S.A. initiatives in the Straits of Georgia, Juan de Fuca and Puget Sound; the Russia - Japan initiative on MEQ in the Japan/East Sea (Peter the Great Bay) and the Korea - China studies on the Gulf of Bo Hai.

Finally, we should note that PICES membership reflects a wide diversity of cultural approaches to science, and a wide range of technical expertise and economic capacity. This is much less the case in ICES, which comprises nations of mainly northern European stock with roughly similar approaches to science and which are at a generally similar level of technological advancement. Although these considerations should not be important in a purely scientific context, the fact remains that different nations have different outlooks, priorities, and ways of doing things, which inevitably affect the extent to which even general objectives can be reached.

### **Future directions for MEQ**

Although this will be the subject of another paper, it is unavoidable that after reflecting on the past decade we should think a bit about the future. Some trends and remaining issues are obvious.

“Assessment of pollution...” is a moving target. A decade ago we would have assessed pollution

largely in terms of the distribution of “classical” contaminants such as POPs, heavy metals and radionuclides (and indeed, those topics were the focus of the background papers prepared for PICES II in which member countries assessed the status of their MEQ programmes); now, we would probably want to consider HABs, eutrophication, introduction of exotic species, habitat destruction, *etc.*, in an assessment of pollution. The obvious response to this has been the formation of WG 15 dealing with the impacts of HABs and related topics. This reflects the general recognition that “pollution” encompasses more than just the distribution and effects of chemicals, and it opens up a new set of problems in “assessing” pollution. These point to the need to develop better indicators of ecosystem change, and while this is not a problem that is unique to PICES, probably the best strategy to deal with it is for PICES to maintain close working relationships with other agencies or individuals working in the area.

A second major area for future MEQ activities is in the context of even larger scale global or hemispheric programmes. Given what we know about the integration of physical processes on a global scale (*e. g.*, the distant effects of ENSO), it would make strategic sense over the next decade or so for MEQ to consider issues such as the trans-Pacific transport of pollutants within the context of structures such as GOOS, which is intended to provide a framework for even larger-scale collaboration than is possible within PICES.

During the last decade, MEQ has developed into a cohesive group, which has collaborated successfully, on problems of common interest, and a measure of its success is the output of the practical workshop, scheduled to be published in a refereed international journal. MEQ has now decided to expand its interests, and while this expansion will undoubtedly raise new (and difficult) scientific questions, the group should be well placed to identify and to address them.