Section I Practical Workshop Description

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This report is a compilation of the data resulting from a collaborative research project conducted in Vancouver Harbour, Canada. This scientific study was part of a Practical Workshop sponsored by the Marine Environmental Quality Committee of the North Pacific Marine Science Organization (PICES). The goal of the workshop was to promote the exchange of information about approaches used by PICES member countries to assess the biological impact of marine pollution. Section I of this report provides an overview and history of the workshop, the work plan and methods used to conduct the workshop, and a summary that includes recommendations for future practical workshops of this nature. Section II provides a description of the physical and oceanographic characteristics of the sampling area, as well as information on contaminant sources. Results from the workshop, and preliminary data interpretations were presented at the PICES Ninth Annual Meeting (PICES IX) in 2000. Extended abstracts of these presentations are included in Section III. Tables containing the data from the workshop are included in Section IV.

Workshop overview

Working Group 8 of the Marine Environmental Quality Committee of PICES held a Practical Workshop on May 23-June 7, 1999, in Vancouver Harbour, Canada. Twenty-four scientists from all PICES member countries participated (see Figure 1.1 for a group photo). Workshop Co-Chairman Dr. Colin Levings and his staff hosted the workshop at the West Vancouver Laboratory, of Fisheries and Oceans Canada.

A wide variety of data were collected, including community structure of benthic invertebrates and fish, evaluation of fish health using biological markers and exposure data, evaluation of contaminant exposure in intertidal invertebrates, imposex in gastropods, and information about natural toxins produced by algae. The cooperative sample collections allowed participants to experience various methods for environmental assessment of marine pollution and its effects. Additional opportunities for exchange of information occurred through laboratory demonstrations of bioanalytical techniques and cooperative sample processing that took place at the laboratory. These activities provided an opportunity for PICES participants to gain an improved appreciation of the approaches and techniques used by other member countries to assess the effects of marine pollution.

The data resulting from the workshop will be used for interpretation of organismal, population, and community responses to marine pollution. The biological responses are evaluated in the context of exposure to different classes of chemical contaminants such as polycyclic aromatic hydrocarbon (PAHs), pesticides, chlorinated hydrocarbons, selected metals and organotins (e.g., TBT). The generic results of this Practical Workshop should be applicable to other coastal areas in the PICES region.

History of Working Group 8

Working group 8 (WG 8) was established by the Marine Environmental Quality (MEQ) Committee in 1994 to promote the collection and exchange of information about approaches PICES member countries use to assess the biological impact of marine pollution. To address this issue, WG 8 organized a Practical Workshop, where participants could work together to evaluate methods used to assess ecological effects of pollution. The format of the Workshop was developed along the lines of the successful

Fig. 1.1 Group photo taken in front of the West Vancouver Laboratory. Back row: Dan Lomax, Colin Levings, Alexander Tkalin, Richard Addison, Terry Sutherland. 2nd row: Zhengyan Li, Jihyun Yun, Tatyana Belan, Beradita Anulacion, Beth Piercey, Seiichi Uno, Toshihiro Horiguchi, Stelvio Bandiera. Front row: Carla Stehr, John Stein, Jong Jeel Je, Gina Ylitalo, Tatyana Lishavskaya, Tian Yan, Brian Bill.

Intergovernmental Oceanographic Commission/ Group of Experts on the Effects of Pollutants (IOC/GEEP) workshops whose results have been published elsewhere (Bayne *et al*. 1988, Addison and Clarke 1990, Stebbing and Dethlefsen 1992).

Plans were originally made to hold the practical workshop in Jiaozhou Bay, China. However, it became impractical for the workshop to be held at this location, so the workshop was relocated to Vancouver Harbour, Canada, and work plans were revised. After considerable preparation (obtaining supplies, laboratory space, research vessel support, sampling equipment, affordable room and board, travel arrangements, sample permits etc.) the workshop was held from May 24 to June 7, 1999. Early results of the workshop were presented at PICES VIII in Vladivostok, Russia, in October, 1999. Workshop results were formally presented at PICES IX in Hakodate, Japan, in October 2000. Plans for publication of the results were finalized, and include publication of this data report, and individual papers in a special issue of Marine Environmental Research.

Work Plan for the Vancouver Harbour Practical Workshop

Site locations

Seven sites were sampled within Vancouver Harbour for sediment, benthos and intertidal invertebrates (Figs. 1.2 and 1.3). Fish were collected by trawl at five of these sites (Fig. 1.4). After field collections were initiated, it was found that gastropod species for imposex evaluations were not present at these sites, so an additional 3 sites near Victoria and one near Mission Point (near the town of Sechelt, not shown on map) (Fig. 1.5) were added to the sampling plan for imposex investigations.

Research vessels

The research vessel used for conducting sediment/benthos grabs and trawling for bottom fish was the R/V *Harold W. Streeter* (14 m, or 46 feet) (Fig. 1.6) of the Northwest Fisheries Science Center (NWFSC), National Marine

Fisheries Service, National Oceanic and Atmospheric Administration, U.S.A. The vessel was operated by US scientists participating in the workshop. A second research vessel, an outboard powered launch operated by staff of the Habitat Enhancement Branch, Fisheries and Oceans Canada, was used to transport scientists to the intertidal collection sites.

Study plan and methods

Several biological responses were evaluated. A list of studies and investigators is shown in Table 1.1. The Workshop activity schedule is shown in Table 1.2 and Table 1.3 contains a detailed list of the samples collected.

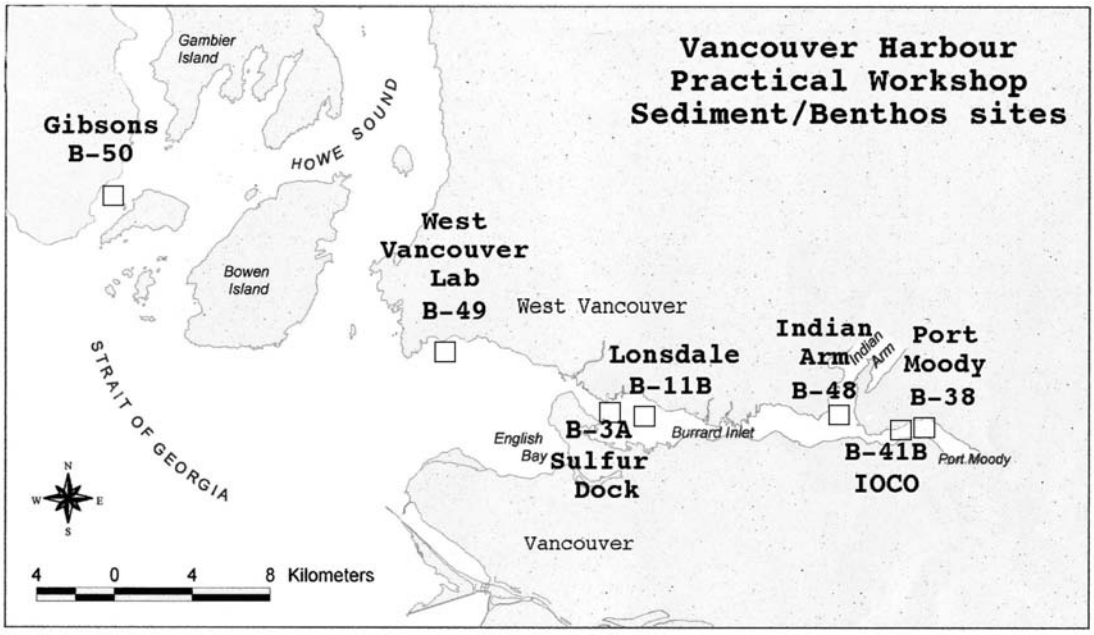

Fig. 1.2 Sediment and benthos collection sites.

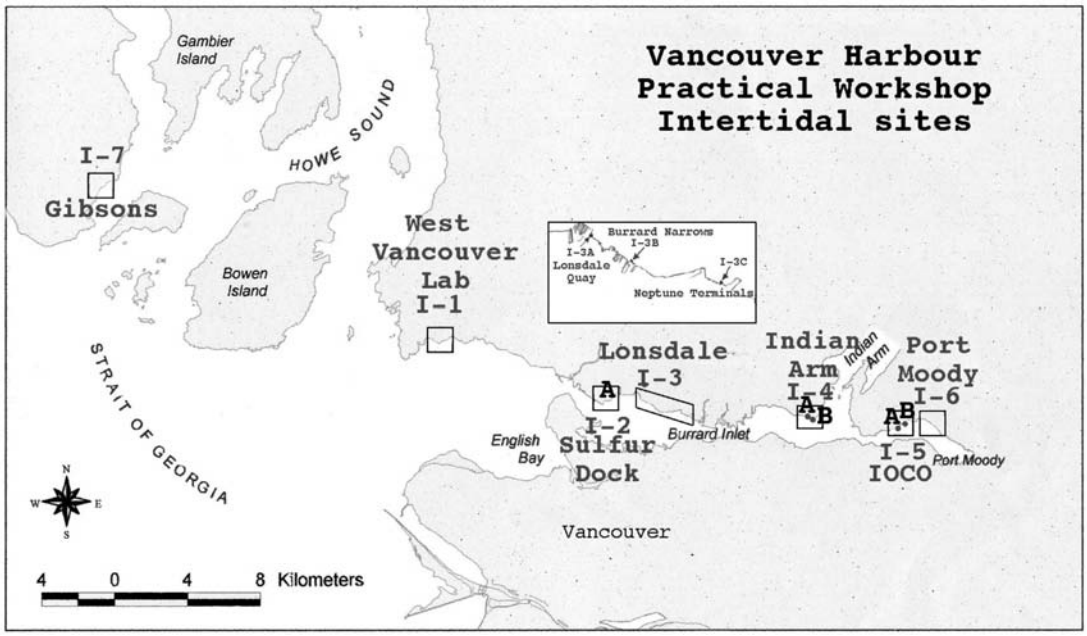

Fig. 1.3 Intertidal collection sites.

Benthic fish

Bottom fish were captured with an Otter trawl at the five sites where there was sufficient space to conduct trawling operations. Species composition, number of individuals, and biomass was determined for the demersal fish catch in each trawl (Fig. 1.7). A target indicator species was retained to examine the relationship between fish health and contaminant exposure. English sole (*Pleuronichthys vetulus*) was selected as the indicator species because this species is common in Vancouver Harbour, and it feeds on benthic organisms living in the sediment (Fig. 1.8). This species is also known to be sensitive to contaminant exposure, and much is known about the relationship between health of English sole and contaminants based on previous studies from other areas similar to Vancouver Harbour (Myers *et al*. 1987, 1994, 1998).

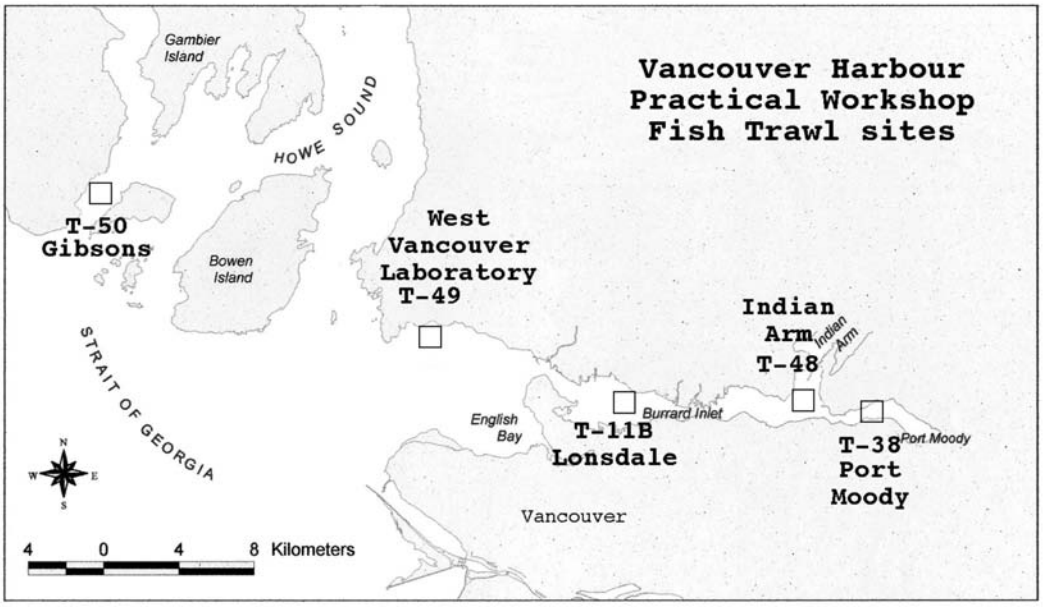

Fig. 1.4 Fish (trawling) collection sites.

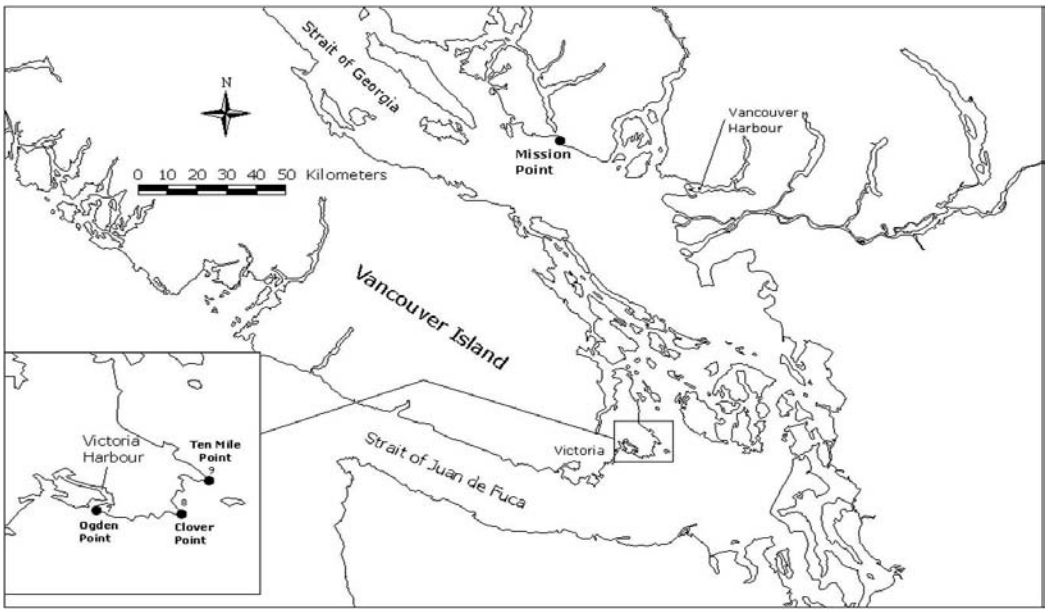

Fig. 1.5 Gastropod collection sites.

Fig. 1.6 The research vessel *Harold W. Streeter*, at anchor while workshop participants collect bottom sediment samples. Yellow material in the background is elemental sulfur.

Fig. 1.8 English sole was the target species collected for several of the fish studies.

Fig. 1.7 Sorting the catch captured with the bottom trawl (Colin Levings, Bernadita Anulacion, Dan Lomax, Mark Myers, Sean Sol).

Fig. 1.9 Tissue samples from English sole were prepared in the shipboard laboratory (Mark Myers).

Two or more trawls were conducted at each site until 30 adult English sole were collected. The English sole were maintained alive in seawater filled containers until tissue samples could be collected. Immediately after trawling operations were complete, the shipboard laboratory was used to collect and preserve fish samples (Fig. 1.9). Otoliths were removed to determine age. Blood was collected from a subset of fish from two sites for vitellogenin assays. Bile was collected for analyses of fluorescent hydrocarbon metabolites, as an indicator of aromatic hydrocarbon (AH) exposure. Liver tissue was collected for cytochrome P450, metals, chlorinated hydrocarbon (CH) and histopathological analyses. Muscle was collected for AH, CH and metal analyses, and gonads were collected for AH and CH analyses. The stomach was removed from each fish and preserved in 10% formalin. Table 1.4 shows more detailed information about the samples collected from English sole.

Table 1.1 List of studies and investigators.

Study	Lead Investigators	Country
Benthic community structure	Dr. Tatyana Belan Dr. Jong Geel Je	Russia Korea
Organic and metal analyses of fish and bivalve tissues	Dr. John Stein (organics in fish) Dr. Seichii Uno (organics in fish and bivalves) Dr. Alex Tkalin (metals in fish and mussels)	USA Japan Russia
Organic and metal analyses of sediment	Dr. John Stein (organics) Dr. Alex Tkalin (metals)	USA Russia
Demersal fish health (using English sole as an indicator species);Indicators of biochemical changes (e.g., induction of cytochrome P-4501A (CYP1A), bile metabolites, vitellogenin	Dr. John Stein (histopathology, bile metabolites, vitellogenin) Dr. Stelvio Bandiera (CYP1A) Dr. Munetaka Shimizu (vitellogenin)	USA Canada Japan
Fish community structure (species distributions, biota age and size relationships, stomach contents)	Dr. Colin Levings	Canada
Community structure of mussels	Ms. Hyun Yun	Korea
Gastropod imposex	Dr. Toshihiro Horiguchi Dr. Zhengyan Li	Japan China
Presence of natural toxins from harmful algae	Dr. Tian Yan (PSP, ARTOX) Dr. Terry Sutherland (cysts)	China Canada
Sediment analyses	Dr. John Stein (organics) Dr. Alex Tkalin (metals)	USA Russia

Table 1.2 Vancouver Practical Workshop schedule.

May 24	Half-day meeting for introductions, laboratory safety training, tour of the lab, and to discuss oceanographic features of Burrard Inlet.
May 24	Half-day meeting for introductions, laboratory safety training, tour of the lab, and to discuss oceanographic features of Burrard Inlet.
May 24	Information about environmental monitoring approaches was presented by a representative from each country. Sampling plan was discussed. R/V *Harold W. Streeter* arrived.
May 26	Supplies and equipment were prepared for sampling. Participants received safety training for the Research Vessel.
May 27	The first site was sampled (trawl site T-49, benthic site B-49, intertidal site I-1). This site was located next to the West Vancouver Laboratory.

Table 1.2 continued

May 28	Sampled Inner Harbour at Lonsdale Quay (Trawl site T-11B, Benthic site B-11B, Intertidal site I-3 via launch).
May 29	Sampled Port Moody (Trawl site T-38, Benthic site B-38, Intertidal site I-6 via launch). Also sampled benthic site B-41B, (but there was insufficient space for trawling at this site).
May 30	Sampled Indian Arm (Trawl site T-48, Benthic site B-48, Intertidal site I-4 via launch).
May 31	Free day, except for scientists Dr. Horiguchi and Dr. Li, who travelled to Victoria to look for snails for imposex research since none were observed at any of the established sites. Snails were successfully located at three sites near Victoria.
June 1	Sampled sulfur dock site (Benthic site 3A, intertidal site I-2 via launch). Not enough room to trawl for fish at this site. Returned to Lonsdale Quay (site T-11B) for additional trawls for fish community data.
June 2	Sampled south through Thornbrough Channel to Howe Sound. One group travelled aboard the R/V *Harold W. Streeter*, another traveled to Gibsons via car and ferry (Trawl site T-50. Benthic site B-50. Intertidal site I-7). This is a reference site. Also collected snails for imposex studies from Mission Point near Sechelt.
June 3	Returned to West Vancouver Lab (site T-49) to get additional samples for fish community data. Demonstrated trawling and sediment collection techniques to scientists who may not have had an opportunity to observe these operations. Research vessel departed.
June 4-6	Processed samples in the laboratory, prepared samples for shipping.
June 7	Final meeting and barbecue at Workshop Co-Chairman Colin Levings' house.

Table 1.3 Sample collection synopsis.

Sites sampled

- 5 sites were sampled for fish.
- 7 sites were sampled for sediment and benthic invertebrates.
- 7 sites were sampled for intertidal invertebrates and algae.
- 4 sites were added for gastropod imposex studies. 3 sites were located on Vancouver Island, near Victoria and 1 site was near Sechelt (north of Howe Sound).

Number of samples collected

Fish

162	Otoliths (Canada)
152	Histology (liver, kidney, gonads) (US)
35	Plasma for vitellogenin (US and Japan)
143	Bile for fluorescent aromatic compound analyses (US)
150	Liver for organic chemical analyses (US)
93	Liver for organic chemical analyses (Japan)
25	Muscle for trace metals analyses (Russia)
49	Muscle for trace metals analyses (Russia)
150	Gonads for organic chemical analyses (Japan)
60	Liver for Cytochrome P450 1-A (CYP1A) (Canada)
60	Liver for DNA adducts (US)
95	Stomachs for taxonomy of contents (Canada)
500	Length/weight of English sole (Canada)
25	(trawls) for species composition and biomass data (Canada)

Table 1.3 continued

Sediment

Benthos

35 grabs (0.1 m^2) (5 grabs at each of 7 sites) for benthic community studies (Russia and Korea)

Sediment Chemistry

21 sediment (3 grabs at each of 7 sites) for trace metals (Russia)
21 sediment samples (3 grabs at each of 7 sites) for organic chemicals (US)
21 sediment samples (3 grabs at each of 7 sites) for total organic carbon (US)

Meiofauna and grain size

245 sediment samples (one grab at each site, 5 samples/grab, 7 slices from each sample with 4 for meiofauna, 3 for grain size) (Canada and Korea)

Microalgae

9 sediment samples (3 sites, 3 reps/site) to culture microalgae from surficial sediments (China and Canada)

Intertidal

Mussels – 7 sites

30/site for trace metals (Russia)
500 g/site whole mussel for algal toxin (China)
50 animals/site (9 sites including Clover Point, Victoria, and Mission Point, Sechelt) for organotin (Japan) (composites will be analyzed)
50 animals/site for OCs and PAHs and lipids (8 sites) (Japan)
4 sites sampled for mussel community data using quadrats (Korea)
100 random mussels collected from 7 sites for condition factor (Korea) and lipid analyses (Japan)

Molluscs for organotin analyses (Japan)

Site	Bivalves collected
I-1	mussel, oysters
I-2	mussel, native littleneck, butter clams, pointed macoma
I-3a	mussel
I-3b	mussel
I-3c	mussel
I-4a	mussel, native littleneck, butter clam, pointed macoma, cockle
I-4b	native littleneck, butter clam, pointed macoma, cockle, horse clam
I-5	mussel
I-6	mussel, softshell, native littleneck, butter clam, oyster
I-7	mussel, softshell, dark mahogany clam, oyster
Ogden Pt.	*Nucella* spp.
Clover Pt.	*Nucella* spp., mussel
Ten Mile Pt.	*Nucella* spp.
Mission Pt.	*Nucella* spp.

(mussel = *Mytilus trossulus*)
(oysters = *Crassostrea gigas*)
(native littleneck clam = *Prototheca staminea*)
(butter clam = *Saxidomus giganteus*)
(cockle = *Clinocardium nuttali*)
(horse clam = *Tresus capax*)
(softshell clam = *Mya arenaria*)
(pointed macoma = *Macoma inquinata*)
(dark mahogany clam = *Nuttallia obscurata*)

Snails for Imposex analyses (Japan and China)

300–400 snails were collected at 3 sites in Victoria including: Ogden Pt., Clover Pt., and Ten Mile Pt., and one site at Mission Pt., Sechelt. Of those collected, approximately 80 were *Nucella emarginata*, 80 were *Nucella lamellosa*, and 100 were *Nucella canaliculata*. The *Nucella canaliculata* could also be *Nucella lima*; Dr. Je will do chromosome tests for species ID.

Table 1.4 Fish tissue collection plan for the Vancouver Harbour Practical Workshop.

Vancouver PICES Practical Workshop Fish Tissue Collection 5/5/99

Randomly select up to **30 adult English sole/ site,** Weigh (g) and measure total length (mm).

Samples to be collected	Number/ species/ sex	Container	Storage
Collect **Blood** (USA and Japan) (1to 3 ml/fish) from male fish with heparinized syringe, centrifuge to separate plasma; aliquot. For vitellogenin samples, add 0.1 M PMSF - 10 ul/ml plasma. Collect at T-48 and T-11B sites only.	**10** or more individuals in glass tubes	cryo vials	ice bath to -20°C
Otoliths (Canada)	**30** per site	provided by W.Van Lab	in glycerin
Bile (USA)	**30** site	amber vial	ice bath to -20°C
Histology (USA) - **liver** - longitudinal section - **kidney** - longitudinal section - **gonad** - cross section **-spleen** - half of spleen (cut sections no thicker than 3mm)	**30** site	white cassette	NBF
If **nodules** are present collect separate section for LM. Also collect heart, spleen and intestine for (LM). Record on card.	as needed	white cassette	NBF
Liver chemistry Organics - USA (half of liver, after histo sample collected)	**30** site	7ml rinsed scint vial	ice bath to -20°C
CYP1A - Canada (half of liver, first 10-15 livers)	**10-15** site	minced in scint. vial	ice bath to -20°C
Organics - Japan (half of liver, rest of fish after CYP1A is collected)	**15-20** site	7ml rinsed scint vial	ice bath to -20°C
DNA adducts -USA (use 5% if whole liver available) for two sites - T-48 and T-49	**30** site	green cap cryovial	liquid N2 to -80°C
Stomach contents - Canada - taxonomy	**30** site	plastic containers	NBF
Gonad organics - Japan Place remaining tissue from histology in 20 ml vial	**30** site	20ml rinsed scint. vial	ice bath to -20°C
Muscle Organics - Japan	**10** site	rinsed glass jar	ice bath to -20°C
Metals - Russia	**5** site	Acid rinsed poly bottle	ice bath to -20°C

Sediment and benthos

A Van Veen grab was used to collect sediment for biological and chemical analyses (Figs. 1.10 and 1.11). Three grabs of sediment were collected and the surface layer (2 cm in depth) was removed and preserved for analyses of organic chemicals and metals. An additional 5 grabs were collected for benthic community studies. The sediment was immediately passed through a 0.5 mm sieve. Benthic organisms were removed from the sieve using forceps and preserved for further study (Fig. 1.12). Another grab was obtained for meiofauna samples. Five replicates cores (one cm diameter) to 10 cm depth were obtained, sectioned at one cm intervals, and preserved in 5% formalin for examination in the laboratory. These samples were archived for future analyses. The sections of one core from each station were used for grain size analyses. After evaporation of preservation fluid at air temperature, the sediment was analyzed for grain size at KORDI using standard sieving and settling tube techniques.

At sites where trawls were also obtained, the sediment/benthos site location was established in the center of the fish collection area. This ensured that the sediment chemistry, benthos and fish data could be correlated.

Fig. 1.10 Collecting sediment with the Van Veen grab (Jong Jeel Je).

Fig. 1.11 Sediment grab being lowered over the side of the research vessel.

Fig. 1.12 Sediment samples were sieved and sorted for benthic organisms (Mark Myers, Alexander Tkalin, Tatyana Belan).

Intertidal organisms

Intertidal clams, mussels, and algae were collected from the beach at each site (Fig 1.13). Site locations corresponded with those for the fish and sediment collections as much as possible, however, beach obstructions, or lack of suitable organisms, sometimes required the intertidal sampling station to be relocated to the next closest area. Clams were collected for hydrocarbon and tributyltin (TBT) analyses. Mussels were collected (Fig. 1.14) for analysis of hydrocarbons, metals including TBT, condition factor and toxins associated with harmful algae. Clams and mussels were cleaned, and removed from their shell. Tissues were frozen or freeze dried, and shipped to the workshop participants home laboratories for further processing and analyses.

Gastropods in the genus *Nucella* were also collected for TBT analyses and imposex evaluations. However, no *Nucella* could be found at any of the established sites. Therefore, four new imposex study sites were established, three were near Victoria, and the fourth was near Mission Point (Sechelt) (Fig. 1.5). Anatomical measurements of gastropods relating to imposex studies were made at the West Vancouver Laboratory shortly after collection. Snails were then frozen and shipped to the workshop participant's home laboratories for further analyses.

Natural toxins - Harmful algae

Sediment samples from the benthic sites were collected to determine if encysted harmful algae were present. Mussels and other bivalves were also collected from intertidal sites for natural toxin analyses. Macroalgae was also collected from intertidal sites, and microalgae was scraped from the surface of the macroalgae for ARTOX analyses. Occasional bivalves occurring as by-catch in the bottom trawl samples were retained for toxin analyses.

Workshop products

1. Data are being archived and are available to PICES country scientists in this report. The database can also be accessed electronically through the PICES Home Page at "www.pices.int". A limited number of CDs

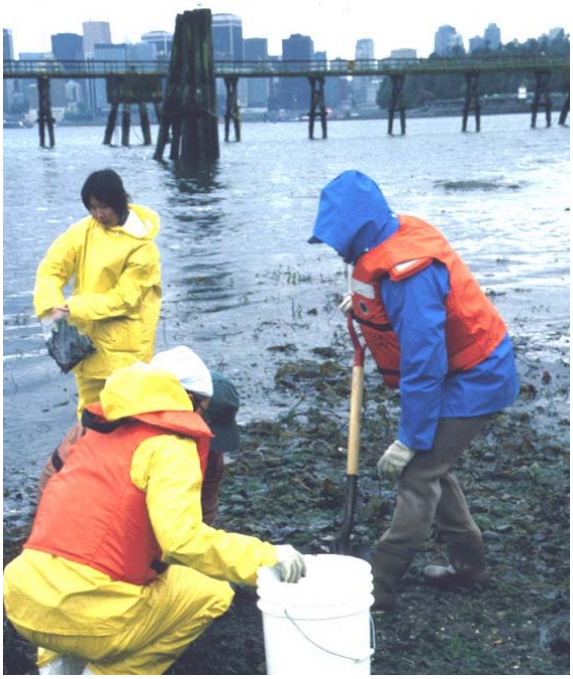

Fig. 1.13 Collection of intertidal clams and algae (Seiichi Uno, Tian Yan, Toshihiro Horiguchi).

Fig. 1.14 Collection of mussels (Alexander Tkalin).

will also be made of the data base, and can be requested from the PICES Secretariat.

2. Plans are in progress for publication of interpreted results in a peer-reviewed journal. Papers are being prepared, and will be considered for publication in a special issue of Marine Environmental Research. It is anticipated that the papers will be published in 2002.

3. PICES participants gained an improved appreciation of the approaches and techniques used by other member countries to assess the effects of marine pollution, and improved mutual understanding and technology transfer among scientists from PICES countries.

Summary

The Practical Workshop conducted by the Marine Environmental Quality Committee of the North Pacific Marine Sciences Organization (PICES) was the first step by member countries in harmonizing methods used to investigate the status of contamination in coastal marine systems and the associated effects on vertebrate and invertebrate species. Success in harmonizing methods should significantly improve our ability to compare data collected by multiple investigators working in diverse ecosystems in the North Pacific. Greater inter-comparability of data also improves our capacity to assess the status and trends in chemical contaminant levels and biological effects among PICES countries. Continued efforts by PICES to harmonize assessments of status and trends in contaminant levels and effects, should increase the level of scientific information available to individual member countries to evaluate the relative risks from chemical contaminants on the health of their coastal ecosystems.

This data report presents the results from the collaborative effort to share expertise and experience in sampling and analyzing both sediment and biota. The data presented here also demonstrates that, during the workshop, we used a wide variety of techniques to measure levels of contaminant exposure and effects across a broad range of biological organization — from biochemical endpoints to benthic and fish community structure. A substantive measure of the scientific success of the project was the commitment by the workshop participants to publish the findings from the workshop in the peer-reviewed scientific literature. Publication of the findings will make the data available to the broader scientific community, demonstrate the success of the workshop, and contribute an increased understanding of the effects of contaminants on biota of Vancouver Harbour.

The following is a list of lessons we learned in conducting this workshop:

- The time committed by the MEQ working group to developing workshop objectives, goals, and work plan was critical to the overall success of the workshop.

- Selection of Vancouver Harbour as the site for the workshop was important, because of the proximity to dry- and wet-lab facilities, availability of housing for workshop participants, and relatively short distances between sampling sites that exhibited a range in chemical contamination. Availability of an "operations room" for daily briefings and discussions of sampling plans by the group was also important as adjustments to logistics had to be made as the work progressed.

- Unrestricted use of a well-equipped research vessel and a small launch provided us with the flexibility to adjust daily plans as needed, and carry out a wide range of different sampling activities.

- The logistical support provided by our Canadian colleagues during the workshop was instrumental in the overall success of the sampling, sample processing and shipment of samples.

- Although we were successful in collecting a wide range of biotic samples, we were not able to conduct many of the chemical and biological analyses on a real time basis during the workshop. Because of the wide range of complex analyses needed, we could not assemble the specialized instruments needed

to carry out many of these analyses at the site of the workshop. Therefore, participants could not demonstrate their analytical techniques or share as much data during the workshop as originally anticipated. However the present data report should facilitate the exchange of data by the workshop participants.

- The rather intense work schedule for the workshop made it difficult for participants to take time from their personal research to participate in projects being conducted by their colleagues. There were opportunities, however, for discussion among participants after daily sampling and sample processing activities were completed. This opportunity was important in initiating exchange of technical information on the analytical techniques being used.

In conclusion, the Vancouver Harbour Practical Workshop was successful in several areas: 1) it brought scientists from all PICES countries together for the first time to carry out a collaborative research project involving sample collection and analysis, 2) the careful planning and execution of the workshop has led to a data set that provides new information on the status of chemical contamination in the Harbour, and 3) the workshop was a key step in initiating efforts to compare and contrast techniques used by PICES member countries in assessing the status and trends of chemical pollution in coastal ecosystems.

There are two recommendations for future PICES activities that have a format similar to our Practical Workshop. First, focusing on a more limited research approach would provide greater opportunity for more in-depth exchange of technical approaches and for conducting analyses during the workshop. The ability to share data and demonstrate techniques in real time would be effective in furthering technology transfer. Second, it is our conclusion that the structure for the workshop we conducted is applicable to other PICES committees, and we encourage the committees to consider the value of a Practical Workshop format in meeting their scientific objectives.

Acknowledgements

Funding for workshop supplies, shipping of samples, and travel for some of the workshop participants were provided by PICES. Appreciation is extended to the Practical Workshop Co-Chairmen Drs. John Stein and Colin Levings, and to Dr. Richard Addison for developing and overseeing the planning of the Workshop. Thanks are also extended to Ms. Christine Elliott and Ms. Beth Piercy who assisted with logistics for lodging, obtaining supplies and helped host the Workshop at the West Vancouver Laboratory, Fisheries and Oceans Canada. Thanks also to Mr. Dan Lomax, Mr. Paul Plesha, and Mr. Brian Bill from the Northwest Fisheries Science Center, National Marine Fisheries Service, U.S.A., for operating the R/V *Harold W. Streeter*, and transiting the vessel to and from Seattle, WA, U.S.A., and Vancouver Harbour, Canada. Appreciation is also extended to launch operators Mr. Bruce Clark and Mr. Corino Salomi from the Department of Fisheries and Oceans, Canada. Thanks is also extended to Mr. Geoff Lang from the Alaska Fisheries Science Center, National Marine Fisheries Service, U.S.A., for developing the relational database so that the Practical Workshop data can be easily accessed. Thanks also to Nara Mehlenbacher, West Vancouver Laboratory, Canada, for assistance with GIS and mapping. Additional personnel who helped with sample collection included Ms. Bernadita Anulacion, Mr. Sean Sol, Ms. Gina Ylitalo, Mr. Mark Myers, and Mr. Larry Hufnagle. The Northwest Fisheries Science Center, U.S.A., provided funding for the operation of the research vessel. Fisheries and Oceans Canada provided funding for the operation of the launch and availability of the laboratory space.

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Participation List

Canada
- Richard F. Addison*
- Stelvio Bandiera*
- Christine Elliott
- Colin D. Levings*
- Beth Piercy
- Terri Sutherland

China
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