

5 Overview and Recommendations

1. Results of three MIEs point out that the Matsuda-Oozeki-Hu Trawl (MOHT) gear was among the most reliable and cost effective micronekton gears examined. It provided high quality, quantitative micronekton samples. It is now available commercially and development of a closing/opening mechanism for this net is presently underway. Equipping the MOHT with an opening/closing mechanism on the cod-end could put this gear in a position to become the standard micronekton gear worldwide, and in the North Pacific, in particular. As a consequence, the MIE-AP strongly supports further work in this direction.
2. Models were developed to predict backscattering volume to allow for comparisons between acoustic and net data. However, preliminary results indicated that the compatibility was low, which suggests that there are problems associated with both sampling techniques, as discussed on several occasions. The closest results were obtained between the MOHT and acoustics. The Advisory Panel felt that further research in improving acoustic estimates should be continued. In addition, acoustic data collected during all experiments still require some degree of work and clean-up.
3. A new system, J-QUEST (Sugisaki and Sawada, 2007), was shown to quantify the epipelagic micronekton and nekton but appeared to be inefficient in detecting the mesopelagic fishes, and myctophids in particular. There is good potential for adopting this system for mesopelagic work but more work is required to determine which light spectrum myctophids are less sensitive to.
4. The Advisory Panel, after a brief review of ICES and PICES inter-calibration experiments, concluded that their inter-comparison is generally impossible. This is due to: first, mainly incomparable sampling gears that have been used during the ICES and PICES experiments, and second, the concentration mainly on mesozooplankton in the ICES experiment.

Appendix 1

PICES Advisory Panel on *Micronekton Sampling Inter-calibration Experiment*

Terms of reference

1. Develop a proposal for a micronekton sampling inter-calibration experiment, arising from the work of PICES WG 14 on Effective Sampling of Micronekton. Advise on appropriate locations as well as identify micronekton sampling gears and other quantifying technologies for inclusion in the inter-calibration experiment;
2. Facilitate the experiment by identifying and securing commitments for resources (personnel and ships) to ensure success of the experiment; provide technical advice in development of sampling protocols and experimental design;
3. Oversee post-survey analysis of samples and data; provide guidance in preparation of results for final report and publication(s).

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Appendix 2

List of fish species collected during the MIE-1 cruise onboard the R/V *Oscar Elton Sette* off Hawaii, October 6–13, 2004.

Taxa	Cobb Trawl	HUFT	IKMT
<i>Acanthuridae</i> gen. sp.	*	—	—
<i>Apogonidae</i> spp.	*	—	—
<i>Argyrolepecus aculeatus</i>	*	—	—
<i>Argyrolepecus affinis</i>	*	*	*
<i>Argyrolepecus hemigymnus</i>	*	*	*
<i>Argyrolepecus sladeni</i>	*	—	—
<i>Astronesthes bilobata</i>	*	*	*
<i>Astronesthes cyanea</i>	*	*	—
<i>Astronesthes indica</i>	*	*	—
<i>Astronesthes splendidus</i>	*	—	*
<i>Astronesthes trifibulata</i>	*	*	*
<i>Astronesthes</i> spp.	—	—	*
<i>Bathophilus kingi</i>	*	—	—
<i>Bathophilus pawnei</i>	*	—	—
<i>Bathophilus</i> spp.	*	—	—
<i>Benthodesmus</i> spp.	*	—	—
<i>Benthoosema suborbitale</i>	*	*	*
Blenniidae gen. sp.	*	—	—
<i>Bolinichthys distofax</i>	*	—	*
<i>Bolinichthys longipes</i>	*	*	*
<i>Bothus</i> spp.	*	—	—
<i>Bregmaceros atlanticus</i>	*	—	—
<i>Bregmaceros maclellandi</i>	*	*	*
<i>Bregmaceros nectabanus</i>	—	*	—
<i>Bregmaceros</i> spp.	*	—	*
<i>Brotulotaenia</i> spp.	*	—	—
<i>Centrobranchus andrea</i>	—	*	—
<i>Centrobranchus choerocephalus</i>	*	*	*
<i>Centrobranchus andrea</i>	—	—	*
<i>Ceratoscopelus</i> spp.	*	*	—
<i>Ceratoscopelus warmingii</i>	*	*	*
<i>Chauliodus sloani</i>	*	*	*
<i>Chauliodus</i> spp.	—	*	—
<i>Coccorella atlantica</i>	*	—	—
<i>Coryphaens</i> spp.	—	*	—
<i>Cubiceps pauciradiatus</i>	*	—	—
<i>Cubiceps</i> spp.	*	—	—
<i>Cyclothone alba</i>	*	*	—
<i>Cyclothone pseudopallida</i>	*	—	—
<i>Cyclothone</i> spp.	*	*	*
<i>Danaphos</i> spp.	*	—	—
<i>Danaphos oculatus</i>	*	*	*
<i>Diaphus adenomus</i>	*	—	—

Taxa	Cobb Trawl	HUFT	IKMT
<i>Diaphus andersoni</i>	*	*	—
<i>Diaphus brachicephalus</i>	*	—	—
<i>Diaphus chrysorhynchus</i>	*	—	—
<i>Diaphus effulgens</i>	—	—	*
<i>Diaphus fragilis</i>	*	*	*
<i>Diaphus fulgens</i>	—	—	*
<i>Diaphus jenseni</i>	*	—	—
<i>Diaphus lucidus</i>	*	*	*
<i>Diaphus mollis</i>	*	*	*
<i>Diaphus percipicillatus</i>	*	—	*
<i>Diaphus phillipsi</i>	—	—	*
<i>Diaphus problematicus</i>	*	*	—
<i>Diaphus richardsoni</i>	*	*	—
<i>Diaphus schmidtii</i>	*	*	*
<i>Diaphus</i> spp.	*	*	*
<i>Diaphus suborbitalis</i>	*	*	*
<i>Diogenichthys atlanticum</i>	*	*	*
<i>Diplophos taenia</i>	*	*	*
Echeneidae gen. sp.	—	*	—
<i>Echiostoma barbatum</i>	*	—	—
<i>Encrasicholina punctifer</i>	*	*	*
<i>Engyprosopon</i> spp.	*	*	*
<i>Eustomias</i> sp. 1	*	*	—
<i>Eustomias</i> sp. 2	*	—	—
<i>Fistularia cornuta</i>	*	—	—
<i>Gempylus serpens</i>	*	*	*
Gobiidae gen. sp.	—	—	*
<i>Gonostoma atlanticum</i>	*	*	*
<i>Howella</i> spp.	—	—	*
<i>Hygophum proximum</i>	*	*	*
<i>Hygophum reinhardti</i>	*	—	*
<i>Ichthyococcus intermedium</i>	*	—	—
<i>Ichthyococcus irregularis</i>	*	—	—
<i>Idiacanthus antrostomus</i>	—	—	*
<i>Idiacanthus fasciola</i>	*	*	*
Labridae spp.	*	*	—
<i>Lampadena luminosa</i>	*	*	*
<i>Lampanyctus nigrum</i>	—	—	*
<i>Lampanyctus nobilis</i>	*	*	*
<i>Lampanyctus</i> spp.	*	*	*
<i>Lampanyctus steinbecki</i>	—	*	*
<i>Lampanyctus tenuiformes</i>	—	—	*
<i>Leptocephalus</i> Type I	*	*	—
<i>Leptocephalus</i> Type II	*	—	—
<i>Leptocephalus</i> Type III	*	—	—
<i>Leptostomias</i> spp.	*	—	—
<i>Lestidiops</i> spp.	—	—	*
<i>Lestrolepis luetkeni</i>	*	—	—
<i>Lobianchia gemellari</i>	*	—	—
Lutjanidae gen. sp.	*	—	—
<i>Macrostomias pacificus</i>	*	—	—

Taxa	Cobb Trawl	HUFT	IKMT
Malacosteidae gen. sp.	*	—	—
<i>Malacosteus niger</i>	*	*	—
<i>Melamphaes longivelis</i>	*	—	*
<i>Melanostomias tentaculatus</i>	*	*	—
Melanostomiidae gen. sp.	*	—	—
<i>Mullidae</i> spp.	*	—	—
<i>Myctophidae</i> unidentified	*	*	*
<i>Myctophum asperum</i>	*	—	*
<i>Myctophum aurolineatum</i>	*	—	—
<i>Myctophum nitidulum</i>	*	—	—
<i>Myctophum obtusirostre</i>	*	—	—
<i>Myctophum orientale</i>	—	—	*
<i>Myctophum spinosum</i>	*	—	—
<i>Nannobranchium nigrum</i>	*	—	*
<i>Nannobranchium regale</i>	—	—	*
<i>Naso</i> spp.	*	—	—
<i>Nemichthys</i> spp.	*	—	—
<i>Nesiarchus nasutus</i>	*	—	*
<i>Notolychnus valdivae</i>	*	*	*
<i>Opisthopoctus soleatus</i>	*	*	*
Paralepididae gen. sp.	*	—	—
<i>Photonectes albipennis</i>	—	*	—
<i>Photostomias gueneri</i>	*	—	—
<i>Pomacanthidae</i> spp.	*	—	—
<i>Rhinecanthus</i> spp.	*	—	—
<i>Rhynchohyalus natalensis</i>	*	—	—
Scombridae gen. sp.	*	*	—
Scopelarchidae gen. sp.	—	—	*
<i>Scopeloberyx opisthopteryx</i>	*	—	—
<i>Scopelogadus misolepis</i>	*	—	—
<i>Scopelosaurus hoedti</i>	*	—	—
Scorpaenidae gen. sp.	*	—	*
<i>Serrivomer</i> spp.	*	*	*
<i>Sigmops</i> spp.	*	—	—
<i>Sigmops elongatum</i>	*	*	*
<i>Sternoptyx diaphana</i>	*	*	—
<i>Sternoptyx</i> spp.	*	*	*
<i>Sygmops elongatum</i>	*	—	—
<i>Symbolophorus evermani</i>	*	*	*
Synodontidae gen. sp.	*	—	—
<i>Taaningichthys minimus</i>	*	—	—
<i>Thysanactis dentex</i>	*	—	—
<i>Triphoturus nigrescens</i>	*	*	*
<i>Tysanactis dentex</i>	*	—	—
<i>Valenciennellus</i> spp.	*	—	—
<i>Valenciennellus tripunctulatus</i>	*	*	*
<i>Vinciguerria</i> spp.	*	*	—
<i>Vinciguerria nimbaria</i>	*	*	*
<i>Vinciguerria poweria</i>	*	—	—
<i>Zanclus cornutus</i>	*	—	*
Total number of taxa	123	61	65

* presence in samples

Appendix 3

MIE-AP Annual Reports

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PICES Twelfth Annual Meeting
October 9–18, 2003
Seoul, Republic of Korea

2003 Report of the Advisory Panel on *Micronekton Sampling Gear Intercalibration Experiment*

Background

While a number of gears are presently being used to sample micronekton in the North Pacific and other parts of the world's oceans, there has been little effort expended in comparing the relative sampling efficiency and selectivity of these gears. At the recommendation of PICES WG 14 on *Effective sampling of micronekton*, a new PICES field effort to evaluate the efficacy of sampling gears and procedures employed by different agencies to sample micronekton in the North Pacific was launched, and the Advisory Panel on *Micronekton sampling gear intercalibration experiment* (MIE-AP) was established at PICES XI to oversee the field program. The first MIE-AP meeting/workshop was convened from 09:00 – 12:15 hours on October 11, 2003, in conjunction with PICES XII.

Workshop summary

This workshop was the first gathering of the MIE-AP members (see *MIE-AP Endnotes 1* for attendance). After short introductions of the participants, a review of the status of the related WG 14 activities (Dr. Richard D. Brodeur), and the project background (Dr. Michael P. Seki), the discussion turned to the goals, objectives, and status of the intercalibration experiment (*MIE-AP Endnote 2*).

The MIE-AP is currently planning to conduct the experiment in two phases: the first cruise in Central North Pacific waters off Hawaii just prior to PICES XIII in Honolulu, and the second cruise in waters of the Bering Sea (or possibly Gulf of Alaska) during the summer of 2005. The Hawaii cruise will serve two purposes: (1) to compare the performance of different types of sampling gears in an oligotrophic subtropical gyre to see how the choice of gear affects our perspective of the micronekton community; and (2) to use the relatively benign sea conditions of the subtropics

to evaluate and refine protocols, logistics, and sampling designs. The northern (Bering Sea) leg will sample a much more productive regime and a faunal community of great interest to many in the PICES member countries. Upon completion, an unprecedented attempt to compare the performance of gears within and between the contrasting environments will highlight the MIE-AP effort.

A commitment for a 10-day shiptime aboard the NOAA ship *Oscar Elton Sette* has been acquired in the first two weeks of October 2004 to support the first leg of the experiment, and a short presentation was made on the facilities and capabilities of the research vessel for the initial phase of the experiment. For the northern cruise in 2005, several scenarios involving other platforms were discussed, including: ships involved with the multinational NPAFC's BASIS project in the Bering Sea, Hokkaido University's R/V *Oshoro Maru*, Japan Fisheries Agency's R/V *Kaiyo Maru*, and Hokkaido National Fisheries Research Institute's "new" *Hokko Maru* scheduled for operation in 2005.

Micronekton gears currently in use by PICES member countries were identified for the experiment. Smaller single warp gear-types included the Methot (5 m²) net, RMT 8+1, fixed frame 4 m² beam trawl, and Isaacs-Kidd midwater trawls (IKMT) (1.8 and 3 m varieties). All of these gears can be accommodated on the *Sette* and will be rigged for monitoring depth and temperature in real-time during operations.

For "larger" dual warp stern trawls, considered were the "Stauffer" modified Cobb trawl and the OSU 100 m² rope trawl. Russian scientists generally use large commercial pelagic trawls equipped with a small mesh codend liner, but shipping such a large net out of Russia may be problematic. It was decided that inquiries will be made about the availability of a net with similar

specifications in the United States for possible use. *Sette's* Netmind mensuration system will be used for monitoring the stern trawl nets performances in the water.

A number of sampling protocols were addressed. Some of the highlights follow:

- to minimize some of the biases associated with diel sampling time, the order of operations conducted would be rotated from night to night;
- net mesh sizes would be standardized to 1 cm for all gears codends;
- tows will be conducted in a horizontal fashion at a depth to be determined in the field;
- many of the gear are designed to perform optimal at specific towing speeds and will be deployed accordingly;
- tow durations will be determined in the field; concern was expressed over the effect of tow duration on animal damage *vs.* reduction of within tow variability of catch.

Assessment of micronekton resources during the surveys will also use acoustic technologies. Specifically, MIE-AP members conducting acoustic assessments employ the Simrad EK60 equipped with two frequencies (38 and 120 kHz). Other gear-types suggested for consideration included visual methods (*e.g.*, video plankton

recorders or cameras to monitor net extrusion), prototype lift nets (*e.g.*, Ocean Friendly design), and concurrent neuston nets. Traditional bongo and ring nets while generally macroplankton nets were also considered for inclusion in the experiment.

An unsuccessful attempt to obtain funding to support the experiment was made to the North Pacific Research Board (NPRB) at last year's request for proposals (RFP). A revised proposal will again be submitted to the current \$3 million RFP by December 5, 2003.

Action items were identified for MIE-AP members in the weeks to come including the determination of the number of participants from each country for the cruises (particularly for inclusion in the NPRB proposal), consideration of specimen disposition and preservation requirements, and consideration to sample set replication for ensuring statistical analysis.

It was also recommended that a 1-day workshop be convened at PICES XIII, immediately after the *Sette* cruise, to review preliminary data and findings from the cruise, and discuss the goals, objectives, and status of the inter-calibration experiment and the future field program.

MIE-AP Endnote 1

Participation list

Members:

Richard D. Brodeur (U.S.A.)
Kazushi Miyashita (Japan)
Vadim F. Savinykh (Russia)
Michael P. Seki (Co-Chairman, U.S.A.)
Won Duk Yoon (Korea)

Observers:

Koh Kawaguchi (Japan)
Vladimir I. Radchenko (Russia)
Orio Yamamura (Japan)

MIE-AP Endnote 2

Workshop Agenda

1. Welcome and introductions
2. Status and review of the WG 14 final report
3. Background and Terms of Reference for the Advisory Panel on *Micronekton sampling gear intercalibration experiment*
4. Discussion of experiment logistics, including proposed platform(s), cruise dates, location (region) of survey, participants sampling gears to be included, experiment logistics, protocols, and analysis
5. Status of financial support status including discussion of scenarios in the absence of funding
6. Summary wrap-up and report write-up

PICES Twelfth Annual Meeting Workshop Summary

Workshop W4 (MIE-AP)

Planning a micronekton sampling gear intercalibration experiment

Co-Convenors: Michael P. Seki (U.S.A.) and Evgeny Pakhomov (Canada)

Background

While a number of gears are presently being used to sample micronekton in the North Pacific and other parts of the world's oceans, there has been little effort expended in comparing the relative sampling efficiency and selectivity of these gears. At the recommendation of PICES Working Group 14 on *Effective sampling of micronekton*, a new PICES field effort to evaluate the efficacy of sampling gear and procedures employed by different agencies to sample micronekton in the

North Pacific was launched, the *Micronekton sampling gear Intercalibration Experiment* (MIE). This ½-day workshop of the MIE-Advisory Panel (MIE-AP) overseeing the field program was convened to discuss the goals, objectives, and status of the experiment, and begin the formal organization and planning process for the experiment. No formal presentations were scheduled or made at the workshop, other than a short presentation on the facilities and capabilities of the research vessel for the initial phase of the experiment.

PICES Thirteenth Annual Meeting
October 14–24, 2004
Honolulu, U.S.A.

2004 Report of the Advisory Panel on *Micronekton Sampling* *Inter-calibration Experiment*

The meeting/workshop of the Advisory Panel on *Micronekton sampling inter-calibration experiment* (MIE-AP) was held from 09:00-15:30 hours on October 14, 2004, and brought together the Advisory Panel members and the participants on the first MIE cruise conducted off Hawaii (*MIE-AP Endnote 1*). After the opening of the meeting by Dr. Michael P. Seki, MIE-AP Co-Chairman, and short introductions by attendees, a background overview of MIE-AP and review of the project to date ensued. The discussion then focused on the activities, preliminary results, lessons learned from the cruise and next steps (*MIE-AP Endnote 2*).

Meeting/workshop summary

The MIE-AP was established at PICES XI (2002) to evaluate the efficacy of sampling gears and the procedures employed by different investigators to sample micronekton in the North Pacific and other parts of the world's oceans (*MIE-AP Endnote 3*). An initial field effort involved an 8-day (October 6–13, 2004) research cruise in Hawaiian waters just prior to PICES XIII, herein referred to as MIE-I. This cruise served two purposes: (1) to compare the performances of different types of sampling gears in an oligotrophic subtropical gyre area to see how the choice of gear affects our perspective of the micronekton community; and (2) to use the relatively benign weather and sea conditions to evaluate and refine the protocols, logistics and design of the sampling. The workshop reviewed preliminary data and findings from the cruise, and the MIE-AP meeting that followed discussed the goals, objectives and status of the future field program.

MIE-I was conducted aboard the NOAA ship *Oscar Elton Sette* in Central North Pacific waters off the west side of Oahu Island. Participants on the cruise included: Michael P. Seki (Chief Scientist), Richard D. Brodeur, Daniel Curran, Reka Domokos and Donald Hawn (U.S.A.);

Douglas Yelland, Evgeny Pakhomov and Larissa Pakhomova (Canada); Masayuki Abe and Hiroki Yasuma (Japan); and Andrei Suntsov (Russia).

Three gear-types were employed in the comparison: a dual trawl warp 140 m² Stauffer modified Cobb trawl, the single warp 1.8 m Isaacs-Kidd mid-water trawl, and the single warp 2 m variety of Hokkaido University's Rectangular Frame trawl. During all tows, acoustic backscatter was monitored and data recorded with a Simrad EK-60 echosounder equipped with 38 kHz and 120 kHz transducers. For daytime tows, trawls were dropped to the target depth (550 m) and towed horizontally for 1 hour (contamination by animals in the catch on the ascent and descent to depth was assumed to be minimal). For nighttime tows, trawls were dropped to the desired depth as defined by acoustic scattering (*ca.* 120 m), and retrieved obliquely through the water column for a 1-hour duration, and the tow ending with the net at the surface. Since only a fraction of the sound scattering layer (SSL) was observed to migrate to shallow waters at night, a series of trawls were also conducted at depth (*ca.* 550 m) during the night, to acquire information of the non-migrants and composition of the SSL with respect to acoustic measurements. The real-time net depths during the tows were monitored with a Northstar NETMIND net mensuration system.

A variety of topics were addressed during discussion, and some of the highlights and recommendations follow.

Lessons learned from MIE-I

- The Panel deemed that it was important to note that MIE-I was accomplished without financial support; all support for the successful execution of the cruise was furnished by the participating agencies.
- The cruise was fortunate to have had specialists for each faunal group among the participating scientific field party. When

planning future cruises, having this expertise is strongly recommended and needs to be considered at the planning stages.

- The leads for various aspects of the cruise data (e.g., biological specimen detailed processing – species identification and measurements for faunal groups) were identified. These include fishes (Suntsov), crustaceans (Pakhomov), cephalopods (Seki), and acoustics (Yelland).
- Preliminary analysis from MIE-I indicated that individual gears sampled different, often non-overlapping, size groups of plankton and micronekton. It points out that successful inter-comparison during future cruises requires a closer scrutiny of gear-types and net mesh sizes prior the experiment.
- The Panel agreed that “what one defines as micronekton may not be the same definition as someone else”. MIE-I planning encouraged participants to bring their micronekton sampling gear which resulted in a range of mesh sizes and abilities to sample. On the positive side, the ability of the cumulative gears to sample the full range from mesozooplankton to micronekton enhanced the ability to interpret the data acquired from the multiple acoustic frequencies.
- The Panel suggested the adoption of a “standard” sampling gear (e.g., RMT 1+8 or a 3-m IKMT) and mesh sizes to allow and guide comparisons for future efforts. For higher acoustic frequencies, a towed transducer to access the deeper depths was recommended.

Plans for MIE-II

- Based on the success and preliminary findings of the first cruise, MIE-AP recommended conducting a second experiment within the subarctic North Pacific using a larger variety of micronektonic sampling gears. This cruise is tentatively planned for the summer of 2005 or 2006, depending on ship time availability, in the Bering Sea (or possibly the Gulf of Alaska or the western North Pacific). This leg will sample a much more productive regime and a faunal community of great interest to many in the PICES member countries. Upon completion, an unprecedented attempt should be made to compare the performance of gears within and between the contrasting environments. This will highlight the MIE-AP effort.

- Dr. Orio Yamamura has requested shiptime aboard the Japan Fisheries Agency research ship *Kaiyo Maru* for conducting MIE-II during the summer of 2005. A decision is expected by the end of the current calendar year on whether the ship time will be awarded.
- The Panel suggested exploring the possibility of joining one of the BASIS cruises to the Bering Sea to accommodate the MIE-II sampling.
- The Panel also recommended pursuing shiptime aboard the NOAA ships *Oscar Dyson* or *Miller Freeman* or Hokkaido University research vessel *Oshoro Maru*. Since most of the sailing schedules for these ships are already set for 2005, any cruise aboard these ships would target the summer of 2006.
- The Advisory Panel discussed using large opening/closing type nets such as the RMT1+8 and the 4 m² MOCNESS, or some other similar gear so that vertically stratified tows can be made during MIE-II.

Publications

- A brief report on MIE-AP activities will be published in the next issue of PICES Press (January 2005).
- A data report containing the detailed processed results from MIE-I will be prepared and a draft completed in time for review at PICES XIV (Vladivostok, Russia). Dr. Seki will take the lead in compiling the information from all contributors. The targeted outlet will be the PICES Scientific Report Series.
- Several formal publications will evolve from MIE-I, but until the detailed processing is completed, a timetable for primary products is very difficult to assemble and will be deferred until better assessment of processing requirements can be accomplished. This will be revisited at PICES XIV.

Proposals

- Another attempt will be made at obtaining financial support for MIE activities from the North Pacific Research Board through the 2004-05 request for proposals process. Dr. Pakhomov will take the lead in preparing the proposal package seeking support for MIE-II either in the summer of 2005 or 2006, depending on platform availability.

MIE-AP membership

- Dr. Pakhomov to continue as Co-Chairman, while Dr. Seki to step down as Co-Chairman but remain a MIE-AP member. The Panel will seek a new Co-Chairman who has expertise working in the subarctic Pacific and/or Bering Sea, the most likely regions to conduct the MIE-II cruise.
- Dr. Yamamura to joint MIE-AP as a member and possibly as Co-Chairman to replace Dr. Seki.
- Nomination of additional members to be requested from all PICES member countries.

MIE-AP Endnote 1**Participation List**Members

Richard D. Brodeur (U.S.A.)
 Kazushi Miyashita (Japan)
 Evgeny A. Pakhomov (Canada, Co-Chairman)
 Vadim Savinykh (Russia)
 Michael P. Seki (U.S.A., Co-Chairman)

Observers

Masayuki Abe (Japan)
 Reka Domokos (U.S.A.)
 R. Ian Perry (Science Board Chairman)
 Andrei Suntsov (Russia)
 Hiroki Yasuma (Japan)
 Douglas Yelland (Canada)

MIE-AP Endnote 2**Workshop Agenda**

1. Welcome and introductions
2. Background and Terms of Reference for the Advisory Panel on *Micronekton sampling inter-calibration experiment*
3. Review of cruise activities, sampling, and status of the data and analysis
4. Discussion on the second MIE-AP cruise logistics, including possible platform(s), dates, participants, region of experiment, sampling gears, sampling protocols, sample analysis and disposition
5. Status of financial support status including discussion of scenarios in the absence of funding
6. Summary wrap-up and report write-up

MIE-AP Endnote 3

**Terms of Reference for Advisory Panel on
*Micronekton sampling inter-calibration experiment***

1. Develop a proposal for a micronekton sampling inter-calibration experiment, arising from the work of PICES WG 14 on *Effective sampling of micronekton*. Advise on appropriate locations as well as identify micronekton sampling gears and other quantifying technologies for inclusion in the inter-calibration experiment.
2. Facilitate the experiment by identifying and securing commitments for resources (personnel and ships) to ensure success of the experiment; provide technical advice in development of sampling protocols and experimental design.
3. Oversee post-survey analysis of samples and data; provide guidance in preparation of results for final report and publication(s).

PICES Thirteenth Annual Meeting Workshop

Workshop and Advisory Panel Meeting W1 (MIE-AP)

Micronekton Sampling Gear Inter-calibration Experiment

Co-Convenors: Michael P. Seki (U.S.A.) and Evgeny Pakhomov (Canada)

The PICES Advisory Panel on *Micronekton sampling inter-calibration experiment* (MIE-AP) was established to evaluate the efficacy of a variety of sampling gears and the procedures employed by different investigators to sample micronekton in the North Pacific and other parts of the world ocean. An initial field effort will involve a 10-day (October 4–13, 2004) research cruise in Hawaiian waters just prior to the PICES Thirteenth Annual Meeting in Honolulu. The Hawaii cruise will serve two purposes: (1) to compare the performance of different types of sampling gears

in an oligotrophic subtropical gyre to see how the choice of gear affects our perspective of the micronekton community; and (2) to use the relatively benign sea conditions of the subtropics to evaluate and refine protocols, logistics, and sampling designs. The morning workshop will review preliminary data and findings from the cruise, while the afternoon meeting of the MIE-Advisory Panel will discuss the goals, objectives, and status of the experiment and the future field program.

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

2005 Report of the Advisory Panel on *Micronekton Sampling* *Inter-calibration Experiment*

The Advisory Panel on *Micronekton sampling inter-calibration experiment* (MIE-AP) has been focusing on fieldwork and did not convene meetings or workshops in 2005.

Membership changes

Since PICES XIII, several changes in membership have occurred to the Advisory Panel. New members include Drs. Alexei Baitalyuk and Oleg Ivanov of the Pacific Fisheries Research Center (TINRO-Center) representing Russia, and Dr. Orio Yamamura of the Hokkaido National Fisheries Research Institute representing Japan. Dr. Yamamura has also been appointed to co-chair MIE-AP replacing Dr. Michael Seki, who stepped down as Co-Chairman but remains as a member of the Panel.

Inter-sessional report, March 2005

Dr. Michael Seki summarized the activities and plans of MIE-AP in March 2005, prior to the inter-sessional Science Board/Governing Council meeting. After the successful completion of the initial MIE-1 in Hawaiian waters just prior to PICES XIII, the Panel began plans to conduct the experiment (MIE-2) in waters of the Bering Sea (possibly in conjunction with a BASIS cruise), Gulf of Alaska, or the temperate waters of the western Pacific. A second attempt to obtain funding from the North Pacific Research Board through the 2004–05 request for proposals was not successful. Nevertheless, Dr. Yamamura offered two cruises in 2005 (July 5–11 and September 27–October 3) aboard the Hokkaido University research ship, *Hokko Maru*, to conduct MIE-2 in waters of the western Pacific off Kushiro, Japan. The R/V *Hokko Maru* is a state-of-the-art 200' stern trawler (905t) equipped with a MOCNESS-10 (enabling discrete depth sampling) and capabilities to deploy other mid-water sampling gear including stern trawls equipped with a MULTI-SAMPLER (an opening-closing multiple codend system). Transit time to sampling sites

would be minimal at just 30 minutes after departure from Kushiro. At that time (March 2005), no firm decisions have been made with regard to proceeding with MIE-2. As for MIE-1, processing of samples collected on the cruise continues.

Status Report at PICES XIV

Drs. Evgeny Pakhomov and Orio Yamamura (MIE-AP Co-Chairmen) provided an update of activities and plans for the period from the inter-sessional report until PICES XIV.

MIE-1 cruise

In 2005, samples collected during the MIE-1 cruise in Hawaiian waters have been transported to the University of British Columbia, where detailed analysis of the sample size-structure has been carried out. Presently, the catch size-structure analysis is in its final stage, and Dr. Pakhomov is going to present the findings at the BIO Committee meeting in Vladivostok.

MIE-2 cruise

Just prior to PICES XIV, the second MIE cruise (MIE-2) took place. The cruise, provisionally scheduled for September 27 to October 3, on board R/V *Hokko Maru* was extended by 2 days and was conducted between September 25 and October 3, 2005. Dr. Yamamura served as the Chief Scientist. The cruise started and ended at Kushiro. The experiment was conducted in the Doto area where the cold Oyashio current prevails. This area represents a relatively simple and stable species composition of micronekton, which makes it fairly easy to compare sampling efficiency of different gears. Since the areas where nets have to be deployed are just 1–2 h sail from the port of Kushiro, it was possible to split the cruise into two legs to accommodate those who can participate in either the first or second half of the cruise only.

The nets deployed in the experiment include MOCNESS-10, 10 ft IKMT, HUFT (Hokkaido University Frame Trawl), MOHT, and mid-water otter trawling net with a mouth opening of *ca.* 30 × 30 m and opening/closing multiple codends. The R/V *Hokko Maru* is equipped with a Simrad EK-60 echosounder that can monitor and record backscattering from micronekton.

MIE-3 cruise

Plans for the 2006 (MIE-3) cruise in the Bering Sea are proposed to coincide with the 2006 NPAFC BASIS program activities in this area. A formal letter has been sent to NPAFC representatives to determine if there is any interest in doing a joint cruise to the Bering Sea in 2006 using one of the BASIS project vessels.

The initial response is promising. Dr. Richard Brodeur is planning to meet with NPAFC

representatives at the joint NPAFC/PICES Symposium in November 2005 to discuss the MIE-3 cruise proposal. Attempts will be made to obtain financial support for MIE-3 from the North Pacific Research Board during 2006. So far, no financial support has been obtained for these experiments.

MIE Workshop and Topic Session at PICES XV

As the dates of the MIE-2 cruise overlap, in part, with PICES XIV, there will be no MIE workshop and business meeting this year. At the next PICES Annual Meeting in Yokohama, MIE-AP would like to convene a 1-day BIO Workshop on “*Synthesis of MIE-AP sampling inter-calibration experiments*” (MIE-AP Endnote 1) and a 1-day BIO Topic Session on “*Micronekton biology: Advances in epi- and meso-pelagic ecosystem research*” (MIE-AP Endnote 2).

MIE-AP Endnote 1

Proposal for a 1-day BIO (MIE-AP) Workshop at PICES XV on “*Synthesis of MIE-AP sampling inter-calibration experiments*”

The Advisory Panel on *Micronekton sampling inter-calibration experiment* (MIE-AP) was established to evaluate efficiency of a variety of sampling gears and procedures employed by different investigators to sample micronekton in the North Pacific and other parts of the world ocean. Two MIE-AP gear inter-calibration experiments were conducted in 2004 (MIE-1 cruise on board of R/V *Oscar Elton Sette*, in

Hawaiian waters) and in 2005 (MIE-2 on board of R/V *Hokko Maru*, in the Oyashio region). The proposed workshop will review and synthesize findings from these two successful sampling experiments.

Recommended convenors: Evgeny Pakhomov (Canada) and Orio Yamamura (Japan).

MIE-AP Endnote 2

Proposal for a 1-day BIO (MIE-AP) Topic Session at PICES XV on “*Micronekton biology: Advances in epi- and meso-pelagic ecosystem research*”

Micronekton is an important component of epi- and meso-pelagic ecosystems linking meso-zooplankton and higher trophic levels. Due to their intermediacy and mobility, quantitative sampling of micronekton has long been regarded as virtually impossible. Recent advances in acoustic devices and efforts in standardizing sampling gear have made the sampling of micronekton more precise. In the PICES area, various ongoing projects such as BASIS (NPAFC), US-GLOBEC and DEEP (Japan FRA) are

studying micronekton. The session will synthesize new knowledge on micronekton biology including distribution, life history and vertical migrations, relationships with commercial species and its functional role in the North Pacific boundary current and open ocean ecosystems. Presentations on quantitative sampling are also welcome.

Recommended convenors: Evgeny Pakhomov (Canada) and Orio Yamamura (Japan).

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

2006 Report of the Advisory Panel on *Micronekton Sampling Gear Inter-calibration Experiment*

The PICES Advisory Panel on *Micronekton sampling inter-calibration experiment* (hereafter MIE-AP) was established to evaluate efficacy of sampling gears and the procedures employed by different investigators to sample micronekton in the North Pacific and other parts of the world's oceans.

MIE-AP met on the morning of October 13, 2006. After brief introductions of the participants (*MIE-AP Endnote 1*), a total 4 presentations were made on the results and data processing from the two field experiments organized by the Panel in 2004 and 2005, followed by questions and brief discussions on future activities (*MIE-AP Endnote 2*).

MIE-AP workshop (Agenda Items 2 and 3)

The workshop (W9) reviewed data and results from the MIE-1 cruise (off the west side of Oahu Island, Hawaii, October 6–13, 2004) and the MIE-2 cruise (in Oyashio waters off Japan, September 27–October 3, 2005). Sample processing and analysis was discussed, as were other sampling gears to be compared, and plans for the MIE-3 experiment. The summary of the workshop can be found in the *Session Summaries* chapter of this Annual Report.

MIE-AP future activities (Agenda Item 4)

Further data analysis

Although substantial progress has been achieved in the analysis of the MIE-1 and MIE-2 data, further analyses are required. In particular:

- The size-structure approach used by Dr. Evgeny Pakhomov for the MIE-1 data could be applied to the MIE-2 data sets.
- An inter-comparison between the MIE-1 and MIE-2 data should be attempted.
- The acoustic data need to be analyzed and compared in the light of gear densities. At first, this should be done separately for each cruise.

Other sampling gears to be tested

- The results of the MIE-2 experiment revealed that the MOHT gear is among the most reliable and cost-effective micronekton gear developed to date, providing high quality and quantity micronekton samples. The development of a closing/opening mechanism could put this gear in the position to become a standard micronekton gear in the North Pacific and elsewhere in the world.
- It has been noted that the RMT-8 gear, as well as Russian micronekton sampling gear, should be included in future experiments to allow comparisons.
- Dr. Hiroya Sugisaki presented some preliminary results on the development a novel technology (a combination of acoustic and high resolution video imaging) to quantify deep-sea micronekton. MIE-AP felt that this technology could be beneficial and encouraged Dr. Sugisaki to describe the preliminary results of trials during the next PICES Annual Meeting.

Possibility of the MIE-3 experiment

MIE-AP felt strongly that a third experiment (MIE-3) is required to complete the geographical coverage, and to include gear types that were missed during the first two inter-comparisons. The major problem at the moment is the availability of ship time, and in this regard MIE-AP suggests pursuing three options:

- MIE-AP should work towards establishing a joint NPAFC-PICES research activity on micronekton sampling and conduct MIE-3 in the Bering Sea. Initial and encouraging contacts have already been made and will be followed in the forthcoming year.
- Dr. Orio Yamamura will apply for ship time (likely for R/V *Hokko-Maru*) to carry out the MIE-3 experiment off Japan.

- The possibility of obtaining ship time for the MIE-3 experiment either in the Bering or Okhotsk Sea should be negotiated with the Russian Delegation.

In the light that the Panel activities will largely be concentrated in the northern Pacific seas, MIE-AP felt strongly that the membership of the Advisory Panel should be increased, particularly from Russia and the United States.

Proposal of workshop/session at PICES XVI

MIE-AP proposed to convene a workshop at PICES XVI on “*Lessons learned during MIE-1 and MIE-2: Reconciling acoustics and trawl data*” with the objectives of (a) finalizing MIE-1 and MIE-2 analyses, (b) presenting and discussing acoustic data sets from both cruises, (c) comparing ICES and PICES inter-calibration experiments, and (d) discussing recent developments in the field of micronekton quantitative techniques (*MIE-AP Endnote 3*). Travel funds from PICES are requested for two invited speakers.

MIE-AP Endnote 1

Participation list

Members

Richard D. Brodeur (U.S.A.)
Kazushi Miyashita (Japan)
Evgeny A. Pakhomov (Canada, Co-Chairman)
Orio Yamamura (Japan, Co-Chairman)

Observers

Yoshioki Oozeki (Japan)
Larissa Pakhomova (Canada)
Hiroya Sugisaki (Japan)
Andrei V. Suntssov (Russia)
Hiroki Yasuma (Japan)

MIE-AP Endnote 2

MIE-AP meeting agenda

- Welcome and introductions
- MIE-1 results and data processing:
 - E.A. Pakhomov, M.P. Seki, A.V. Suntssov, R.D. Brodeur and K.R. Owen. *Comparison of three sampling gears during the first Micronekton Intercalibration Experiment (MIE-1): Size composition of selected taxonomic groups and total macroplankton and micronekton*
 - A.V. Suntssov, M.P. Seki, E.A. Pakhomov and R.D. Brodeur. *Diversity and abundance of Hawaiian ichthyoplankton: Comparison of three types of midwater nets*
- Discussion on MIE-2 results and data processing:
 - O. Yamamura, H. Sugizaki, S. Abe, K. Sadayasu, R.-I. Matsukura, K. Miyashita, A. Hino and T. Tokai. *Inter-calibration of micronekton sampling gear during the 2005 MIE-2 cruise*
 - H. Yasuma, K. Miyashita and O. Yamamura. *Acoustic identification and density estimate of a lanternfish, Diaphus theta, off Hokkaido, Japan*
- Discussion on future MIE-AP activities:
 - further data analysis
 - other sampling gears to be tested
 - possibility of the MIE-3 experiment
 - workshop/sessions at PICES XVI

MIE-AP Endnote 3**Proposal for a 1/2 or 3/4 -day workshop at PICES XVI on
“Lessons learned during MIE-1 and MIE-2: Reconciling acoustics and trawl data”**

Micronekton is one of the important but largely understudied components of marine ecosystems functionally linking small zooplankton and higher trophic levels. Recent advances in acoustic devices and efforts to standardize sampling gears undertaken by both PICES and ICES communities have made the sampling of micronekton more precise. Nevertheless, the issue of inter-calibrating the growing number of micronektonic gears is still unresolved. The PICES Advisory Panel on *Micronekton sampling inter-calibration experiment* (MIE-AP) organized two field experiments (off Hawaii in 2004 and off Japan in 2005) to collect comparative data for several

micronekton sampling gears and a wealth of acoustic information. The main objective of this workshop will be: (1) to finalize the analysis and to compare MIE-1 and MIE-2 data sets; (2) to present and discuss acoustic data sets from both cruises; (3) to compare ICES and PICES inter-calibration experiments; and finally (4) to discuss new developments in the field of micronekton quantitative techniques.

Recommended convenors: Evgeny A. Pakhomov (Canada) and Orio Yamamura (Japan).

PICES Fifteenth Annual Meeting Workshop Summary

MIE-AP Workshop W9

Micronekton sampling gear inter-calibration experiment

Convenors: Evgeny A. Pakhomov (Canada) and Orio Yamamura (Japan)

Background

The PICES Advisory Panel on *Micronekton sampling inter-calibration experiment* (MIE-AP) was established to evaluate efficacy of sampling gears and the procedures employed by different investigators to sample micronekton in the North Pacific and other parts of the world's oceans. MIE-AP carried out their first 8-day cruise from October 6–13, 2004, aboard the NOAA ship *Oscar Elton Sette* in Central North Pacific waters off the west side of Oahu Island (MIE-1). The second cruise (MIE-2) took place from September 27 to October 3, 2005, on board R/V *Hokko Maru* in Oyashio waters off Japan. The workshop reviewed data and findings from both cruises.

Summary of presentations

Pakhomov *et al.* recommended pursuing the use of larger size-classes of micronekton (10 mm instead of 5 mm) for inter-comparison of gears. They noted that the Cobb trawl mouth area should be adjusted according to the mesh size, which really catches micronekton. The use of total mouth area can result in underestimating plankton and micronekton densities. It was suggested that perhaps acoustic data should be encouraged to become an “ideal” universal gear.

Suntsov *et al.* provided a remarkable overview of ichthyoplankton and an inter-comparison of their diversity between different gears. It also appears

from their research that the Hokkaido net was the best gear for the quantitative and qualitative sampling of fish larvae. Two important questions were raised in this presentation: (a) What kind of analysis (*e.g.* community structure analysis) could be conducted with the data sets? and (b) Would further analysis of the adult population be beneficial for the community analysis of larvae?

Yamamura *et al.* compared six different sampling gears during their MIE-2 cruise. Sample composition, to a large extent, was mono-specific, which simplified the inter-calibration. Their experiment revealed that the MOHT gear is among the most reliable and cost-effective micronekton gear developed to date, providing high quality and quantity micronekton samples. The development (in progress) of a closing/opening mechanism could put this gear in the position to become a standard micronekton gear in the North Pacific and elsewhere in the world. It was also found that towing speed matters, *e.g.* MOHT had the fastest towing speed, which raises standardization issues.

Yasuma *et al.* presented very encouraging results of developing a technique for an acoustic identification of myctophid fishes. The inter-comparison between acoustic and gear estimates of micronekton was highly recommended as the next step. Concern was raised on how organism orientation affects the target strength estimates. Authors were strongly encouraged to continue their analyses.

List of papers

Oral presentations

Evgeny A. Pakhomov, M.P. Seki, A.V. Suntsov, R.D. Brodeur and K.R. Owen

Comparison of three sampling gears during the first Micronekton Intercalibration Experiment (MIE-1): Size composition of selected taxonomic groups and total macroplankton and micronekton

Andrey V. Suntsov, Michael P. Seki, Evgeny A. Pakhomov and Richard D. Brodeur

Diversity and abundance of Hawaiian ichthyoplankton: Comparison of three types of midwater nets

Orio Yamamura, Hiroya Sugizaki, Shin-suke Abe, Kazuhiro Sadayasu, Ryu-ichi Matsukura, Kazushi Miyashita, Akihiro Hino and Tadashi Tokai

Inter-calibration of micronekton sampling gear during the 2005 MIE-2 cruise

Hiroki Yasuma, Kazushi Miyashita and Orio Yamamura

Acoustic identification and density estimate of a lanternfish, *Diaphus theta*, off Hokkaido, Japan

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

2007 Report of the Advisory Panel on *Micronekton Sampling Inter-calibration Experiment*

A subset of the Advisory Panel on *Micronekton Sampling Inter-calibration Experiment* (hereafter MIE-AP) and several observers (*MIE-AP Endnote 1*) met on the evening of October 28, 2007, immediately after the BIO workshop on “*Lessons learned during MIE-1 and MIE-2: Reconciling acoustics and trawl data*”. Details of this workshop (W1) can be found in the *Session Summaries* chapter of this Annual Report. Discussion topics of the MIE-AP meeting are listed in *MIE-AP Endnote 2*.

Developments in micronekton quantification (Agenda Item 1)

Models were developed to predict backscattering volume to allow for comparisons between acoustic data and the net data. The new system, J-QUEST, was shown to quantify the epipelagic micronekton and nekton but appeared to be inefficient in detecting the mesopelagic fishes, and myctophids in particular. The discussion revolved around the possibility of using a red light or another part of the light spectrum to which myctophids are less sensitive. Experimental trials indicated that myctophids were able to detect and avoid J-QUEST while it used red light.

After briefly reviewing current sampling gears, present information points to the Matsuda–Oozeki–Hu Trawl (MOHT) gear as being among the most reliable and cost effective micronekton gears to date. It provides high quality and quantity micronekton sampling. Dr. Hiroya Sugisaki reported that the development of a closing/opening mechanism is underway (trials are to be conducted within months). Equipping MOHT with the opening/closing mechanism on the codend could put this gear in the position to become a standard micronekton gear world-wide, and in the North Pacific, in particular.

Comparison between ICES and PICES inter-calibration experiments (Agenda Item 2)

After a brief review of both ICES and PICES micronekton inter-calibration experiments, the Panel concluded that it is generally impossible to undertake a comparison of these experiments due mainly to incomparable gears used for sampling, and because the ICES experiment concentrated on mesozooplankton in a fjord system in Norway.

Progress on acoustic data analyses (Agenda Item 3)

Acoustic data from the MIE-2 cruise (Oyashio waters off Japan, September 27–October 3, 2005) are mostly analyzed and reconciled with the trawl data. Acoustic data collected during the MIE-1 cruise (off the west side of Oahu Island, Hawaii, October 6–13, 2004) still require some work and cleaning. Data collected during the MIE-3 cruise (the eastern Bering Sea, September 18–27, 2007) have yet to be released by the U.S. colleagues who provided the vessel. The data will be analyzed jointly by Japanese and U.S. scientists.

Compatibility of acoustic and trawl data (Agenda Item 4)

Preliminary results indicate that the comparability of the trawl and acoustic estimates is low. This points to problems associated with both sampling techniques, which have been discussed. The closest results were obtained between MOHT and acoustics. MIE-AP felt that research to improve the acoustics estimates should be continued.

Overview of MIE-3 (Agenda Item 5)

The third micronekton inter-calibration experiment (MIE-3) was carried out onboard the R/V *Oscar Dyson* in the eastern Bering Sea, from September

18–27, 2007. The ship was engaged in the BASIS (Bering-Aleutian Salmon International Surveys) program under NPAFC, (North Pacific Anadromous Fish Commission) operated by the Auke Bay Laboratory, NOAA/NMFS. Dr. Jim Murphy kindly donated the ship time for the micronekton experiment. This experiment was led by Dr. Orio Yamamura (Hokkaido National Fishery Research Institute, Japan). Other participants included: Drs. Hiroki Yasuma (Hokkaido University, Japan) and Andrey Suntsov (Northwest Fisheries Science Center, U.S.A.).

The sampling gears planned to be compared were the 1.8-m Isaacs–Kid mid-water trawl (IKMT), MOHT and Cantrawl 300/262 rope trawl. However, due to the limited time available for the experiment, only IKMT and MOHT were used. A comparison between IKMT and MOHT was essential because there are so much historical data collected with an IKMT. Aside from the sampling gears, backscattering data were recorded using a Simrad EK-60 echosounder with 15, 38, 70, 120 and 200 kHz transducers.

Due to rough seas, the ship time assigned for the experiment was reduced to 24 hours. Therefore, the nets were deployed at a 60-m depth station near St. Paul Island instead of near the shelf break of the eastern Bering Sea. The sampling was in a day/night sequential design, with different gears towed sequentially at each location, with triplicate samples collected during daylight and night at the same ship speed (3 knots).

The catch was exclusively dominated by age-0 walleye pollock (>99%), offering a good opportunity for gear comparison. The nets showed similar catchability during daytime (1.1 times larger for MOHT in density estimate), but MOHT showed significantly higher catchability in night sampling (2.8 times higher). In the comparison of body length frequency distribution, MOHT caught slightly larger fish than IKMT, suggesting net avoidance from the latter net.

The echo sounding data are yet to be released by the U.S. colleagues and will be analyzed jointly by Japanese and U.S. scientists.

Future activities (Agenda Item 6)

The members of MIE-AP felt that there will be no further inter-calibration experiments. It appears to be extremely difficult to obtain ship time, and the Panel expressed its gratitude to the member countries that donated the ship time to conduct three experiments. The participants also concluded that much of the data have been worked up at this point, and some encouraging results were obtained.

There was unanimous agreement for the suggestion that it was time to prepare the final MIE-AP report and to write related publications in the peer-reviewed literature. It was suggested that some travel funds should be requested to facilitate the data analysis. In particular, the identification of fish and crustaceans collected during the MIE-1 cruise should be completed before writing the final report. In this regard, MIE-AP requested PICES to cover travel expenses for Dr. Suntsov to come from the Northwest Fisheries Science Center (Newport, Oregon) to the University of British Columbia (Vancouver) for 7–10 days to assist with fish identification. Furthermore, the MIE-3 cruise data need to be worked up.

Realistically, an advanced report on the MIE-AP activities could be available at the next PICES Annual Meeting in Dalian, China. Most of the work has been divided between groups of experts, and MIE-AP Co-Chairmen were charged with the task of overseeing the progress. To facilitate the development of the final report, MIE-AP requested financial support for one of Co-Chairmen (Dr. Evgeny Pakhomov) to travel to Dalian.

Below is a preliminary draft of the MIE-AP final report structure (the names listed in parentheses are responsible for writing each section):

1. Introduction, background, major idea of micronekton inter-calibration experiments (Brodeur, Pakhomov, Yamamura)
2. MIE-1
 - Description of the experiment
 - Composition and diversity indices of the samples: crustaceans (Pakhomov, Brodeur), fish (Suntsov), squid (Seki)
 - Abundance and (biomass) of the micronekton
 - Size structure (Pakhomov)

- Acoustic data (Domokos)
 - Inter-comparison between gears and between gears and acoustics (All, lead: Pakhomov, Domokos)
3. MIE-2
 - Description of the experiment
 - Composition and diversity indices of the samples: crustaceans (Yamamura), fish (Yamamura), squid (Yamamura)
 - Abundance and (biomass) of the micronekton
 - Size structure (Yamamura)
 - Acoustic data (Yasuma)
 - Inter-comparison between gears and between gears and acoustics (lead: Yamamura)
 4. MIE-3
 - Description of the experiment
 - Composition and diversity indices of the samples: crustaceans (Yamamura), fish (Suntsov, Yamamura), squid (Yamamura)
 - Abundance and (biomass) of the micronekton (Yamamura)
 - Size structure (Yamamura, Suntsov)
 - Acoustic data (Yasuma)
 - Inter-comparison between gears and between gears and acoustics (lead: Yamamura)
 5. General conclusions and recommendations.

MIE-AP Endnote 1

Participation list

Members

Richard D. Brodeur (U.S.A.)
 Kazushi Miyashita (Japan)
 Evgeny A. Pakhomov (Canada, Co-Chairman)
 Orio Yamamura (Japan, Co-Chairman)

Reka Domokos (U.S.A.)
 Yasuzumi Fujimori (Japan)
 Hideki Hamaoka (Japan)
 Julian A. (Tony) Koslow (U.S.A.)
 Todd W. Miller (U.S.A.)
 A. Jason Phillips (U.S.A.)
 Hiroaki Saito (Japan)
 Hiroya Sugisaki (Japan)
 Andrei V. Suntsov (U.S.A.)
 Hiroki Yasuma (Japan)

Observers

Seok-Gwan Choi (Korea)

MIE-AP Endnote 2

MIE-AP meeting agenda

1. New developments in the field of micronekton quantification: Could acoustics be the way forward?
2. Is it possible to undertake a comparison between ICES and PICES inter-calibration experiments?
3. How far are we in the acoustic data set analyses?
4. Compatibility of acoustic and trawl data: Caveats, problems and solutions
5. Lessons from the MIE-3 cruise
6. An inter-sessional workshop to look at the data from 3 inter-calibration experiments and to discuss drafting of the MIE-AP report (schedule, contents and allotment of writers)

PICES Sixteenth Annual Meeting Workshop Summary

BIO Workshop (W1)

Lessons learned during MIE-1 and MIE-2: Reconciling acoustics and trawl data

Co-Convenors: Evgeny A. Pakhomov (Canada) and Orio Yamamura (Japan)

Background

Micronekton is one of the important but largely understudied components of marine ecosystems functionally linking small zooplankton and higher trophic levels. Recent advances in acoustic devices and efforts to standardize sampling gears undertaken by both PICES and ICES communities have made the sampling of micronekton more precise. Nevertheless, the issue of inter-calibrating the growing number of micronektonic gears is still unresolved. The PICES Advisory Panel on *Micronekton Sampling Inter-calibration Experiment* (MIE-AP) organized two field experiments (off Hawaii in 2004 and off Japan in 2005) to collect comparative data for several micronekton sampling gears and a wealth of acoustic information. The main objective of this workshop was: (1) to finalize the analysis and to compare MIE-1 and MIE-2 data sets; (2) to present and discuss acoustic data sets from both cruises; (3) to compare ICES and PICES inter-calibration experiments; and finally (4) to discuss new developments in the field of micronekton quantitative techniques.

Summary of presentations

Two contributions on the analysis of acoustic data described attempts to compare acoustic data with the densities of micronekton estimated by trawling during MIE-1 and MIE-2 cruises. The main conclusion was that the acoustic data represented an important technique to quantify micronekton. While showing some significant progress, both failed to reconcile the acoustic and trawl data. The main problems were associated with:

- additional noise induced by other acoustic systems during the MIE-1 experiment;
- absence of target strength measurements for the micronekton species (particularly for MIE-1); and

- undersampling the micronekton due to net avoidance or loss of gelatinous zooplankton (both MIE-1 and MIE-2).

J-QUEST technology for observing and quantifying micronekton using acoustics and video appeared to be very advantageous for resolving some outstanding issues between acoustic and trawl density assessments, although it still has some difficulties in species identification of micronekton. MIE-AP concluded that using acoustics in a diverse community (*e.g.* MIE-1) requires numerous measurements of the individual species target strengths. The absence of such measurements translates into large discrepancies between acoustic and trawl density estimates. At the same time, when only a few species dominate the micronekton community (*e.g.* MIE-2), it is possible to achieve reasonable agreement between acoustic and trawl density estimates. It was concluded that a newly developed MOHT net appears to be consistently the best sampling gear for micronekton and perhaps should be recommended as a standard gear for use by PICES nations to collect micronekton.

After looking at the intercomparison of gears used during the MIE-1 and MIE-2 cruises, MIE-AP concluded that when a small number of species (or a single species) was dominant in micronekton community, the intercalibration between gear types appeared to be a relatively straight forward exercise. The catchability ratios between gear types produced comparable densities. However, in a highly diverse community, as it was during MIE-1, only the size composition data of large taxonomic groups lumped into 10-mm size intervals can be compared quantitatively with any success. This approach allowed the calculation of intercalibration coefficients between three gear types used during MIE-1 and yielded relatively accurate (within 12–30%) intercomparison of micronekton densities obtained by different gears.

List of papers*Oral presentations*

Réka Domokos, Evgeny A. Pakhomov, Michael P. Seki and Jeffrey J. Polovina (Invited)

Acoustic characterization of the mesopelagic community off the Leeward coast of Oahu, Hawaii

Hiroki Yasuma, Kazushi Miyashita and Orio Yamamura

Acoustic monitoring of a lanternfish *Diaphus theta* in the northwestern Pacific

Evgeny A. Pakhomov, M.P. Seki, A.V. Suntov, R.D. Brodeur and K.R. Owen

Inter-comparison of three sampling gears during the first Micronekton Intercalibration Experiment (MIE-1): Size composition approach

Hiroya Sugisaki and Koichi Sawada (Invited)

Introduction to J-QUEST research project: Quantification of micronekton using an integrated system of echosounder and stereo TV cameras

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

2008 Report of the Advisory Panel on *Micronekton Sampling Inter-calibration Experiment*

At the 2007 Annual Meeting, the Advisory Panel on the *Micronekton Sampling Inter-calibration Experiment* (MIE-AP) prepared to submit a draft of the final report at the time of 2008 Annual Meeting. However, the necessity of conducting additional sample analyses from the MIE-1 and MIE-2/3 cruises caused a delay in the preparation of the draft report. Consequently, the Advisory Panel decided to postpone the draft submission until PICES-2009. A brief description of the analyses, presently ongoing, follows.

MIE-1

Scientists participating in MIE-1 have finished identification of all fish and squid specimens collected during the cruise, but they still have some crustacean samples to identify. Although about half samples have already been analyzed, currently the complete size- frequency analyses of all crustaceans and other plankton from remaining samples are underway. The addition of more samples will provide higher statistical power in the comparative analysis by reducing the deviation of data.

To date, three papers directly from the results of the cruise are at different stages of preparation (sampling gear comparison, comparison between nets vs. acoustics, and fish larvae).

MIE-2 and 3

Comparison of sampling efficiency for dominant fish species has been finished for both of the cruises. But that for euphausiids, including size-frequency distribution, is underway. Scientists at Hokkaido University analyzed acoustic data obtained during the MIE 2/3 cruises, including density estimate and geostastical analyses of fish/euphausiids. Publication of two papers are anticipated from the gear comparison (one for comparison of sampling efficiency of fish by different fishing gears; another for euphausiids), and one paper from the net/acoustic comparison. Scientists at Hokkaido University analyzed acoustic data obtained during the MIE 2/3 cruises, including density estimate and geostastical analyses of fish/euphausiids.

Apart from these analyses, Japanese scientists made a cruise to test J-QUEST, an integrated system to visualize and quantify micronekton, in August 2008. A topical issue for this year is a new lighting apparatus which is invisible to fish and therefore does not affect fish behavior. The development of J-QUEST will be summarized in the final report.

Appendix 4

PICES Press Articles

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Micronekton - What are they and why are they important?

Richard D. Brodeur, Michael P. Seki, Evgeny A. Pakhomov and Andrey V. Suntsov

Background

Micronekton are relatively small but actively swimming organisms ranging in size between plankton (< 2 cm), which drift with the currents, and larger nekton (> 10 cm), which have the ability to swim freely without being overly affected by currents. Although there are some precise definitions based on Reynolds numbers, micronekton may be operationally defined as taxa too vagile to be caught with conventional plankton nets and too small to be retained by most large-meshed trawls. Micronekton are diverse taxonomically. The principal groups include the cephalopods (small species and juvenile stages of large oceanic species), crustaceans (including adult euphausiids, pelagic decapods and mysids), and fishes (mainly mesopelagic species and juveniles of pelagic nekton). Although not generally fished commercially because of their relatively small size and high lipid content, mesopelagic fishes represent a substantial biomass in oceanic waters and are a critical but poorly understood intermediate trophic link between the mesozooplankton and the higher trophic levels including fishes, seabirds and marine mammals. Many studies have shown that micronektonic species are a primary food source for a wide variety of harvested nektonic species.



Fig. 1 Diversity of life forms considered as micronekton.

Many micronektonic species can be found close to shore or near the sea surface (e.g., Abookire *et al.*, 2002, *Fish. Bull. U.S.*, 100: 376-380), but most occur in the midwater

pelagic realm mainly at the edge of, or beyond the continental shelves. Indeed, micronekton are one of the most conspicuous and ecologically-important components of the vast mesopelagic zone of the world's oceans, arguably the largest and one of the least variable ecosystems on the planet. This dark, cold, and relatively unproductive system extends from around 200 m to depths greater than 1000 m, and many of these organisms have evolved unique adaptations to this environment (Fig.1). Most mesopelagic micronektonic organisms undertake extensive vertical migrations on a daily basis, occupying the productive surface waters at night and descending to midwater during the daytime to reduce predation. Diel vertical migration of micronekton has been shown to contribute significantly to the rapid vertical transport of organic material from epipelagic to mesopelagic zones, referred to as the biological pump, where carbon fixed as living organic matter plus anthropogenic substances, such as insecticides and pollutants, are transported to deep-sea ecosystems. These micronektonic organisms in turn may be consumed by epipelagic predators in the near-surface waters, large nekton such as tunas, sharks and swordfishes that migrate diel with the micronekton, and deep-sea fishes that migrate up to midwater. All of these predators capitalize on this vast and highly predictable food source.

Despite their importance to many consumers in the ocean, relatively scant attention has been paid to micronekton as a whole, especially compared to the primary consumer and top trophic levels that they link. Much of what is known and published in the literature was generated in the 1960s and 1970s and was not synthesized in any manner. A need was identified within the PICES community, especially among the ecosystem modelers, for a summary of the available information on micronekton in the North Pacific. In response to this, a scientific session dedicated to micronekton was held during the 1997 PICES Annual Meeting in Pusan, Korea, that brought together a large number of experts within the North Pacific region. It was at that time that a proposal was put forth to establish a PICES Working Group to assimilate knowledge of micronekton and their sampling in the North Pacific. This led to the formation of Working Group 14 (WG 14) on *Effective sampling of micronekton* which met for the first time in 2000. Initial summaries of the sampling conducted by each member nation were contained in a report presented at the PICES/CoML/IPRC workshop on "Impact of climate variability on observation and prediction of ecosystem and biodiversity changes in the North Pacific" held in Honolulu, in March 2001 (Brodeur, 2001, *PICES Sci. Rep.*, 18: 86-90). Prior to the 2000 PICES Annual Meeting in Hakodate, Japan, WG 14 co-sponsored a symposium on "Advanced techniques of sampling gear and acoustic surveys for estimation of fish abundance and

behavior”, the proceedings of which has since been published electronically and available from Hokkaido University (Iida, 2003). The final report of that group (Brodeur and Yamamura (Eds.), 2005, *PICES Sci. Rep.*, **30**) synthesizes what is known about the distribution, biomass, growth, reproduction, and trophic relationships of micronekton in the North Pacific Ocean and adjacent seas, with a summary of the present state of sampling of these organisms. It also attempted to identify key knowledge gaps that should be filled in the coming years.

Included in the terms of reference was a request to examine the efficacy of available micronekton sampling gears and propose new sampling devices if the available ones were not adequate for the task. One of the recommendations included in the WG 14 report is that although a number of gears are presently being used to sample micronekton in the North Pacific and other parts of the world’s oceans, there has been little effort expended in comparing the relative sampling efficiency and selectivity of these gears. The merits and shortcomings of many different gear types for sampling micronekton have been discussed at length in reports and publications arising from the SCOR Working Group on *Methods of Sampling Micronekton* (Pearcy, 1981, *Biol. Oceanogr.*, 2(2-4): 1-456). In most studies, only one type of gear was used so it is impossible to deduce the various biases associated with each gear. Moreover, sampling gears have become more advanced in time (see review by Wiebe and Benfield, 2003, *Prog. Oceanogr.*, 56: 7-136) and the older technologies have been abandoned, often without any inter-calibration with the gears that replace them. This has hampered efforts to look at inter-decadal or even regional comparisons of micronekton composition and biomass since very often, different gears are used.

As a result of the recommendations of WG 14, PICES formed an Advisory Panel on *Micronekton sampling inter-calibration experiment* (MIE-AP) in 2002, to conduct a field study to compare micronekton sampling gears and other quantifying technologies such as acoustics and visual sampling methods, similar to that done by the International Council for the Exploration of the Sea (ICES) in the North Atlantic Ocean utilizing mainly plankton gears (Wiebe *et al.*, 2002, *ICES Coop. Res.*, 250, 25 pp). The role of MIE-AP was to oversee planning and implementation of the field program and dissemination of the results to the scientific community.

Initial field work

A preferred location is thought to be one that is known to contain high densities of all major micronektonic categories (midwater fishes, cephalopods, and crustaceans), and thus it would have to be an area that has been sampled previously to a great extent. It should also be an area that is relatively uniform over various spatial and temporal scales, and exhibits a high degree of repeatability among

repeat tows taken at the same station, so that the majority of variability between tows could be ascribed to gear differences. It is desirable that the ocean conditions in the study area be relatively calm to facilitate deployment and recovery of complex gear types. Finally, the station should be in relatively deep water but also close to shore to minimize transit time. Although there are several areas within the PICES region that meet these requirements, the one recommended by MIE-AP is the area off the Hawaiian Islands. A pilot cruise was organized by the Panel to occur just prior to the PICES Annual Meeting in Honolulu to take advantage of the possibility that many potential participants would be attending the meeting. The leeward side of Oahu was chosen as the location for the experiment for several reasons including the benign weather conditions and relatively homogeneous distribution of the target taxa.

Ship time was secured on the NOAA research vessel, the *Oscar Elton Sette*, based in Honolulu, Hawaii. This vessel is over 70 m long and has the capability to tow large dual-warp trawls requiring doors as well as large and small single-warp midwater trawls. The ship also has several additional oceanographic winches equipped with conducting cable and sufficient deck space to stage several gear types. It also has advanced acoustic and oceanographic sampling capabilities needed for such a study.

An international team of experts in micronekton taxonomy and sampling and acoustics (Table 1) was assembled for the cruise, and the ship sampled continuously for seven days, alternating among three different gears (Fig. 2): a 140 m² pelagic Cobb trawl, a 4 m² Hokkaido University Rectangular Frame Trawl (HN), and a 2-m Midwater Trawl (IKMT). Sampling was conducted entirely during daylight and night periods, avoiding the crepuscular migration periods when the mesopelagic layer was in flux. Daytime

Table 1 Micronekton inter-calibration experiment cruise participants.

Organization/Institute	Name
Institute of Ocean Sciences, Fisheries & Oceans, Canada	Douglas Yelland
Earth & Ocean Sciences, University of British Columbia, Canada	Evgeny Pakhomov Larissa Pakhomova
Graduate School of Fisheries Sciences, Hokkaido University, Japan	Masayuki Abe Hiroki Yasuma
Pacific Islands Fisheries Science Center, National Marine Fisheries Service (NMFS), U.S.A.	Michael Seki (Chief Scientist) Daniel Curran Donald R. Hawn Reka Domokos
Northwest Fisheries Science Center, NMFS, U.S.A.	Richard Brodeur
Harbor Branch Oceanographic Institution, U.S.A.	Andrei Suntsov

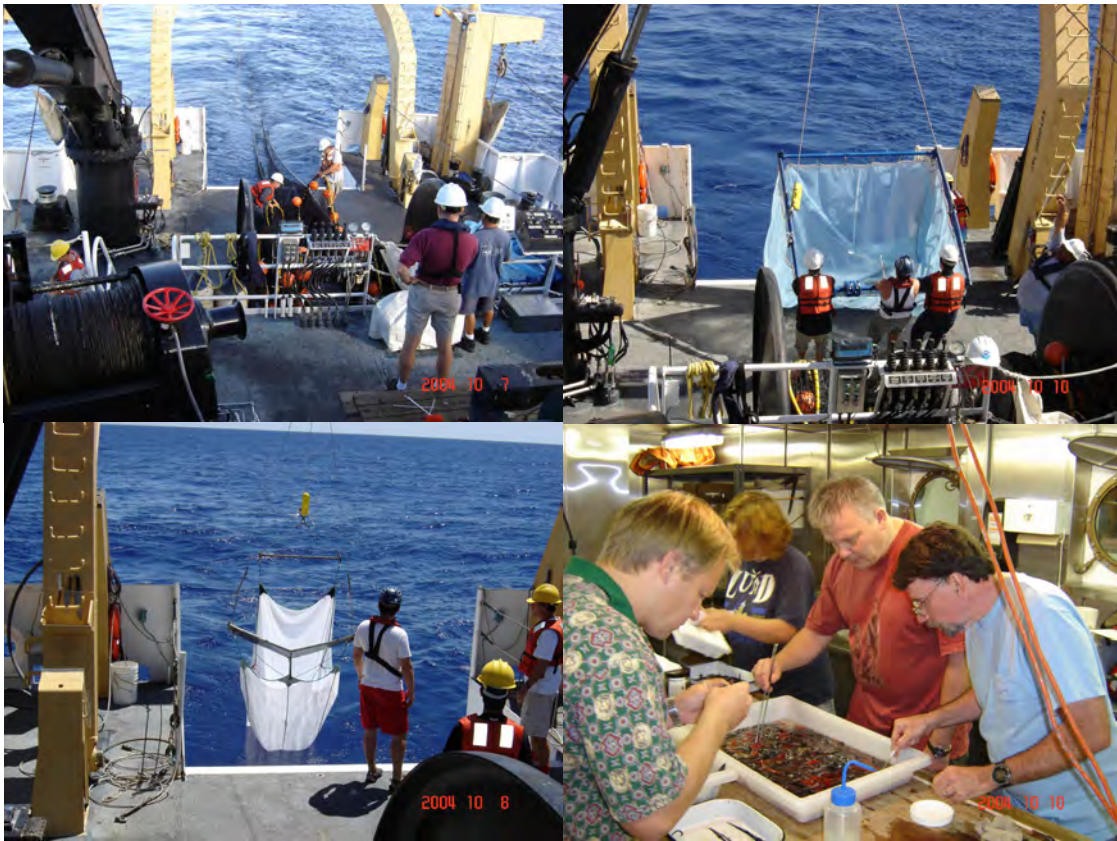


Fig. 2 Deployment of the different sampling gears and sorting the catch.

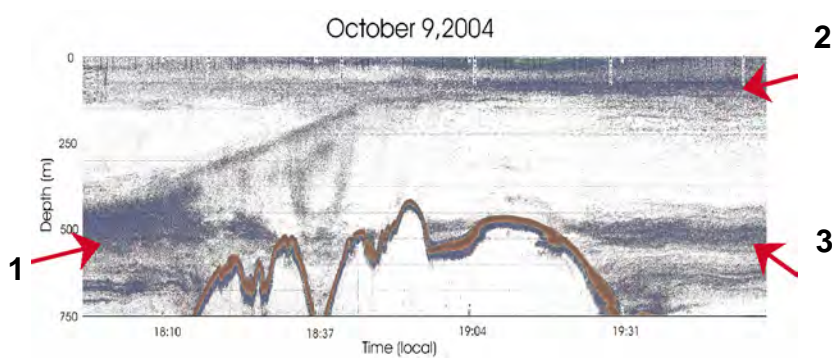


Fig. 3 An EK-60 38 kHz echogram collected from 1800-2000 h on October 9, 2004, showing the dusk migration of the scattering layer from a normal daytime depth around 550 m up to the surface, and the locations of sampling during the micronekton intercalibration experiment. (1) Day tows \approx 550 m, (2) Night tows \approx 120 m, (3) One series night tows \approx 550 m.

sampling was entirely in a deep layer (typically targeting 550 m), while nighttime sampling was mainly targeted the upper 120 m of the water column, although one series was conducted at depth to sample the non-migratory layer (Fig. 3).

Preliminary results from the cruise were presented at a MIE-AP Workshop convened prior to PICES XIII. It was found that while small sampling gears provided similar micronekton abundances, densities measured using both HN and IKT were generally significantly higher than densities obtained by Cobb trawl for main taxonomic groups sampled during the survey (Fig. 4), in part because these nets had finer mesh sizes than the Cobb trawl. The Cobb trawl, however, caught substantially larger organisms

than either of the other gears due principally to its large mouth opening.

Deployment of the three types of gear resulted in a collection of approximately 43-46 species of fishes from 24-25 families. At present, these numbers exclude all representatives of the rather speciose midwater family Myctophidae, which were not identified to species at sea. The majority of fish families (21) encountered during our sampling are truly mesopelagic with only few representatives from coastal and epipelagic communities.

The quantitative composition of the entire fish collection was very uneven, with myctophids contributing close to 60% of all specimens collected. The second most abundant

were in the family Gonostomatidae (largely due to abundant and ubiquitous *Cyclothone* spp.) which totals close to 38% of the total catch. The remaining families contributed less than 4% to the total fish collection.

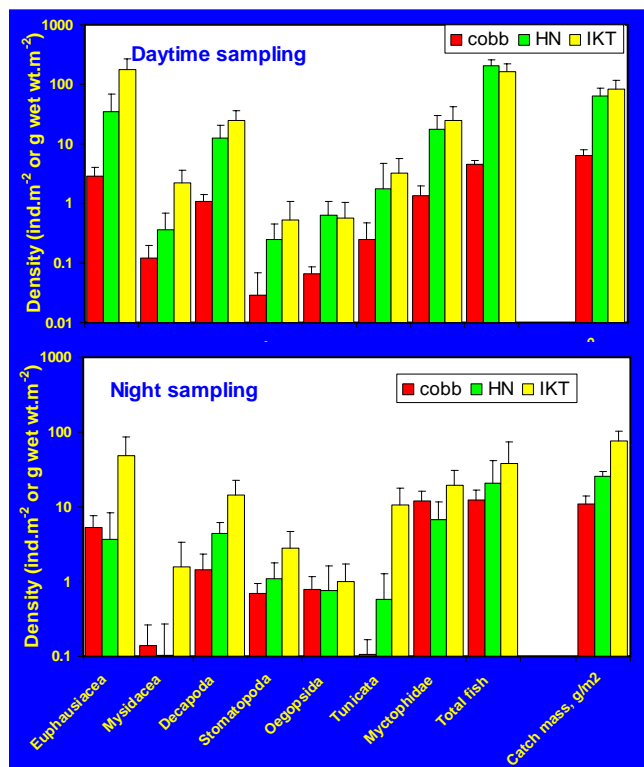


Fig. 4 Comparative catch by three sampling gears of the main taxonomic groups and overall catch biomass during day (top panel) and night (bottom panel) sampling during the inter-calibration cruise.

Based on our preliminary taxonomic treatment, we calculated basic community indices to estimate diversity, evenness and species richness (Fig. 5). As seen for densities of particular midwater groups, these indices are very similar for the HN and IKT gears. This is particularly evident for the number of species and for daytime diversity and evenness indices. Both day and night deployment of the Cobb Trawl clearly procured more species per trawl, which is also reflected in the higher diversity and evenness indices. After completing our taxonomic analysis, we expect to analyze additional data on ichthyoplankton and invertebrate abundances and species composition to complement inter-gear comparison and estimate relative catchability for each gear.

In terms of acoustics, two prominent scattering layers were observed at ~10-140 m and ~450-750 m. The surface layer was due primarily to organisms migrating to the surface at night, while the deep scattering layer was a permanent feature that may be representative of non-migratory organisms and/or organisms that migrate up from deeper

water during the night (Fig. 3). The water column between the two prominent scattering layers lacked significant backscatter indicating that the water column was basically devoid of organisms outside the layers, which was verified by a single haul during daytime that fished only the upper 300 m and came back nearly empty.

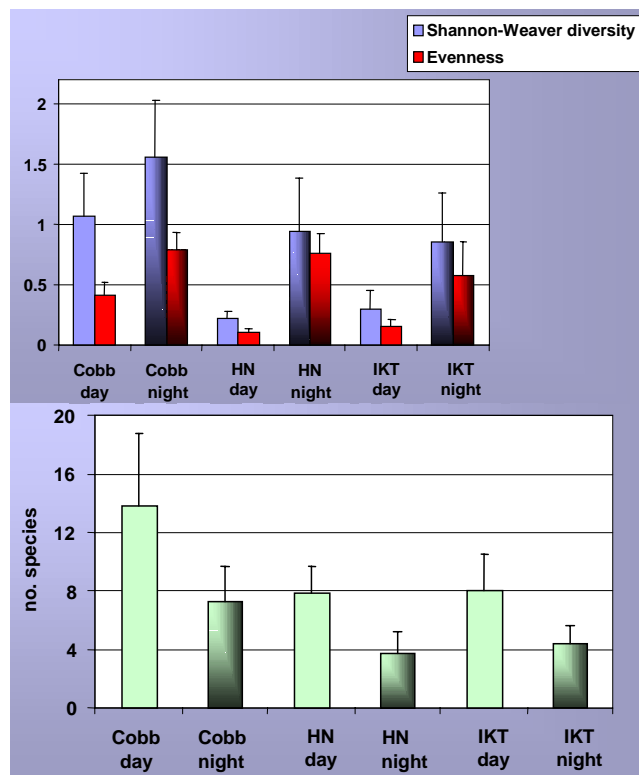


Fig. 5 Diversity and evenness indices (top panel) and total number of species (bottom panel) caught by each sampling gear by time of day.

Future directions

Preliminary analysis from the 2004 experiment indicated that individual gears sampled different, often non-overlapping, size groups of plankton and micronekton. This appeared to be relevant for our ability to interpret the data acquired from the multiple acoustic frequencies. However, it also points out that successful inter-comparisons during future cruises requires a closer scrutiny of gear-types and net mesh sizes prior to the experiment. Adoption of a “standard” sampling gear (such as a Rectangular Midwater Trawl (RMT 1+8) or a 3-m IKMT) and mesh sizes was suggested to facilitate comparisons. Based on the success and preliminary findings of the first cruise, MIE-AP recommended conducting a second experiment within the subarctic North Pacific using a larger variety of micronektonic sampling gears. This cruise is tentatively planned for summer 2005 (or 2006, depending on ship time availability) in the Bering Sea.



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Dr. Michael Seki (Michael.Seki@noaa.gov) is the Deputy Director of the Pacific Islands Fisheries Science Center located in Honolulu, Hawaii and has been with NOAA Fisheries since 1980. He has conducted studies on marine resources in the Pacific region including seabirds, sea turtles, tropical snappers, oceanic squid, tunas, and billfishes, and has authored or co-authored over 40 scientific papers on topics such as open ocean food webs (ecosystems) and the influence of the physical oceanographic environment on the distribution and abundance patterns of living marine resources. Mike received his M.S. in oceanography from the University of Hawaii, and his Ph.D. in marine environment and resources from Hokkaido University (Graduate School of Fisheries Science). Dr. Seki is the Co-Chairman of the PICES Advisory Panel on Micronekton sampling inter-calibration experiment.

Dr. Evgeny Pakhomov (epakhomov@eos.ubc.ca) is a Faculty in Biological/Fisheries Oceanography at the Department of Earth and Ocean Sciences of the University of British Columbia, Vancouver, Canada. His research focuses on topics ranging from species ecology, at the level from zooplankton to fish, to ecosystem structure as well as physical-biological and biochemical coupling. Recently, Evgeny has developed interests in the applications of stable isotopes (bulk and compound specific measurements) in food web studies to reconstruct trophic pathways in pelagic ecosystems. He has also published on variability and responses of marine ecosystems to climate change using stable isotopes, large-scale and retrospective analyses. Dr. Pakhomov co-chairs the PICES Advisory Panel on Micronekton sampling inter-calibration experiment.

Dr. Andrey Suntsov (ASuntsov@HBOI.edu) is a Postdoctoral Fellow at Harbor Branch Oceanographic Institution, Florida. After graduating from Moscow State University in 1993, he started work on oceanic ichthyoplankton/mesopelagic fishes at P.P. Shirshov Institute of Oceanology in Moscow. He entered the graduate program at the Virginia Institute of Marine Science, earning his M.S. in 1997. Andrey subsequently returned to Russia and completed his doctorate degree on ichthyoplankton in Peruvian waters in 2003. At present, Andrey is involved in the study of age and growth patterns of deep-sea fishes from the North Atlantic. His research interests encompass early life history of marine fishes, oceanic micronekton and mesopelagic biology.

Recent results of the micronekton sampling inter-calibration experiment

by Orio Yamamura

Micronekton (osteichthyes, cephalopods and crustaceans) are ubiquitous in oceanic and neritic areas and are an important component of marine ecosystems. In terms of body size and swimming ability, they are intermediate between mesozooplankton and nekton, so they have an important role in transporting organic materials from the productive euphotic zones to the less productive mesopelagic layers through diurnal vertical migration. Furthermore, in subarctic ecosystems micronekton have indispensable roles in smoothing the seasonal variation of prey availability during the less productive autumn and winter seasons.

MIE-1 cruise

The PICES Working Group (WG 14) on *Effective sampling of micronekton* was established in 1997, under the direction of the Biological Oceanography Committee, to tabulate information on micronekton in the North Pacific, including taxonomic composition, biomass, sampling methods and trophic relationships. At the recommendations of WG 14, PICES formed an Advisory Panel on *Micronekton sampling inter-calibration experiment* (MIE-AP) in 2002, to conduct a field study to compare micronekton sampling gears and other quantifying technologies such as acoustics and visual sampling methods. The initial field survey, MIE-1, was carried out aboard the NOAA R/V *Oscar Elton Sette* in October 2004, off Oahu, Hawaii. Three sampling gears were compared: a 140-m pelagic Cobb trawl, a 4-m Hokkaido University Rectangular Frame Trawl (HUFT), and a 1.8-m Isaacs-Kidd Mid-water Trawl (IKMT). For detailed description and results of that survey, please refer to Brodeur *et al.* in PICES Press Vol. 13(1), pp. 7–11.

MIE-2 cruise

In September–October 2005, AP-MIE conducted its second cruise aboard the R/V *Hokko-maru* (902 t) of the Hokkaido National Fisheries Research Institute (HNFRI), Japan. *Hokko-maru*, launched in 2004, is a state-of-the-art 65-m stern trawler with a MOCNESS-10 and has capabilities to deploy other mid-water sampling gears, including stern trawls equipped with a MULTI-SAMPLER (an opening-closing multiple cod-end system, Simrad Inc.). Other gears compared during the cruise were the Matsuda–Oozeki–Hu Trawl (MOHT; Oozeki *et al.*, 2004) and HUFT (**Fig. 1**). The former gear is a 5-m² rectangular mid-water trawl with a newly developed depressor, which enables the net to be towed at a desired depth at higher speed (5 knots) with a near perpendicular and stable angle of 8°. For the latter gear, two nets with different mesh sizes (3 mm and 9 mm) were used separately. In addition to the sampling gears, backscattering from the scattering layers was recorded using a Simrad EK-60 echosounder with 38, 70, 120 and 200 kHz transducers. The scientists onboard were: Orio Yamamura (HNFRI), Hiroya Sugisaki (Tohoku NFRI), Kazuhiro Sadayasu, Shinsuke Abe and Ryuichi Matsukura (all Hokkaido University). Since the cruise overlapped the dates of PICES XIV in Vladivostok, Russia, members of AP-MIE from countries other than Japan were not able to participate in the cruise.

Basically, every fishing gear was towed at 4 stations which were all located at the outer shelf of the Doto area, off southeastern Hokkaido Island (bottom depth 380–480 m), during the daytime and nighttime, with an exception of MT (rope trawl with multi-sampler), which was towed at



Fig. 1 Comparison of sampling gears during the MIE-2 cruise: MOHT (left top), MOCNESS-10 (right top), rope trawl with multi-sampler (left bottom), and HUFT (right bottom).

2 stations only during the daytime. Every gear sampled the 0–300 m layer. In total, the myctophid *Diaphus theta* was dominant in both numbers (>80%) and weight (>70%). A brief comparison of catch efficiency of different gears for *D. theta* revealed that MOHT was evidently the most effective gear for the sampling of micronekton (Fig. 2).

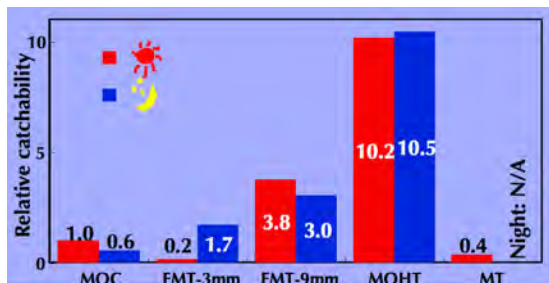


Fig. 2 Comparison of catchability (number of *Diaphus theta* (in >40 mm SL) per volume of seawater filtered) for different sampling gears during MIE-2: MOCNESS-10 (MOC), Hokkaido University Frame Trawl (FMT), Matsuda–Oozeki–Hu Trawl (MOHT), and rope trawl with multi-sampler (MT). Numbers are standardized so that MOCNESS-10 during daytime = 1.0.

MIE-3 cruise

After the MIE-2 cruise, AP members were keen to find ship time for some unfinished business. A direct comparison between IKMT and MOHT was essential because there are so much historical data collected with an IKMT. After two years, the third experiment was carried out onboard the R/V *Oscar Dyson* in the eastern Bering Sea, from September 18–27, 2007. Despite the vessel being engaged in an NPAFC/BASIS salmon survey, Dr. Jim Murphy of the Auke Bay Laboratory (NOAA/NMFS) kindly donated ship time for our experiment. The scientists participating in the experiment were: Orio Yamamura (HNFRI), Hiroki Yasuma (HU) and Andrey Suntsov (NWFSC, NOAA). Although 48–72 hours of ship time were expected for the experiment, the actual duration was only 24 hours due to the extraordinarily rough weather in the Bering Sea during autumn. The gears compared during this cruise were a 1.8-m IKMT and a MOHT. A Cantrawl 300/262 rope trawl was also included in the arsenal, but the limited time window excluded this gear from the comparison. To reduce the time required for each deployment, a site adjacent to St. Paul Island, with a bottom depth of ca. 60 m, was chosen for the experiment where age-0 walleye pollock were densely distributed. The

sampling was in a day/night sequential design, in which different gears were towed sequentially at each location, with triplicate samples collected during daylight and night at the same ship speed (3 knots). Aside from the sampling gears, backscattering from the scattering layer was recorded using a Simrad EK-60 echosounder with 15, 38, 70, 120 and 200 kHz transducers. The catch was dominated by age-0 walleye pollock (>99%), offering a good opportunity for gear comparison (Fig. 3). The catchabilities of the nets were compared by relative number of pollock per volume of seawater filtered by the nets. The nets showed similar catchability during the daytime (1.1 times larger for MOHT in density estimate), but MOHT showed significantly higher catchability in night sampling (2.8 times higher). The fact that the catch efficiencies during the daytime were similar for both gears indicates that visual avoidance by age-0 pollock was virtually identical between these gears. The 2.8 times difference for nighttime tows may represent the difference in the stability of net angle and net mouth opening during hauls.

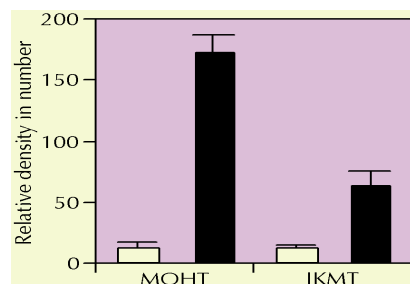


Fig. 3 Comparison of catchability (number of walleye pollock per volume of seawater filtered) between MOHT and IKMT during MIE-3; open bars: daytime, solid bars: nighttime.

How do we proceed?

We have undertaken 3 inter-calibration experiments, providing data for direct and indirect comparison of 8 different micronekton sampling gears. The results suggest that MOHT is the most reliable sampling gear for micronekton. Nevertheless, a brief comparison between acoustic and net sampling suggests that MOHT still underestimates the standing stock by >50%. Fortunately, some data sets are available for direct comparison between results of acoustic and net sampling. We are planning to include a comparison in the final AP-MIE report to be submitted to BIO next fall at PICES XVII in Dalian, China.



Dr. Orio Yamamura (orioy@affrc.go.jp) is a Fisheries Biologist working for Ecosystem Studies in Hokkaido National Fisheries Research Institute (HNFRI), Kushiro, Japan. He received his M.S. and Ph.D. in Marine Ecology from Hokkaido University and then began his career at HNFRI. Orio's research focuses on topics ranging from trophodynamic processes of walleye pollock in the coastal area to carrying capacity for salmonids in the Bering Sea. Since 2005, he has supervised the Steller sea lion research program in Hokkaido Island. Orio co-chairs the PICES Advisory Panel on Micronekton sampling inter-calibration experiment.