

Report of the Section on *Marine Birds and Mammals*

The meeting of the Section on *Marine Birds and Mammals* (S-MBM) was held from 13:00–17:00 hours on September 24, 2017 in Vladivostok, Russia. The business meeting focused on the current activities of S-MBM and on preparations for activities associated with the S-MBM project.

AGENDA ITEM 1

Welcome

Dr. Patrick O’Hara (Canada) and Dr. Kaoru Hattori (Japan), Co-Chairs of S-MBM, called the meeting to order and welcomed members and observers (*S-MBM Endnote 1*). S-MBM members representing Canada, Japan, Korea and USA were present. Dr. Miran Kim was welcomed as a new member of S-MBM, representing Korea, replacing Drs. Kyum Joon Park and Hawsun Sohn. S-MBM members from China and Russia did not attend.

AGENDA ITEMS 2 and 3

Adoption of agenda

The agenda was reviewed and approved (*S-MBM Endnote 2*).

AGENDA ITEM 3

Reports from participants

- a) Dr. Andrew Trites introduced S12: BIO Topic Session entitled, “*Seasonal and climatic influences on prey consumption by marine birds, mammals and predatory fishes*” (*S-MBM Endnote 3*) to be held September 26, 2017 at PICES-2017. One invited and 8 contributed presentations will be presented, including 5 for mammal presentations, 2 for seabirds and one for fish. Working toward the goal of understanding prey consumption by mid to upper trophic levels, the project completion is going well on the mammal side, but it is turning out to be more challenging for data compilation for birds.
- b) Dr. Robert Suryan and Dr. O’Hara reported on past and upcoming meetings related to S-MBM activities. Notable symposia include:
 - Annual Meeting of Pacific Seabird Group in Tacoma, Washington, USA, from February 21–24, 2017;
 - PICES/ICES Symposium on “*Drivers of dynamics of small pelagic fish resources*” in Victoria, BC, Canada, from March 6–11, 2017;
 - Annual Meeting of Pacific Seabird Group, to be held in La Paz, Mexico, from February 21–24, 2018;
 - PICES International Symposium on “*Understanding changes in transitional areas of the Pacific*” to be held in La Paz, Mexico, from April 24–28, 2018;
 - Workshop 7 on “*What do seabirds reveal about the effects of climate change on the World’s Oceans?*” at the 4th International PICES/ICES/IOC/FAO Symposium on “*The Effects of climate change on the world’s oceans*”, to be held in Washington, DC, USA, from June 4–8, 2018.
- c) Dr. Trites noted that the 22nd Biennial Conference on the Biology of Marine Mammals will be held in Halifax, Nova Scotia, Canada, from October 22–27, 2017.

- d) Dr. Suryan introduced POC Topic Session (S9) entitled “*Meso-/submeso-scale processes and their role in marine ecosystems*” which is related to the Working Group on *Mesoscale and Submesoscale Processes* (WG 38) activities. The goal of this 1-day session, to be held September 28, 2017, is to understand the interaction between physics, chemistry, biology and fisheries of the ocean at the meso- and sub-mesoscale. It was suggested that WG 38 merge their proposal with seabirds at Workshop 7 for upcoming symposium on “*The effects of climate change on the world’s oceans*”.
- e) Dr. Elliot Hazen, representing the Working Group on *Common Ecosystem Reference Points* across PICES Member Countries (WG 36), requested S-MBM’s participation in identifying indicators/ reference points for ecosystem changes.
- f) Dr. O’Hara briefly introduced the presentation that he will give (*Seasonal variability in vulnerability for Cassin’s Auklets exposed to plastic pollution in the Canadian Pacific region*) in S2: MEQ Topic Session “*Microplastics in marine environments: Fate and effects*” to be held September 28, 2017 at PICES-2017.
- g) Dr. Konstantin Zgruvsky will give talk on his work with WWF Russia on “*Results of positive partnership of WWF, scientists and fishermen in the Vulnerable Marine Ecosystem conservation in the Arctic*” at the S8/HD-Paper Session on “*Marine ecosystem health and human well- being: A social-ecological systems approach*”, to be held September 26, 2017 at PICES-2017.
- h) S-MBM discussed possible contribution to Working Group on *Third North Pacific Ecosystem Status Report* (WG 35). S-MBM members discussed how the Section can play a role and facilitate inclusions of S-MBM data (for example, State of the CCE and State of the Pacific Ocean reports).
- i) Dr. Tsutomu Tamura provided his report on the 2017 International Whaling Commission Scientific Committee (IWC/SC) meeting in Bled, Slovenia (**S-MBM Endnote 4**). S-MBM members discussed the results, particularly in view of recent observations of increase mortality in grey whales and humpbacks in the eastern Pacific.
- j) The report on “*Spatial ecology of marine top predators in the North Pacific*”, related to 2012–2014 AP-MBM activities, has been published as PICES Scientific Report No. 50.

AGENDA ITEM 4

Discussions

a) *Review of Terms of Reference*

S-MBM reviewed its current Terms of Reference. No changes were suggested.

b) *Review 2018 Topic Session/Workshop proposal ideas*

Dr. Trites submitted a proposal for a Workshop on “*Diets, consumption, and abundance of marine birds and mammals in the North Pacific*” for PICES-2018 (**S-MBM Endnote 5**) to create a new database and populate it with data from participants. The database will be the product/outcome of this workshop.

c) *S-MBM annual activity report to FUTURE SSC*

See **S-MBM Endnote 6**.

d) *2015–2019 S-MBM report*

S-MBM reviewed timelines for Phase 1 and concluded that:

- 1) Workshop (W6) on “*Consumption of North Pacific forage species by marine birds and mammals*” (PICES-2016, San Diego, USA) and report has been completed;
- 2) Diet database will not be completed by 2017, and instead, will be shifted to 2018;
- 3) Report on new diet database will be shifted to 2019.

Because Phase 1 products have been deferred, Phase 2 products will also be delayed to 2020. Dr. Trites reported on the first workshop (W6, PICES-2016) that the general consensus was that there was enough compiled information to do a good job estimating diet for mammals but not so well for seabirds. He will take the lead on compiling information for marine mammals including: 1) Caloric content of prey which should also be applied for seabird work, 2) Some species have lots of information on diet and others not so much, 3) Simple equations available to help fill data gaps for mammals. Dr. William Sydeman and Dr. Yutaka Watanuki are expected to provide leadership for compiling diet information for seabirds.

See *S-MBM Endnote 7* for S-MBM past and future activities.

S-MBM Endnote 1**S-MBM participation list**Members

Yong-Rock An (Korea)
 Kaoru Hattori (Japan, Co-Chair)
 Elliott Hazen (USA)
 Miran Kim (Korea)
 Patrick O’Hara (Canada, Co-Chair)
 Tsutomu Tamura (Japan)
 Andrew Trites (Canada)

Observers

Selina Agbayani (Canada)
 Mijin Hong (Korea)
 Robert Suryan (USA)
 Soeon Ahn (Korea)

Members unable to attend

Canada: Douglas Bertram, Ken Morgan
 China: Shuai Chen, Enyuan Fan, Wei Lei, Chao Song, Xuelei Zhang, Can Zhou
 Japan: Yutaka Watanuki
 Korea: Hyun Woo Kim
 Russia: Alexander Boltnev, Vjatcheslav Shuntov, Andrey Vinnikov
 USA: Rolf Ream, Willam Sydeman

S-MBM Endnote 2**S-MBM meeting agenda**

1. Call to order – meeting participants, new members of PICES community
2. Review Agenda (modify as needed)
3. Reports from participants
 - a) Introduction of S12 on “Prey Consumption” (Trites)

- b) International Symposium related to S-MBM activities
- c) Link with other groups during this meeting
- d) Report of IWC activities (Tamura)
- e) Report of WWF Russia (Zgurovsky)
- 4. Discussions
 - a) Review S-MBM Terms of Reference
 - b) Review 2018 Topic Session and workshop proposal ideas
 - c) S-MBM Annual Activity Report to FUTURE SSC
 - d) Annual Activities Report to 2017 and to 2018 to BIO Committee
 - e) 2015–2019 S-MBM project

S-MBM Endnote 3

Summary for BIO Topic Session S12

Seasonal and climatic influences on prey consumption by marine birds, mammals and predatory fishes

September 26, PICES-2017

Co-Convenors: *Andrew Trites (Canada), Rob Suryan (USA), Mike Seki (USA), Tsutomu Tamura (Japan)*

Invited Speaker:

Jock Young (CSIRO, Tasmania, Australia)

Background

Prey consumption by mid to upper trophic level marine birds, mammals, and predatory fishes is influenced by changes in prey abundance, prey availability, ocean climate and anthropogenic stressors. However, the extent to which predators can adapt to such changes and still meet their minimum energy requirements is uncertain. Understanding dietary changes of predators under varying environmental conditions is critical to informing prey consumption models and estimating relative contributions of bottom-up vs. top-down forcing in marine systems. Understanding how prey consumption of marine birds, mammals and predatory fishes will respond to climate change is also needed to predict changes in energy flow pathways in ecosystems, and has consequences for conservation initiatives and ensuring the sustainability of commercially important fishery resources. For this session, presentations were requested on topics that address (a) the significance of seasonal changes in prey consumption on energy budgets and ecosystem dynamics, (b) the effects of changes in water temperature and other climatic variables on food requirements, (c) relationships between dietary shifts and population trends, (d) the limits of plasticity in prey selection, and (e) how prey consumption of birds, mammals, and predatory fishes is affected by the recent extreme climatic events—the Blob, El Niño, ice cover changes, *etc.*

Summary of presentations

The session's Plenary Speaker, Dr. Jock Young (CSIRO, Tasmania, Australia), introduced the development and application of a global data base that aims to bring data from different methodologies to examine the impact of ocean warming on three tuna species—yellowfin (*Thunnus albacares*), bigeye (*T. obesus*) and albacore (*T. alalunga*) tuna. He showed how the available data can assist ecosystem-based management models by providing macro-scale understanding of oceanic food webs.

Robert Suryan (replacing Stephani Zador who was unable to attend) reported on factors affecting change in the diets of common murrelets at nesting colonies in the California Current System. Dynamic local- and basin-scale drivers including climate indices and water column metrics correlated with temporal changes in prey species consumed, whereas static coastal topography and bathymetry correlated with spatial variability in diets. Furthermore changes in nutrient sources and potentially trophic level (additional analyses are underway) were linked to physical climate drivers. Such climate-diet relationships are important to include when considering spatial and environmental variability in prey consumption models.

Jumpei Okado introduced “*Climate and prey consumption by Rhinoceros Auklets and Japanese Cormorants breeding*”. He and his colleagues found that climate change had a significant effect on prey consumption. He also pointed out that diets of auklets are often different between parents and chicks. They estimated prey consumption using samples of stomach contents of adults and bill-loads for chicks collected in 2004–2005 (warm regime) and 2014–2015 (presumed cold regime).

Miran Kim reported on “*Breeding phenology and diet shift of seabirds in South Korea*”. She and her team analyzed carbon and nitrogen stable isotopes of chick body feathers on Hongdo Islet to investigate annual change of diet from 2002 to 2016. They found that carbon and nitrogen stable isotope values tended to increase, which may reflect marine environmental change in South Korea. The sea surface temperature in the waters of South Korea has increased slightly in the last 40 years.

Xuelei Zhang reported on an integrated study of marine mammals in the Southeast Asia. Some methods and preliminary results were presented from regional research efforts jointly funded with the China–ASEAN Maritime Cooperation Fund and other partners.

Selina Agbayani presented “*Bioenergetic requirements of migrating eastern North Pacific grey whales in the face of climate change*”. She and her co-author derived daily food requirements (e.g., kg of amphipods, mysid shrimp, etc.) for all age classes of grey whales. Their goal is to predict future mortality rates as a function of varying prey densities due to climate change. They showed how bioenergetic models can be used by managers and policy makers to assess and anticipate the likelihood of climate-induced mortality events occurring.

Tsutomu Tamura reported on the results of “*Estimation of prey consumption by cetaceans in the western North Pacific-Update to Hunt et al. (2000)*”. The assessment of prey consumption was based on 1) recently available abundance estimates of cetaceans (after 2000), 2) daily prey consumption rates of cetaceans estimated, 3) estimated biomass of cetaceans by use of average body weight and abundance, and 4) composition of prey species of cetaceans. However, more information is needed on the abundance, body weight and prey composition of cetaceans to address a more realistic strategy for fisheries management and the conservation of cetaceans in future.

Hiroko Sasaki presented on “*Spatial estimation of prey consumption by sei whales in the western North Pacific during the summers of 2008 and 2009*” using a density surface model (DSM) approach. The product of the DSM and individual consumption models yielded a spatial pattern of prey consumption in the survey area.

Andrew Trites introduced simple models used to predict daily energy requirements and prey consumption by marine mammals in the North Pacific. He reviewed all existing estimates of energy requirements for marine mammals to identify species that have well supported estimates—which he then used to derive generalized equations that predict the energy requirements of all pinnipeds and cetaceans as a function of body mass. These new equations are superior to existing generalized equations that have been used in the past to estimate

energetic needs, and can be used to derive estimates of prey consumption for species of marine mammal with unknown energy requirements in the North Pacific.

Conclusion

This session drew diverse papers focussed on diets and prey consumption of top trophic level marine birds, mammals and predatory fishes. Four of the papers presented addressed methods to estimate prey consumption of marine mammal species that inhabit the North Pacific. Three of these papers made simplifying assumptions about average energy requirements, while one paper emphasized the importance of determining spatial consumption. Two of the presentations addressed the effects of climate on prey consumption by seabirds, and drew attention to shifts that can occur in sea bird diets. Overall, the collection of presented studies in this session contributed to the efforts of the Section on *Marine Birds and Mammals* to estimate prey consumption of birds and mammals. They provided new methods to estimate prey consumption of marine mammals and gave better understanding and insights into the existing databases of diets and population estimates that can be used to further this effort. The presentations also drew attention to the need to address dietary shifts and effects of climate change on the availability of prey and energy requirements of marine birds. All are important considerations that need to be reflected in future estimates of prey requirements and prey consumption of marine birds and mammals in the North Pacific.

List of papers

Oral presentations

From regional to global-scale understanding of tuna food webs (Plenary)

Jock W. Young (and the CLIOTOP trophodynamics team)

Spatial and temporal variability in diets of common murre

Robert M. Suryan, Amanda J. Gladics, Alessandra J. Jimenez-Yap, Jane E. Dolliver

Climate and prey consumption by Rhinoceros Auklets and Japanese Cormorants breeding in Teuri Island, Hokkaido, Japan

Jumpei Okado, Motohiro Ito and Yutaka Watanuki

Breeding phenology and diet shift of seabirds in South Korea

Miran Kim, Youngsoo Kwon, Mijin Hong, Ho Lee, Hong-chul Park and Na-yeon Lee

Integrated study of marine mammals: An update of the regional project in the Southeast Asia

Xuelei Zhang, Kongkiat Kittiwatanawong, Saifullah Arifin Jaaman

Bioenergetic requirements of migrating eastern North Pacific grey whales in the face of climate change

Selina Agbayani, Andrew W. Trites

Estimation of prey consumption by cetaceans in the western North Pacific-Update to Hunt et al. (2000)

Tsutomu Tamura

Spatial estimation of prey consumption by sea whales in the western North Pacific during the summers of 2008 – 2009: Density surface model approach

Hiroko Sasaki, Tsutomu Tamura, Takashi Hakamada, Koji Matsuoka, Hiroto Murase and Toshihide Kitakado

Simple models to predict daily energy requirements and prey consumption by marine mammals in the North Pacific

Andrew W. Trites

S-MBM Endnote 4**PICES Observer Report on the 2017 IWC Scientific Committee Meeting**

Tsutomu Tamura
The Institute of Cetacean Research, Tokyo, Japan.

The 67th Scientific Committee meeting (SC)

Meeting place: Bled, Slovenia

Meeting period: May 9 to 21, 2017

Chair: Caterina Fortuna

Participants: National delegates 148, Invited Participants (IP) 77, Representatives of specified intergovernmental organizations 3, and secretariat 7

Under the IWC/SC, following seven sub-committees, five working groups and four *Ad hoc* Working Group were established in this year:

- Sub-Committee
 1. Revised Management Procedure (RMP)
 2. In-depth Assessment (IA)
 3. Special Permit (SP)
 4. Other Northern Hemisphere whale stocks (NH)
 5. Other Southern Hemisphere whale stocks (SH)
 6. Small Cetaceans (SM)
 7. Whale Watching (WW)
 8. Conservation Management Plans (CMP)

- Working Groups
 1. Aboriginal Whaling Management Procedure (AWMP)
 2. Stock Definition/DNA (SD/DNA)
 3. Non-Deliberate Human-Induced Mortality of Cetaceans (HIM)
 4. Environmental Concerns (E)
 5. Ecosystem Modelling (EM)

- *Ad hoc* Working Groups
 1. Abundance Estimates, Stock Status and International Cruises (ASI)
 2. IWC Global Data Repositories and National Reports
 3. Photo-ID
 4. Interactions between Scientific and Conservation Committees

Every substantial issue was discussed once at the sub-committees or the working group (8 days) and then went to plenary of the committee (3 days).

- Revised Management Procedure (RMP): Sub-Committee

The Revised Management Procedure (RMP) is the process developed by the IWC's Scientific Committee to estimate sustainable catch limits for commercial whaling of baleen whales. The RMP has two stages. The first is the *Catch Limit Algorithm (CLA)*. The same *CLA* is used for all whale species and all areas. This is a

mathematical formula which requires only the two most reliable pieces of information (abundance estimate of whales and past catch numbers) to calculate a safe catch limit. The second stage of the RMP is known as *Implementation* or *Implementation Review*. This is a review of all the available information on all the populations of a single species within a specific region (usually an ocean basin, for example the North Atlantic), at a particular time. The following topics are related to the North Pacific matters.

1. The sub-committee noted that discussion of stock structure for western North Pacific minke whales by the SD working group. The next *Pre-Implementation Review* will take place in February 2018.
2. The *Implementation Review* for the North Pacific Bryde's whales was held in February 2017. The Workshop made considerable progress. It reviewed the new information relevant to stock structure and agreed to take forward two stock structure hypotheses. Work has begun updating the previous Implementation Simulation Trials for the North Pacific Bryde's whales to include the new hypotheses and trials, as well as estimated additional variance. The *implementation Review* will be completed in February 2018.

▪ In-depth assessment (IA): Sub-Committee

In this Sub-Committee, the in-depth assessment of several whale species is discussed. An in-depth assessment includes the examination of current stock size, recent population trends, carrying capacity and productivity. The following topics are related to the North Pacific matters.

1. The IWC's first workshop on the Comprehensive Assessment of North Pacific Humpback Whales was held from April 19–21, 2017, in Seattle, USA. The objective was to identify and review available information on stock structure, removals (catches, bycatches and ship strikes), abundance and trends (by stock and area), biological parameters and environmental issues.
2. The Committee **agrees** to proceed with assessment modelling for North Pacific sei whales based on two alternative hypotheses – a single stock and 5 stocks though the evidence for the latter is weak.
3. The Committee **recommends** that the preparation for eventual assessment of North Pacific blue whales in the North Pacific will be undertaken.
4. For North Pacific right whales, the Committee made several research recommendations that will improve its ability to assess the status of right whales in the North Pacific.

▪ Special Permit (SP): Sub-Committee

SP discusses proposals and results of research programs that accompany lethal method in accordance with Article VIII of the International Convention for Regulation of Whaling. In this year, the plan of NEWREP-NP (Japan's New Scientific Whale Research Program in the western North Pacific) was discussed as follows.

1. The Expert Panel Workshop of the Proposed Research Plan for NEWREP-NP was held in Tokyo, in January 2017. The report of the Panel as well as further analyses conducted by the proponents from it were presented and discussed in this IWC/SC. The Committee agreed that, overall, the Expert Panel had conducted a detailed, fair and thorough review of the NEWREP-NP proposal. It reviewed progress and responses made by the proponents relative to those recommendations of the Panel and provided its views thereon.
2. The IWC/SC observed different views on NEWREP-NP. Though some members expressed their opposition to the initiation of lethal sampling, the proponents and some other members stated that the proponents had demonstrated the justification for lethal sampling sufficiently by responding in good faith to all the recommendations by the Expert Panel.

▪ Aboriginal Whaling Management Procedure (AWMP): Working Group

In this Working Group, stock structure, movement, and management advice of Bowhead and gray whales is discussed. The following topics are related to the North Pacific matters.

1. As in previous years, the Committee **agrees** that the Gray Whale SLA remains the appropriate tool to provide management advice for eastern North Pacific gray whales. The Committee **advises** that the present block quota is in accord with the SLA and will not harm the stock. In addition, it confirmed that a six-year block quota beginning in 2019 of up to 815 strikes would not harm the stock.
2. Weller reported that the US Government is currently reviewing a revised whaling management plan for the Makah hunt in Washington State. The Committee **encourages** the USA to provide the Committee with any revised plans as early as possible to allow consideration of the revised hunt management plan to occur intersessionally, such that, should they be deemed necessary, there is time for additional trials to be developed and run before the Annual Meeting in 2018. An Implementation Review for gray whales is currently planned in 2019.

- Stock Definition and DNA testing: Working group

This working Group continues to develop guidelines for preparation and analysis of genetic data within the IWC context and provided the Committee with feedback and recommendations concerning stock structure related methods and analyses presented to other sub committees.

1. For the western North Pacific minke whales, in reviewing the result of kinship-based analyses of North Pacific common minke whales, the Committee **agrees** that this work provides a good example of the value of increasing the number of loci in analysis of kinship in reducing False Discovery Rate and increasing statistical power. The Committee **recognises** the value of having biological data associated with the individuals used in kinship-based analyses, which allowed the plausibility of genetically inferred Parent-Offspring pairs to be verified, and **encourages** the inclusion of such biological data when available. The Committee **agrees** that the results of the kinship analysis are inconsistent with the mixing matrices associated with Hypothesis C as currently implemented in the RMP trials.

- Abundance Estimates, Stock Status and International Cruises Stock Definition and DNA testing: *Ad hoc* Working group

This year, a new approach was adopted such that all abundance estimates were reviewed by a dedicated Working Group on Abundance Estimates, Stock Status and International Cruises (ASI).

1. For the North Pacific Bryde's whales, the working group **agreed** to accept the total abundance estimate of 26,299 (CV = 0.185; 95% CI = 18374–37643) and the additional variance estimate of 0.335 (SD 0.161) for inclusion in the IWC Abundance Table under Category 1, noting that the estimate assumes that $g(0)=1$.
2. North Pacific Sighting survey cruise (IWC/POWER): The project includes a line transect sighting for estimating population abundance and biopsy skin-sampling and photo ID for stock structure on major large cetaceans. It started in 2010. This SC received the 2016 cruise report conducted in in the central North Pacific (with the dedicated research area located between 20°N–30°N and between 135°W– 160°W) (Figure 1). The 2017 POWER cruise was conducted in waters surrounding Bering Sea from July to September.

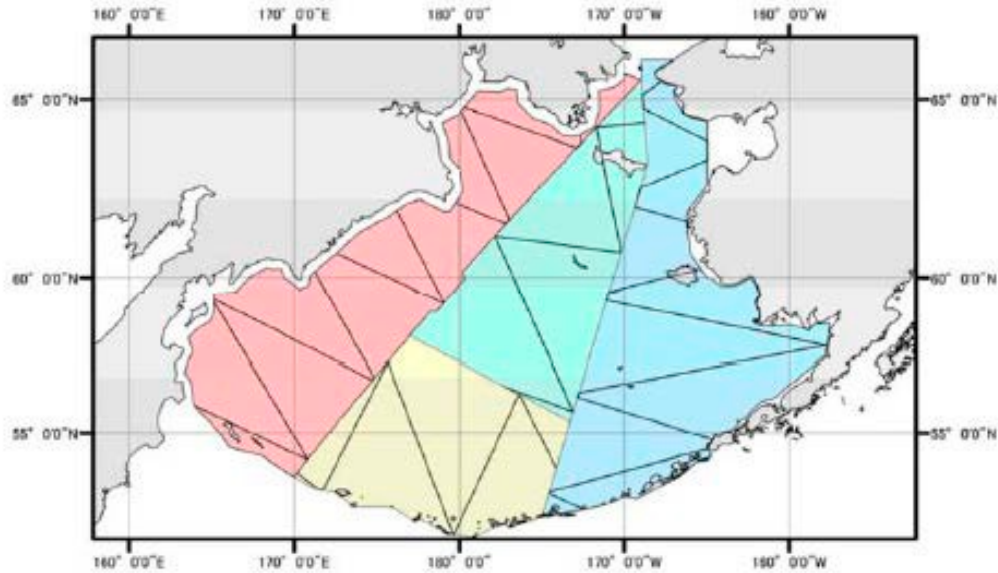


Figure 1. Survey strata and proposed tracklines for POWER-cruises planned for the period 2017–2019. In 2017, the eastern (blue) block was covered.

Other matters

The SC also covers the other Sub-Committees and Working Groups, such as environmental concerns, small cetaceans, whale watching, by-catch and humane deduced mortality. The 2017 Scientific Committee report of IWC can be downloaded from <https://archive.iwc.int/pages/view.php?ref=6557&k=58742a54b3>.

▪ 2018 Schedule

1. The RMP workshop on the *Implementation Review* of North Pacific Bryde's whales and western North Pacific minke whales, **February 12-16, 2018 (Tokyo, Japan)**
2. Range-wide review of population structure and status of North Pacific gray whales, March 29-31, 2018 (La Jolla, USA)
3. Workshop for an in-depth assessment of North Pacific humpback whales, TBD (Seattle, USA)
4. Scientific Committee (SC/68a), April 24 –May 6, 2018 (Bled, Slovenia)

S-MBM Endnote 5

**Proposal for a Workshop on
 “Diets, consumption, and abundance of marine birds and mammals in the North Pacific”
 at PICES-2018**

Duration: 1 day

Convenors: A.W. Trites (Canada), T. Tamura (Japan), Y. Watanuki (Japan), R.M. Suryan (USA)

Suggested Invited Speakers: Jerome Spitz (University of La Rochelle, France); Robert Furness (University of Glasgow, UK)

The S-MBM/BIO is midway through a 5-year program to update the 2000 PICES Scientific Report on Predation by Marine Birds and Mammals in the Subarctic North Pacific Ocean. To date, we have held a successful workshop (2016) to frame the program and agree on general modelling approaches, spatial boundaries, time scales and other considerations (see PICES W6 Workshop Report: Consumption of North Pacific forage species by marine birds and mammals). Since our 2016 workshop, we initiated the agreed upon databases to estimate prey consumption, and will continue to add and verify data over the coming 12 months in anticipation of our workshop, when invited experts will review the compiled information. Obtaining this expert consensus on model input parameters through the proposed workshop process is a necessary and critical next step to ensure the success of our program to estimate the amounts of prey consumed by seabirds and marine mammals in the North Pacific. The workshop participants will advance finalizing our databases of diets, abundances, distributions, and energy requirements of 135 species of seabirds, and all 47 species of marine mammals in the 12 PICES eco-regions. During the workshop, the invited holders of data and knowledge on the feeding ecology of seabirds and marine mammals in the North Pacific will 1) review the data summaries compiled by S-MBM members, 2) identify data gaps and sources of missing information, and 3) assist in framing appropriate educated guesses on possible values for missing data. The workshop will be structured with two breakout groups (birds and mammals), where data are presented by individual species and consensus is obtained on their accuracy and completeness. This process will result in near-complete databases of diets, abundances, and energy requirements of marine birds and mammals in the North Pacific.

The workshop participants will advance finalizing our databases of diets, abundances, distributions, and energy requirements of X species of seabirds, and all 47 species of marine mammals in the 12 PICES eco-regions. During the workshop, the invited holders of data and knowledge on the feeding ecology of seabirds and marine mammals in the North Pacific will 1) review the data summaries compiled by S-MBM members, 2) identify data gaps and sources of missing information, and 3) assist in framing appropriate educated guesses on possible values for missing data. The workshop will be structured with two breakout groups (birds and mammals), where data are presented by individual species and consensus is obtained on their accuracy and completeness. This process will result in near- complete databases of diets, abundances, and energy requirements of marine birds and mammals in the North Pacific.

S-MBM Endnote 6

Template of Expert Group Annual Activity Report

August 30, 2017

- 1) Name of Expert Group: S-MBM
- 2) Chair: Kaoru Hattori, Patrick O’Hara
- 3) Reporter (if not Chair):
- 4) Activities 2016–2017:
 - a) Activities (since last Annual Meeting):
 - (a) Finalized the report for PICE-2016 W6 “Consumption of North Pacific forage species by marine birds and mammals”.
 - (b) Dr. Jock Young (CSIRO, Tasmania, Australia) is an invited speaker for Topic Session 12.
 - b) Sessions & Workshops (past and upcoming Annual Meetings):
 - (a) S12 “Seasonal and Climatic influences on prey consumption by marine birds, mammals, and predatory fishes” in annual meeting.
 - c) Publications or Other Products:
 - (a) “Spatial ecology of marine top predators in the North Pacific” in PICES Sci. Rep. No. 50, related to 2012-2014 MBM-AP activities.
 - d) Collaboration with other PICES Expert Groups:
 - (a) S9 related WG38; R Suryan is and invited speaker “Characteristics of meso- and submeso-scale features used by MBMs.
 - (b) WG36 requested our participation identifying indicators/reference points for ecosystem changes.
 - (c) WG35; S-MBM members can play a role and facilitate inclusions of S- MBM data.
 - e) Collaboration with Organizations/Scientists external to PICES:
 - (a) IWC (T Tamura)
 - (b) Pacific Seabird Group meeting (W Sydeman, P O’Hara, R Suryan)
 - (c) State of the Pacific Ocean (DFO), State of the California Current (NOAA, W Sydeman, R Suryan, E Hazen)
- 5) Contributions to FUTURE (Include specific **products** of the Expert Group that FUTURE program would benefit from knowing about; please provide specific details of how the product contributes to the FUTURE questions (e.g., WG 29 developed regional climate models to improve understanding of how important physical & chemical processes might change as a result of climate change):
 - a) Datasets (species distributions, energy/prey requirements, and diets for marine birds and mammals) that can be used to answer questions posed by FUTURE.

- b) Developing species distribution and prey consumption models for MBM.
 - c) Contaminants and impacts from contaminants on both MBM
 - d) MBM and fishery interaction
- 6) Remaining activities to reach the goals of the Expert Group:
- a) Workshop to complete database of MBM diet (2018).
 - b) Bottom-up and Synthesis; phase 2 of “Climate and Trophic Ecology” (–2019+).
- 7) Impediments (organizational, funding, meeting schedule, member support, etc. For each, please identify potential solutions where possible):
- a) Funding required to complete activities;
 - i) Support travel to participate in meetings
 - ii) Student stipends (contributing to our projects which require considerable more time than country delegates can commit to).
 - b) Key countries do not participate in our activities; For example, Russia has a wealth of information that would be critical for completing our datasets.
- 8) Outreach (Please provide specific recommendations about potential groups to reach out to with specific products): None
- 9) Other: None

S-MBM Endnote 7

S-MBM Activity Plan (2015–2017 and 2018–2019)

The S-MBM proposes to address the climate and trophic ecology of Marine Birds and Mammals (MBMs) over the next 3–5 years. We have chosen this emphasis because birds and mammals can have substantial top-down effects on marine ecosystems and because birds and mammals respond to multiple scales of variability in the environment and their prey-base. This program will meet the goals of FUTURE by contributing to the understanding and forecasting of North Pacific ecosystem dynamics relative to climate change as well as contribute to communications with stakeholders.

We will update the Hunt *et al.* (2000) report on diets and food consumption of 135 species of seabirds and 47 species of marine mammals using new datasets on food habits, population sizes, and greatly improved bioenergetic models. Combining this information with data on prey quantity, quality, composition and distribution will allow us to understand and predict the impacts of changing mid-trophic level micronekton communities on marine birds and mammals. We will use this information to examine the influence of climate variability and change on trophic linkages and the distribution and abundance of marine birds and mammals in the North Pacific. In this manner, our project will link directly with PICES committees (FIS and POC), and will provide improved data needed on energy flow for ecosystem models.

Our project is based on MBMs being important top predators that consume large amounts of forage species. They also respond directly to changes in prey abundance and indirectly to changes in ocean climate. Our project also recognizes that MBMs can induce trophic cascades, and that they are susceptible to changes in marine food web structure and productivity as a result of both natural and anthropogenic impacts. MBMs are easily observed and highly mobile, and are generally believed to be sentinels of ecosystem health. As such, we believe the detailed analyses of MBMs we are proposing will contribute significantly to meeting the objectives of FUTURE.

The following describes 1) the rationale of our proposed project, 2) summarizes related past activities, and 3) describes potential activities or products to be accomplished by the S-MBM.

Title: Climate and Trophic Ecology of Marine Birds and Mammals

Leader: Andrew Trites (Canada)

Co-leaders: Yutaka Watanuki (Japan), William Sydeman (USA), Elliott Hazen (USA)

Rationale

Marine birds and mammals (MBMs) are known to respond quickly to the changes in distribution and abundance of their prey through behavioral changes that include feeding time, location, attentiveness at the colonies, diet, and energy delivered to offspring (Cury *et al.* 2011). However, MBMs in the North Pacific are also known to respond more gradually to changes in their prey bases through demographic responses that include offspring production, adult survival and population size (Cury *et al.* 2011). Factors that can change the prey base of the North Pacific include fishing, ocean climate, and competition with other marine species (Checkley and Barth 2009).

The ability to easily monitor the behaviours and demographics of marine birds and mammals make them ideal sentinels of environmental change. Thus, synthesizing the variability of trophic responses of MBMs in the local ecosystems can improve understandings of bottom-up effects of climate and anthropogenic global impacts on ecosystems.

MBMs are known to consume substantial amounts of prey species (Yodzis 2001), and can impact prey populations and sometimes induce trophic cascade (Estes *et al.* 1998). Therefore, MBMs can impact forage fish populations as well as lower trophic level organisms, and may compete with fisheries (Smith *et al.* 2011) and other top-predators (Ainley *et al.* 2006).

Quantifying the effects of MBMs on marine ecosystem requires knowledge of diets and quantities of prey species consumed. Such data are also needed to examine the influence of climate variability and change on trophic linkages in the North Pacific, as well as to understand how changes in prey quantity, quality, composition and distribution affect the abundance and distribution of marine birds and mammals.

Related past activities

PICES Scientific Report No. 14 on Predation by Marine Birds and Mammals in the Subarctic North Pacific Ocean edited by Hunt, G.L. Jr., Kato, H., and McKinnell, S.M. provides an overview of the trophic requirements and trophic roles of marine birds and mammals for the North Pacific in the 1990s.

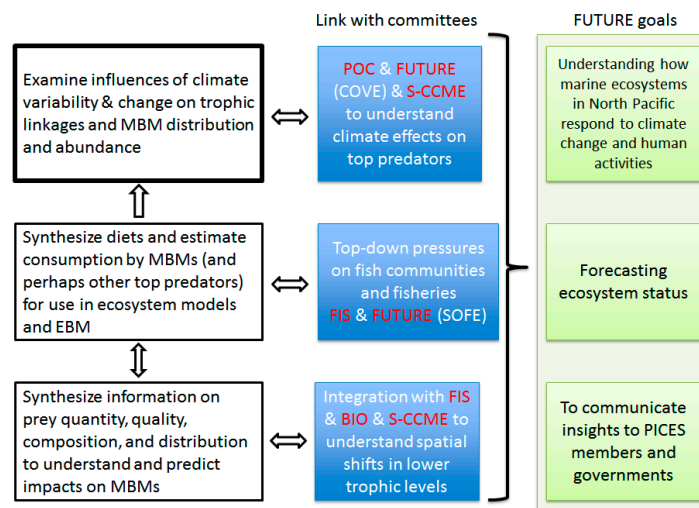
In October 2012 (PICES-2012, Hiroshima Japan), the AP-MBM held a workshop to review whether an updated report was warranted [W3: *The feasibility of updating prey consumption by marine birds, marine mammals, and large predatory fish in PICES regions*, Dr. Hunt (USA), Dr. Kato (Japan), and Dr. Michael Seki (USA)]. The workshop concluded that knowledge of the distribution and abundance of marine birds and mammals, and large predatory fish across the North Pacific has advanced greatly since the 1990s. W3 participants also agreed that an update of the information on prey consumption is warranted where new data are available, and that it would be valuable to include large predatory fishes.

During the 2012–2014 Spatial Ecology project, and through the 2013 BIO/FIS/POC Topic Session, titled “*Are marine ecosystems of the North Pacific becoming more variable?*”, S-MBM explored large spatial and temporal variability in the densities of MBMs, and we discussed tools to model their spatial pattern. We are now ready to focus on how spatial and climate forced variability in the densities of MBMs relate to trophic linkages between MBMs and their prey at various temporal and spatial scales.

Activity plan

Our ultimate goal is to examine the influence of climate variability and change on trophic linkages and the distribution and abundance of MBMs. This will require us to synthesize new dietary information and estimate food consumption using a new generation of bioenergetic models. It will also require synthesizing information of prey quantity, quality, composition and distribution to predict their impacts on MBMs. As shown in the flow chart below, we will be seeking input from BIO, FIS, POC and S-CCME to achieve our goals, and will provide these groups with output from our efforts that we expect will further their collective goals and those of FUTURE.

We expect graduate students from the PICES member countries, working under the guidance of the S-MBM to compile data and estimate consumption. We plan to have three students working on marine mammals (pinnipeds, odontocetes, and balaenoptera) and two on seabirds (piscivorous seabirds, and planktivorous seabirds). Data will be compiled at a resolution of 1° (100 × 100 km) when possible, and we plan to synthesize diets by month (ultimately grouped by season) and by year. We will also seek a post-doctoral fellow to describe and analyze prey distributions relative to the distributions, diets, and consumption estimates of marine birds and mammals. We foresee the graduate students attending the annual PICES meetings for the duration of our study, and expect them to play leading roles in the workshops and symposiums we propose to hold (see below).



We expect our study will take 5 years to complete. However, to adapt to the the schedule of FUTURE, we have separated our activities into two phases. The first phase will focus on top-down effects (2015–2017), second phase on bottom-up effects (2018–2019). The S-MBM will thus:

- 1) Examine influences of climate variability and change on trophic linkages and MBM distribution and abundance.
- 2) Synthesize diets and estimate consumption by MBMs (and perhaps other top predators) for use in ecosystem models, and
- 3) Synthesize information on prey quantity, quality, composition, and distribution to understand and predict impacts from climate variability and change on MBMs.

These efforts will be useful to understanding 1) top-down pressures on fish communities and fisheries, 2) spatial shifts in lower trophic levels and in turn top predators, and 3) climate effects on top predators—thereby contributing to FUTURE.

Climate and Trophic Ecology: Products

Phase 1: Top-down

2017: A database will be created on seabird and marine mammal diets, and population abundance in the North Pacific.

2017: PICES Scientific Report will be prepared summarizing diets of seabirds and marine mammals (MBMs) in the North Pacific including a full bibliography of data sources, reports and publications. The report will also contain the review of session and workshop that will be held in 2016 and 2017 and related to variation in diets of MBMs.

Phase 2: Bottom-up and Synthesis

2019: A PICES Scientific Report will be prepared on the effects of climate-induced changes in prey quantity and quality on the consumption of prey by seabirds and marine mammals in the North Pacific.

In addition to these two PICES reports, we anticipate a number of primary publications stemming from the research and the syntheses papers. We may also seek to publish some of these papers in a special journal issue along with other related papers that might be presented at our proposed sessions.

Climate and Trophic Ecology: Potential sessions and workshops

Phase 1: Top-down

PICES-2015 (China)

- Business meeting. 1 day full meeting on implementing S-MBM activity plan.

PICES-2016 (USA)

- Topic Session on “*What factors make or break trophic linkages?*” – Hazen *et al.*
- Workshop on “*Satellite and modeled oceanographic products as proxies for predator and prey distributions*” – O’Hara *et al.*
- Workshop on “*Consumption of North Pacific forage species by marine birds and mammals*” – Trites *et al.*

PICES-2017 (Russia)

- Topic Session on “*Seasonal and climatic influences on consumption by marine birds and mammals, and top predatory fish*” summarizing the first phase of top-down effects by proceedings or scientific report.
- Workshop on “*Predicting shifts of forage species and response of top predators*”

Phase 2: Bottom-up and Synthesis

PICES-2018 (Japan)

- Topic Session on “*Predicting shifts of forage species and response of top predators*”
- Workshop on “*Individual-based models of top predator demography in response to changes in prey*”

PICES-2019 (Canada)

- Topic Session on “*Influences of climate variability & change on trophic linkages and MBM distribution and abundance*”
- Synthesize results of our activity plan on the climate and trophic ecology of MBMs by PICES region. Produce PICES Science Report on our findings.