Report of the Advisory Panel on *Marine Birds and Mammals*

The meeting of the Advisory Panel for *Marine Birds and Mammals* (AP-MBM; under the auspices of the BIO Committee) was held from 09:00–18:00 hours on October 17, 2014 in Yeosu, Korea. The meeting focused on the current activities of AP-MBM at the Annual Meeting, and on preparations for adopting a new Activity Plan (and associated projects) to begin in 2015.

Dr. Yutaka Watanuki (Japan), Co-Chairman of AP-MBM, called the meeting to order and welcomed members and observers (*AP-MBM Endnote 1*). AP-MBM members representing Canada, Japan, and USA were present. Dr. Tsutomu Tamura was welcomed as a new member from Japan, replacing Dr. Hidehiro Kato. AP-MBM members from China, Korea, and Russia were not able to attend. AP-MBM asks that BIO request all member countries to send delegates to PICES Annual Meetings, and AP-MBM business meetings. The agenda was reviewed and approved (*AP-MBM Endnote 2*).

AGENDA ITEM 3
Reports

Dr. Elliot Hazen (USA) reported on PICES Workshop W1 entitled "*Top predators as indicators of climate change*" that was held April 14, 2014 at the FUTURE Open Science Meeting on the Kohala Coast, Hawaii. The 1-day workshop was well attended and featured 4 invited and 7 contributed presentations, with the primary goal of reviewing existing examples of observed and predicted top predator responses to climate change and variability in the North Pacific. The workshop objectives, background, activities, summary and conclusions can be found in the workshop report (*AP-MBM Endnote 3*) and are also included in an article in the PICES Press (2014, Vol. 22, No. 2). A review paper resulting from the Workshop is planned.

Dr. Watanuki (Japan) introduced BIO Topic Session S2 entitled "*Strengths and limitations of habitat modeling: Techniques, data sources, and predictive capabilities*" to be held October 23, 2014. Two invited and 8 contributed papers will be presented, in addition to 5 poster presentations. A wide variety of taxa are represented in the presentations, including deep-sea sponges and corals, zooplankton, krill, squids, seabirds and marine mammals. A primary objective of the session is to examine factors causing biases, identify the direction of biases, discuss techniques for mitigating or accounting for biases, and create a best-practices guide for using habitat modeling approaches to predict the distribution of marine organisms in dynamic marine environments. A brief report summarizing the presentations and conclusions will be prepared by the co-conveners following the session (see Session Summaries elsewhere in the PICES Annual Report).

AP-MBM members and participants briefly introduced presentations that they will give in S2 (Sydeman, O'Hara, Inoue), as well as in S3: "*Tipping points: Defining reference points for ecological indicators of multiple stressors in coastal and marine ecosystem*" (Sydeman) and S7: "*Recent assessments of climate change impacts on marine ecosystems*" (Hazen).

Dr. Hazen reported that a proposal entitled, "*Quantifying existing and predicting future climate change effects on marine top predators*" was not accepted for a session at the PICES/ICES 3rd International Symposium on "*Effects of climate change on the world's oceans*". The goals of the proposal were to: (a) identify key species that serve as climate sentinels, (b) assess and synthesize global top predator datasets (biologging, surveys, *etc*.), (c) strategize on the use of global climate models to predict spatio-temporal shifts, population responses, and ecosystem-level effects of climate change, (d) and synthetically consider the ecological and economic impacts of climate change on top predator communities. AP-MBM noted that the proposal is particularly relevant to the activities of the AP, and encouraged submission of the proposal to other conferences. Possible venues for this session include: Species on the Move (February 10–12, 2016, Hobart, Australia), and the 3rd CLIOTOP Symposium (September 2015, San Sebastian, Spain).

Dr. Tamura (Japan) provided the AP-MBM with Dr Kato's (Japan) report on his activities as the PICES liaison to the International Whaling Commission (IWC; *AP-MBM Endnote 4*). Dr. Tamura agreed to take over Dr. Kato's responsibilities for reporting on IWC issues, and the AP recommends to BIO that Dr. Tamura replace Dr. Kato as the PICES liaison to IWC in order to integrate PICES science in the IWC science-policy arena.

AGENDA ITEM 4
Discussions

The AP-MBM Terms of Reference were reviewed, particularly as they relate to the FUTURE Science Plan. AP-MBM members agreed that they were appropriate for both current and planned activities.

Dr. Watanuki led a review of the activities conducted by AP-MBM during its 2012–2014 Spatial Ecology and Conservation Activity Plan. Activities over the past three years have included:

- PICES-2012 (Hiroshima, Japan)
  - BIO/MEQ Topic Session S6: *Environmental contaminants in marine ecosystems: Seabirds and marine mammals as sentinels of ecosystem health*;
  - BIO Workshop W3: *The feasibility of updating prey consumption by marine birds, marine mammals, and large predatory fish in PICES regions*.
- PICES-2013 (Nanaimo, Canada)
  - BIO/FIS/POC Topic Session S2: *Are marine ecosystems of the North Pacific becoming more variable?*
  - *BIO Workshop W3: Marine bird and mammal spatial ecology*.
- FUTURE Open Science Meeting (April 14, 2014, Hawaii, USA)
  - W: *Top predators as indicators of climate change: statistical techniques, challenges and opportunities*.
- PICES-2014 (Yeosu, Korea)
  - BIO Topic Session S2: *Strengths and limitations of habitat modeling: Techniques, data sources, and predictive capabilities*.

AP-MBM reviewed ongoing preparations for a PICES Scientific Report from the Spatial Ecology and Conservation Activity Plan. The structure of the Report will be as follows:

- Introduction: R. Suryan (lead)
- Chapter 1: Datasets, R. Ream (lead)
- Chapter 2: Integration, R. Suryan (lead)
- Chapter 3: Habitat Modeling, Y. Watanuki (lead)
- Chapter 4: Uses, W. Sydeman (lead)

Drs. Ream, Watanuki, and Sydeman discussed the progress and plans for the chapters of the Scientific Report that they are each leading. Dr. Suryan was unable to attend the meeting in Yeosu. It was agreed that final drafts of each section of the Scientific Report would be completed by April 30, 2015.

The remainder of the meeting was spent discussing and developing a proposal for a new AP-MBM Activity Plan, and outlining how this new Activity Plan will relate and contribute to the FUTURE Science Plan. The goal of the Activity Plan, led by Dr. Andrew Trites (Canada) and titled "*Climate and trophic ecology of marine birds and mammals*", is to examine the influence of climate variability and change on trophic linkages and the distribution and abundance of MBMs (*AP-MBM Endnote 5*). To accomplish this, the AP-MBM will synthesize new dietary information and estimate food consumption using a new generation of bioenergetic models. The AP-MBM will also synthesize information of prey quantity, quality, composition and distribution to predict their impacts 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.

AP-MBM Endnote 1

AP-MBM participation list

Members

Yutaka Watanuki (Japan, Co-Chairman)
Kaoru Hattori (Japan)
Pat O'Hara (Canada)
Rolf Ream (USA, Co-Chairman)
William Sydeman (USA)
Tsutomu Tamura (Japan)
Andrew Trites (Canada)

Observers

Steven Bograd (USA)
Elliot Hazen (USA)
Yukiko Inoue (Japan)
Stephani Zador (USA)

AP-MBM Endnote 2

AP-MBM meeting agenda

1. Call to order – Review agenda (modify as needed)
2. Introductions - meeting participants, new members of PICES community
3. Reports from participants
   a. Workshop (POC; BIO; FUTURE/WG27) 2014 Hawaii (E. Hazen)
   b. 3rd International Symposium, Santos, Brazil, March 2015 (E. Hazen)
   c. S2 2014 (Y. Watanuki)
   d. Link with other groups
4. Discussions
   a. Review MBM-AP Terms of Reference
   b. Review 2014 session proposal?
   c. Scientific report on "SPATIAL ECOLOGY" (lead, R. Suryan)

AP-MBM Endnote 3

PICES Workshop W1
Advisory Panel on Marine Birds and Mammals

"Top predators as indicators of climate change: Statistical techniques, challenges and opportunities"

2014 PICES FUTURE Open Science Meeting

Co-Convenors

Elliott Hazen
NOAA SWFSC Environmental Research Division, USA

Robert Suryan
Oregon State University, USA

Steven Bograd
NOAA SWFSC Environmental Research Division, USA

Takashi Yamamoto
Graduate School of Fisheries Sciences, Hokkaido University, Japan

April 14, 2014
Kohala Coast, Hawaii, USA

Objectives:

1. The primary goal of this workshop was to review existing examples of observed and predicted top predator responses to climate change and variability in the North Pacific.

2. Additional goals included to:
   - Identify existing top predator, ecological, and oceanographic datasets that can be used to examine response to climate variability and change;
   - Review statistical techniques that can be used to differentiate top predator response from climate variability and change;
   - Identify sentinel species and life history characteristics that may best reveal responses to physical and biological changes;
   - Discuss synthetic approaches, beyond single measurement types, that are needed to understand how climate variability and change in integrated by top predator behavior, distribution, abundance, and demography.

3. We identified four main objectives to pursue in discussions following the workshop:
   - Summarize our findings in this workshop report, an article for the PICES newsletter, and a statement outlining the need for enhanced sampling for top predator response to the predicted 2014 El Niño event;
   - Outline and write a review paper on a framework for assessing climate response in North Pacific top predators;
   - Realize the goal of an interdisciplinary, North Pacific-wide proposal to synthesize top predator datasets relative to potential climate change effects;
   - Continue efforts in collaboration with CLIOTOP and IMBER at the 3rd PICES/ICES symposium on the "*Effects of climate change on the world's oceans*" in 2015.

Background:

Top predators such as fish, turtles, seabirds, and marine mammals integrate multiple lower trophic level processes and can also exert top-down control of marine food webs. Climate change and variability affect the timing and productivity of pelagic ecosystems. This variability is integrated into the life histories of top predators, potentially affecting their breeding patterns, migration strategies, diets, and ultimately fitness and reproductive success. Pan-Pacific data about top predators are generated by surveys, animal tracking studies, dietary analyses, and measurements of reproductive performance. Environmental and climate data can be synthesized and compared to ecosystem responses in many locations. To incorporate top predators into our understanding of climate change impacts on marine ecosystems and supporting the objectives of FUTURE, the PICES Advisory Panel on *Marine Birds and Mammals* (AP-MBM) with joint support from IMBER's regional program, CLIOTOP (Climate Impacts on Oceanic Top Predators), proposed this workshop to examine how top predators have responded and are predicted to respond to climatic variability and long term change.

With the primary goal of FUTURE, "To understand and forecast responses of North Pacific marine ecosystems to climate change and human activities at basin and regional scales, and to broadly communicate this scientific information to members, governments, resource managers, stakeholders and the public," top predators are particularly useful given their integration across the physical environment and multiple trophic levels, making their responses a metric of ecosystem change. Also, there is strong public interest in many top predators making outreach and engagement easier than for other ecosystem components. Furthermore, a wide variety of data has been collected on top predators, including multiple responses (behavior, distribution, fitness) to climatic events (*e.g.*, El Niños) that may give us insight of future long-term changes.

Workshop Activities

There were 22 participants in the workshop (Appendix 3.1). The structure of the workshop included 4 invited talks, 7 contributed talks, and 2 hours of discussion. The talks were organized largely by species groups, starting with predictions of fish populations as a function of climate change and finishing with baleen whales. Unfortunately, our first speaker Emanuele Di Lorenzo was unable to attend but this gave us additional time for discussion at the beginning of the workshop.

The first talk by M. Gadea Pérez-Andújar (University of Hawaii, USA) reviewed tagging results and vertical movement of deep-water sharks relative to the oxygen minimum zone. By comparing species with different movement patterns (deep water activity within the OMZ), we may be able to understand how different species are likely to respond to expansion of the OMZ. Rachael Orben (UC Santa Cruz, USA) discussed black-legged kittiwake winter movements from the Pribilof Islands to the sub-arctic North Pacific across three winter seasons. She found higher use of the Bering Sea during the El Niño conditions of 2009/10 and that individuals traveled farther, flew more, and used more area in La Niña conditions in 2010/11. Stable isotopes also showed greater individual variability in carbon isotopes in 2010/11, suggesting a use of broader prey base in this year.

William Sydeman (Farallon Institute for Advanced Ecosystem Research, USA) gave an invited presentation on challenges and opportunities for assessment and attribution of climate impacts on North Pacific seabirds. A meta-analysis underway has found that increased temperatures had mixed effects on North Pacific seabirds, highlighting the need for more detailed examination of climate change mechanisms and responses. Additional important points were that we need more data and climate projections on mid-trophic forage species that greatly influence these top predators, and that we will likely need both mechanistic numerical models combined with statistical models to begin teasing apart the effects of climate variability from change.

This invited talk was followed by two more seabird talks from Takashi Yamamoto (University of Hokkaido, Japan) and Rob Suryan (Oregon State University, USA). Takashi's talk examined both tracking data and shipboard sightings from shearwaters in the Northwest Pacific. He used generalized additive models to partition sightings data into likely colony origination and sex, and also to predict changes in sea distribution with increased temperatures up to 4°C. Suryan used a 10-year time series to assess changes in common murre chick stable isotope signatures and diets as a function of local- and basin-scale environmental forcing. Specifically, he found a strong relationship between murre nitrogen isotope ratios and local upwelling intensity, suggesting possible trophic level shifts associated with upwelling regimes. It is unclear whether this represents a change in the food chain length or changes in nitrogen values at the base of the food web. In contrast, carbon was most strongly associated with basin-scale indices of water mass transport impacting nutrient sources.

Chandra Goetsch (University of California Santa Cruz, USA) on northern elephant seal foraging behavior changes and diet switching during the 2010 Central Pacific El Niño. Female elephant seals show extreme fidelity to their migrations, so changes in diet are likely a function of prey densities or selectivity by foraging elephant seals. Diet estimates from fatty acid analysis differed between ENSO states (negative, neutral, and positive) with positive, or El Niño, conditions being significantly different from neutral and negative (La Niña) conditions. Future analyses will examine specific remotely sensed oceanographic conditions, which may be driving the behavioral and diet changes observed.

Our second invited speaker, Jeffrey Polovina (NOAA Pacific Islands Fisheries Science Center, USA) spoke about climate impacts on Hawaiian monk seals and loggerhead sea turtles relative to changes in the North Pacific Transition Zone (NPTZ). One of the strongest messages highlighted the complexity in predicting climate change effects on top predators, and why tagging studies like those presented are critical to assess species range shifts and reliance on prominent oceanographic features. Specifically, models predicting a northward migration of the NPTZ may not have a large effect on sea turtles if the Kuroshio Extension and Bifurcation also migrate north ensuring that the "highways" are still aligned with increased productivity. Furthermore, central place foragers, like monk seals, that are tied to land may no longer be able to reach

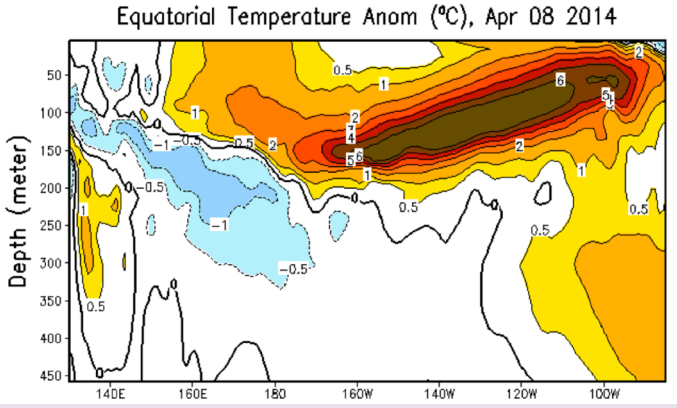
critical foraging habitat after northward movement of the NPTZ which likely will create negative population level effects.

Our third invited speaker, Kevin Weng (University of Hawaii, USA) gave a presentation on fish futures and how species are likely to adapt and respond to climate change. His talk discussed physiological responses to climate change and the potential interplay among CO_2, O_2 and temperature on fitness. Kevin discussed the use of end-to-end (E2E) ecosystem models such as SEAPODYM and APECOSM that are predicting climate change effects on distribution and abundance of top predatory fish. Furthermore, the point was made that we need to seek integrative funding calls to complete the research necessary to understand top predator responses to climate variability and change. Kevin also discussed the role of CLIOTOP and highlighted potential joint interests between the FUTURE and CLIOTOP programs on observing and predicting the effects of climate on top predators.

Brianna Witteveen (University of Alaska Kodiak, USA) talked about the Gulf of Alaska Apex Predator– Prey (GAP) integrated research project which is studying spatial and temporal patterns in habitat use and consumption estimates of top predators in the ecosystem around Kodiak Island. These integrative surveys measured physical oceanography, lower trophic level species (zooplankton and fish) up to top predator sightings. Multi-scale data including aerial surveys, stable isotopes, and individual tracking data were also collected and can be used collectively to examine ecological changes in baleen whales since 1997.

Our final presentation was by Kathy Kuletz (U.S. Fish and Wildlife, USA) who provided an overview of available at-sea observer data for the subarctic and arctic North Pacific. A suite of studies are underway examining spatial shifts in seabird species and likely population changes such as for northern fulmars, in addition to combining sightings data with prey and oceanographic data. Long-term datasets and synthetic studies like these highlight the importance of understanding both responses to climate variability (*e.g.*, extreme climatic events) but also long-term (20+ years) trends in top predator distribution and abundance.

Box 1. Climate predictions for 2014 suggest a strong El Niño (see link below) - potentially similar in magnitude to the strongest previously recorded ENSO events - is developing in the tropical Pacific that may have large ecosystem effects throughout the North Pacific. Based on discussions from our PICES FUTURE workshop, we would like to emphasize the importance of data collection to monitor the ecosystem response to the impending El Niño. Specifically, 1) ensure existing sampling and monitoring programs on physical & biological oceanography, forage species, and top predators are continued, 2) implement additional sampling to test key mechanistic hypotheses of ecosystem change that were generated during prior ENSO events, and 3) obligate sufficient funding to compile and analyze data with respect to previous El Niño events (1982–3 / 1997–8). Given the broad-reaching effects of El Niño events on ocean ecosystems, data collection and analyses should be coordinated throughout PICES member countries. Understanding the response of ecosystems to extreme climate events is a critical piece towards understanding how ecosystems may respond in the future with projected effects of climate change.
http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/enso_disc_apr2014/ensodisc.html.



Summary and conclusions from the Workshop

There were several key take away messages from the workshop discussion: 1) A need to define the term "indicator" particularly for top predators; 2) A need to identify the mechanistic processes through which climate change affects top predators; 3) The importance and need for the synthesis and analysis of existing data particularly in extreme years; and 4) A need to identify life history characteristics and metrics that are inherent to sentinel

species. As part of these discussions, we came up with a suite of tasks mentioned in the objectives above that we hope to accomplish as part of MBM-AP, FUTURE, and CLIOTOP upcoming activities.

First, our use of the term "indicators" refers to sentinel species that reflect (indicate) the impact of climate change on upper trophic level species and may serve to highlight or even lead certain biophysical processes that particularly impact upper trophic level species. Inclusion of sentinel species in FUTURE, therefore, fulfills a critical objective of assessing ecosystem impacts of climate change. The use of sentinel species to be early "indicators" of climate change is most appropriate in situations where information obtained from them is not being collected otherwise (*e.g.*, top predators can be indicators of prey species such as the abundance of Pacific sand lance, *Ammodytes hexapterus* which is difficult to sample using traditional fisheries methods). Sentinel species will be most useful when: (a) measurable variables in the species respond early to climate change, i.e., provide early warning of change; (b) changes in the sentinel species mean that changes will also occur broadly through other components of the ecosystem, i.e., the response is not purely species-specific, but reflects broad changes.

Second, understanding mechanisms (for example, PICES Topic Session S2, convened by Alheit, Hazen, Katugin, Suryan, Watanuki, Yasuda,2011; Marine Ecology Progress Series Theme Section Special Issue487: 176–304, 2013) by which sentinel species are affected by climate change is critical to modeling ecosystem impacts to upper trophic levels. This effort will require a combination of statistical, numerical, and energy flow modeling approaches to tease apart mechanisms. The group also acknowledged that understanding all mechanisms is unrealistic given the suite of variables integrated by top predators, but identifying a few dominant mechanisms is realistic and should be a goal in the future. Particular life history traits may cause mechanistic differences in top predator response to climate change, such as a) central place forager *vs*. migratory species, b) trophic position in the food web, c) specialist *vs*. generalist foragers, d) air breather vs. gilled organism. We proposed that a subset of the workshop participants develop a review paper that examines the framework needed and mechanisms involved to understand responses of top predators to climate change.

Third, there is still much to be learned by compiling and analyzing existing datasets, particularly in response to extreme climatic events. This is critical for not only learning from past events, but also for targeting future research to fill knowledge gaps. It is essential torequest adequate funds for data synthesis in any future funding of field data collection.

Fourth, and perhaps most importantly, there was much discussion about taking advantage of very strong climate variability events, which provide broad perturbations in environmental variables. There are several key classes of potential responses (*e.g*., spatial shifts, temporal shifts, dietary changes, fitness and demographic change). Furthermore, with an extreme El Niño predicted for summer of 2014 (**see Box 1**), there is an urgent need to understand ecosystem responses to this event and measure important variables that were not considered during previous events in 1997 and 1983. We have written a statement for distribution among the PICES community stating the importance of continued measurements, and where possible additional data collection (see Appendix 3 for top predator data needs identified). We foresee the need to collaborate across PICES committees to identify physical, biological, top predator, and ecosystem data needs to measure the response of the North Pacific to climatic extremes.

Acknowledgements
We thank the speakers for taking the time to travel to attend the workshop, summarizing and sharing their data, and contributing to a fruitful discussion. We would especially like to thank those individuals who contributed additional time to analyze new datasets specifically for this workshop. We thank the BIO and POC Committees, Science Board and the PICES Secretariat for supporting the workshop and for providing travel funds for our invited speakers. We also thank CLIOTOP for co-sponsoring an invited speaker for the session.

AP-MBM Endnote 3.1

Participants

Elliott Hazen	USA
Steven Bograd	USA
Takashi Yamamoto	Japan
Emanuele DiLorenzo	USA
Rob Suryan	USA
Libby Logerwell	USA
Kevin Weng	USA / CLIOTOP
Gen Del Raye	USA
Gadea Perez Andujar	USA
Rolf Ream	USA
Sacha Vignieri	USA
Jeffrey Polovina	USA
Oleg Katugin	Russia
Hiroaki Saito	Japan
Rachel Orben	USA
Chandra Goetsch	USA
Kathy Kuletz	USA
Nate Mantua	USA
Jake Rice	Canada
Bree Wittiveen	USA
Megumi O. Chikamoto	USA
Bill Sydeman	USA

AP-MBM Endnote 3.2

Workshop W1 schedule

Monday, April 14 (09:00-18:00)

09:00	*Introduction by Workshop Convenors*
09:10 W1-O1	**Emanuele Di Lorenzo, Mark D. Ohman and Salvador Lluch-Cota (Invited)** A filtering-hypothesis to explain climate synchrony in fish populations (9365)
09:40 W1-O2	**Gadea Pérez-Andújar, Christina Comfort and Kevin Weng** Deep-water sharks: Their ability to withstand hypoxic conditions provides hints on how animals may respond to climate change (9326)
10:00 W1-O3	**Rachael A. Orben, Rosana Paredes, Daniel D. Roby, Richard Phillips, David B. Irons and Scott A. Shaffer** Annual variation in habitat use of black-legged kittiwakes (Rissa tridactyla) wintering in the sub-arctic North Pacific (9320)
10:20	*Coffee/Tea Break*
10:50 W1-O4	**William J. Sydeman, Sarah Ann Thompson, Julie A. Thayer, Mike Litzow, Marisol Garcia-Reyes, Jarrod A. Santora, Heather Renner, John F. Piatt and Yutaka Watanuki (Invited)** Challenges and opportunities for assessment and attribution of climate change impacts on North Pacific seabirds (9375)
11:20 W1-O5	**Takashi Yamamoto, Akinori Takahashi, Katsufumi Sato, Nariko Oka and Yutaka Watanuki** Spatial utilization of streaked shearwaters in the Northwestern Pacific (9382)
11:40 W1-O6	**Robert M. Suryan, Amanda J. Gladics, Julia K. Parrish, Elizabeth A. Daly and William T. Peterson** Diet composition and isotopic signatures of sentinel species as indicators of climate change (9370)
12:00 W1-O7	**Chandra Goetsch, Melinda Conners, Yoko Mitani, William Walker, Samantha E. Simmons, Colleen Reichmuth, Suzanne Budge and Daniel P. Costa** Climate variability is linked to diet switching in a marine predator, the northern elephant seal (*Mirounga angustirostrus*) (9316)
12:20	*Lunch*
14:00 W1-O8	**Jeffrey Polovina, Jason Baker, George Balazs and Denise Parker (Invited)** Loggerhead sea turtles and Hawaiian monk seals as sentinels of climate change in the central North Pacific (9286)
14:30 W1-O9	**Kevin Weng, Gen Del Raye, Christina Comfort, Gadea Pérez-Andújar and Danielle Garcia (Invited)** Fish futures: Observation, adaptation and response to climate change (9395)
15:00 W1-O10	**Briana H. Witteveen, Kate M. Wynne and Lei Guo** Whales as sentinels in a changing marine environment in the Gulf of Alaska (9285)
15:20	*Coffee/Tea Break*
15:40	**Kathy Kuletz** Introduction to program: US Fish and Wildlife surveys of birds and mammals at sea in the Gulf of Alaska and Eastern Bering Sea.
15:50	*Discussion*
18:00	Workshop Ends

AP-MBM Endnote 3.3

Proposed sampling considerations to monitor impending El Niño effects on North Pacific ecosystems

There were three potential data collection approaches identified but it was difficult to suggest a single approach necessary to move forward. There was discussion of whether such a program should aim for depth or breadth. Some participants suggested that monitoring broadly across species and systems would spread resources too thin, and that a more focused effort should concentrate on drilling down more deeply into the underlying mechanisms that drive top predator responses.

- Targeted process sampling (target specific important food web nodes that may shed light on specific mechanisms);
- Broad scale monitoring of system changes (ensure we quantify as many potential responses as possible);
- Coordinated synthetic analysis of data that is already planned to be collected (additional analysis funding rather than additional data collection).

A summary of data collection approaches that we identified that meet the above criteria are outlined below.

- Satellite tagged individuals to observe potential range shifts and quantify phenotypic plasticity;
- Increased frequency in sampling of:
  - Physical and biological oceanographic variables,
  - Mid-trophic level prey sampling ,
  - Top predator surveys for identification of tipping points / changes in timing and phenology;
- Continued long term surveys and colony sampling of top predators;
- Mechanistic measurements needed to (experts in these methods were not part of the group):
  - Genetic basis for adaptation – "evolveability?"
  - Physiological metrics e.g. oxygen tolerance, metabolic needs, enzyme activity, stress;
- Trophic ecology, changes in food web dynamics (condition, and food web tracers such as diet data, *e.g.*, stomach lavage, scat, stable isotopes, and fatty acids);
- Use ecosystem models to predict El Niño response, *e.g.*, end to end models, and use sampling efforts to test these predictions.

AP-MBM Endnote 4

PICES Observer Report on the 2014 IWC Scientific Committee Meeting

Hidehiro Kato
Tokyo University of Marine Science and Technology, Tokyo 104-8477, Japan

The 66th scientific committee meeting (SC) of the International Whaling Commission (IWC) was held at Bled, Slovenia from May 12–24, 2014. A total of 87 participants from 24 contracting governments, in addition to 54 invited experts and 6 observers from 6 international organizations (CCAMLR, IUCN, PICES, SPAW, *etc*.), participated at this year's annual meeting. For the management of cetacean stocks, which is the most important task for the committee, the SC explored improvement of management methods for cetacean stocks after enforcement of the commercial whaling moratorium in 1985, and had agreed with the scientific basis of RMP (Revised Management Procedure) in 1996 through long-term endeavors by many scientists. The IWC/SC is continuing work on checking the trial performance and implementation of the RMP for the stocks after completion of their comprehensive assessments. According to resolution adopted at last year's commission meeting, the commission plenary meeting, which is usually held immediately held after the SC meeting, and is biennial, was held September 15 to 19, 2014, in Portoroz, Slovenia.

Under the IWC/SC, the following seven sub-committees and seven working groups have been established:

- Sub-committee on Revised Management Procedure (RMP),
- Sub-committee on Bowhead, Right and Gray Whales (BRG),
- Sub-committee on In-Depth Assessment (IA),
- Sub-committee on Other Southern Hemisphere Whale Stocks (SH),
- Standing Sub-Committee on Small Cetaceans (SM)
- Sub-committee on Whalewatching (WW);
- Working Group on an Aboriginal Whaling Management Procedure (AWMP),
- Working Group on Stock Definition (SD),
- Working Group on Non-deliberate Human-induced Mortality of Large Whales (HIM),
- Working Group on Environmental Concerns (E),
- Working Group on Ecosystem Modeling (EM),
- Working Group on DNA testing (DNA),
- Working Group on Special Permits (PS).

Every substantial issue is discussed once at the sub-committees or the working group and then goes to plenary of the committee. After completion of its business at its annual meeting, the IWC/SC makes scientific advice and recommendations to the IWC commission.

This year following topics were noted in discussions from the 2014 annual meeting:

1. <u>RMP implementation</u>

For the RMP implementation, no further trials were carried out for the North Pacific stocks in this year. It was agreed that the proposed start of implementation on North Pacific stock Bryde's whales in 2016 be postponed to 2017. There were some developments of methods to estimate MSYR using an IBEM model in relation to CLA process. Whale sighting cruises in the western North Pacific, including Okhotsk Sea, were proposed by Japan and the plans for those were reviewed and endorsed by the SC.

2. <u>Comprehensive assessment, *etc*.</u>

Under the comprehensive assessments through IA, SH and BRG sub-committees, this year the IWC/SC continued the review of stock status of blue and humpback whales in the southern hemisphere, and completed humpback whale stock review. There was some progress on North Pacific sei whales in relation to both stock separation and population abundance. For the Antarctic minke whale stocks, conducted through the JARPA review meeting and other sources, there was good progress in VPA type analyses (statistical catch-at-age models), stock separation and population abundance within sea ice areas. For conservation of western North Pacific gray whale stock, which is highly depleted, the SC continued organizing the WGWAP (Western Gray

Whale Advisory Panel) in cooperation with IUCN, and this year especially discussed the mixing of the eastern and the western stocks.

3. Management of aboriginal and subsistence whaling

The IWC/SC has managed ongoing aboriginal and subsistence whaling using AWMP (aboriginal and subsistence whaling management scheme), including Bowhead whale stocks in the Arctic region, fin whale, minke whale and humpback whale stocks of west Greenland, humpback whales off St. Vincent and Grenadines, and Eastern stock of gray whales of Chukotoka. After examining updated scientific information, the IWC/SC concluded that the present catch levels for respective stocks would not harm the stocks. This year whale stocks including fin, common minke and humpback whales of west Greenland were especially discussed.

4. Scientific permits

The SP Sub-Committee to examine the scientific permit program (based on Article VIII of the international convention for regulation of whaling), reviewed the report from the Icelandic scientific permit workshop and research results and plans for Japanese scientific permits. In advance of the regular SC meeting, a dedicated review meeting on JARPA II (scientific permit program in the Antarctic) was held in Tokyo in January. Some countries did not participate because of their position on the ICJ judgments on the JARPA II program made in the Hague in March 2014.

5. Environment issues and ecosystem modeling

For environment issues around cetacean stock managements, the SC has two working groups (E, Environmental Concerns; EM, Ecosystem Modeling) and discussed a number of matters related to environmental factors that affect cetaceans. This year progress on the following issues were reviewed for E Working Group:

1) State of the Cetacean Environment Report,
2) Review progress in planning for POLLUTION 2020+I,
3) Review oil spill impacts, especially in deep water,
4) Review activities by working group of CERD (cetacean emerging and resurging disease),
5) Review anthropogenic sounds related issues,
6) Review activities related to climate change issues,
7) Cetacean and marine debris.

For ecosystem modeling, EM Working Group dedicated its time to three general tasks: (1) reviewing ecosystem models and modeling approaches that were developed outside of the IWC/SC, especially CCMLR's ecosystem monitoring (WG-EMM) and management programme; (2) exploring how the ecosystem model (IBM; Individual-based simulation model) can contribute to developing scenarios for simulation testing of the RMP; (3) reviewing issues relevant to ecosystem modeling within the SC, focusing on changes in blubber thickness of the Antarctic minke whales in conjunction with environmental changes used in the analyses based on JARPA II (Japanese scientific permit sampling) .

6. North Pacific Sighting survey cruise (IWC/POWER)

IWC sponsors an international cetacean sighting survey program, started in 2010, in cooperation with Japan, Korea and United States. The project includes line transect sighting for estimating population abundance and biopsy skin-sampling and photo ID for stock structure on major large cetaceans. The program was renamed POWER (North Pacific whales and ecosystem research project) in 2011, and this year the SC received the 2013 cruise report conducted in waters surrounding 30°N–40°N and 134°W–160°W, which sighted 64 Bryde's and 3 sei whales during its effective searching distance of 3,036 nm. A 2014 POWER cruise is planned for waters surrounding 30°N–40°N and 170°E–160°W. Dr. Kato presented a request by PICES' AP-MBM to do a piggyback survey of sea-birds on the vessel. The request was denied again due to logistical reasons, mainly the limitation in the number of researcher that can be accommodated.

7. Other issues

The SC also covered relevant issues on small cetaceans, whale watching, by-catch and human-deduced mortality of large whales, *etc*. as in previous years.

Next year's annual meeting of the IWC/SC will be held for two weeks in May 2015 in San Diego, USA.

8. Commission Meeting

The Commission meeting was held September 15 to 19, 2014, in Portoroz, Slovenia. Dr. Kato also participated at this meeting as a PICES observer. Highlights of the meeting are available at https://survey.iwc.int/index.php/331119/lang-en.

AP-MBM Endnote 5

AP-MBM Activity Plan, 2015–2017, 2018–2019

2014.10.22
Co-Chairs: Rolf Ream (USA), Yutaka Watanuki (Japan)

The AP-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 and anthropogenic influences (AP-COVE and AP-AICE), as well as contribute to PICES communications with stakeholders (AP-SOFE).

We will update the Hunt *et al*. (2000) report (PICES Scientific Report No. 14) 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 AP-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, non-member)

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 tropic 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 of the AP-MBM

PICES Scientific Report No. 14 on *Predation by marine birds and mammals in the subarctic North Pacific Ocean* (2000) edited by G.L. Hunt, Jr., H. Kato, and S.M. McKinnell provides an overview of the trophic requirements and trophic roles of marine birds and mammals for the North Pacific in the 1990s.

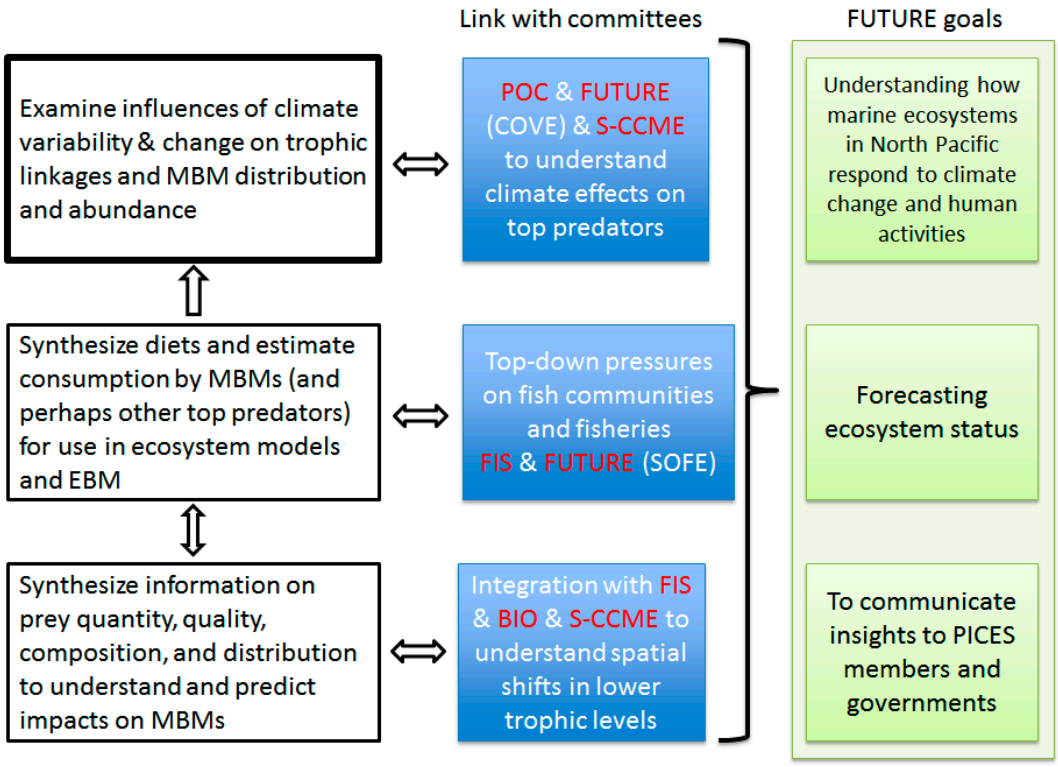
The AP-MBM held a workshop at PICES-2012 (October 12–21 2012, Hiroshima, Japan) to review whether an updated report was warranted (W3: The feasibility of updating prey consumption by marine birds, marine mammals, and large predatory fish in PICES regions, Dr. Hunt (USA), Dr. Kato (Japan), and Dr. Michael 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?" (W. Sydeman lead), we 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 AP-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 time line of PICES AP Committees and 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 AP-MBM will thus:

1) Examine influences of climate variability & 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: 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 contains 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 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 business meeting on implementing MBM-AP 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*" will summarize 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 and 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 regions and produce PICES Science Report on our findings.