

MBM-AP Activity Plan (2011–2014)

Marine birds and mammals (MBMs) are top predators that consume substantial amounts of forage prey and are susceptible to the changes in marine food web structure and productivity and to a variety of anthropogenic impacts. Although their population level response to environmental change is generally slow since most marine mammals have long life-span, they can show quick responses in diet, condition and breeding biology. They are highly vulnerable to adult mortality factors (*e.g.*, by-catch), and they are known to accumulate often high levels of persistent environmental contaminants. Marine mammals and seabirds as used by researchers in some nations ‘sentinels’ of marine ecosystem health. Incorporating these roles and characteristics of MBMs in the ecosystem, and the objectives of FUTURE, we propose SPACIAL ECOLOGY AND CONSERVATION as the priority topic for MBM-AP future activities. MARINE CLIMATE IMPACTS ON MBMs THROUGH FOOD WEB and INDICATORS OF TEMPORAL AND SPATIAL VARIATIONS OF POLLUTANTS are ranked as the second and the third priorities and may be considered.

In this document, we briefly provide the rationale for each topic, summarize related past activities, and describe potential activities or products to be accomplished by MBM-AP during the next three years (the reviewed period for Advisory Panels in PICES).

SPACIAL ECOLOGY AND CONSERVATION

Leaders: Rob Suryan (U.S.A.) and Yutaka Watanuki (Japan)

MBMs are not distributed evenly and aggregate at various temporal and spatial scales due to physical forces, chemical factors, the patchiness of their prey, behavioral and social factors, and the spatial dynamics of marine ecosystems. Thus, coupling their distribution at sea and physical and biological factors has been studied extensively (Coyle *et al.* 1992, Hunt *et al.* 1993 and many others). Research on the distribution and movement of MBMs in marine ecosystems can be relatively easy to accomplish, and the information would prove useful for marine spatial planning and management (LME, IBA, IEA, and MPA; Hyrenback *et al.* 2000, Hooker 2008). Additionally, the identification of biological hot spots, where abundance and/or biodiversity are high, and gaining an understanding of the mechanisms responsible for establishing and maintaining (spatial and temporal stability/frequency) the hotspots is important for fisheries and the conservation of MBMs.

At PICES 2004, MBM-AP sponsored a Topic Session on “*Hot spots and their use by migratory species and top predators in the North Pacific*”, and the papers presented at this session were subsequently published in a special issue of *Deep Sea Res II* (2006, Vol. 53, Nos. 3-4, pp. 247-449). MBM-AP will also contribute to the PICES-2011 Topic Session on “*Mechanisms of physical-biological coupling forcing biological hotspots*”. Due to technological advancements with tracking techniques, studies on the movements of MBMs and the factors affecting their distribution, have increased substantially (Pinaud *et al.* 2005, and many others). At-sea bird census data is also accumulated and analyzed with the aid of new spatial statistics. Identifying and describing the hotspots using MBMs provides habitat information that is necessary to allow incorporation of these hotspots into marine spatial plans (*e.g.*, MPA; Louzao *et al.* 2009, Worm *et al.* 2003, Hooker 2008). Moreover, combining biological (movement of MBMs and primary production) and physical information to understand spatial dynamics of marine ecosystem in the PICES region will help understand the forcing mechanisms.

MBM-AP will summarize information on the distribution and movement of multiple species of MBMs that would be useful for defining important habitats used by MBMs in the PICES region, and help to understand the spatial and temporal dynamics responsible for variable habitat use (*i.e.*, biological hotspots). Knowledge of MBM habitat use, now and in the future, will also contribute to the FUTURE mission of understanding climate change and anthropogenic impacts on marine ecosystems in the PICES region.

Time schedule

PICES-2011: Topic Session on “*Mechanisms of physical-biological coupling forcing biological hotspots*”

- PICES-2012: Workshop on “*Prey consumption by marine birds, marine mammals, with the addition of prey consumption by large predatory fish in the PICES regions*”
- PICES-2013: Workshop
- PICES-2014: Topic Session; proceedings (special issue) and PICES Science Report

MARINE CLIMATE IMPACTS ON MBMs THROUGH FOOD WEB

Leader: William Sydeman (U.S.A.)

Seasonal, interannual and decadal variability of climate can affect the foraging behavior, diet, timing of breeding, breeding success, and population dynamics of MBMs through bottom-up effects. Thus, it is believed that MBMs can be used as an index of ecosystem change (Aebischer *et al.* 1990, Montevecchi 1993, Reid and Croxall 2001, Hunt and Stabeno 2002, Frederiksen *et al.* 2006, Loeng and Drinkwater 2007, Piatt, Sydeman, Wiese 2007, Sandvik *et al.* 2008, Sydeman and Bograd 2009; but see Durant *et al.* 2009). Seabirds may be more likely to provide an index of ecosystem change than marine mammals (Hunt 2006). Also, there are increasing evidence indicating that climate change can affect seabird populations and is expected to force extinction (Jenouvrier *et al.* 2009).

At PICES 2007, MBM-AP convened a Workshop on “*Responses of marine mammals and seabirds to large-scale and long-term climate change: Mechanisms of environmental forcing*”, and the papers were subsequently published in *Mar. Ecol. Prog. Ser.* (2009, Vol. 393, pp. 185-301). A recent review (Sydeman *et al.* 2011, ESSAS Open Science Meeting) shows that there are large regional and species variation in the responses of seabirds to climate variability. Further efforts to understand the mechanisms and variability should provide useful information for the task of the FUTURE Advisory Panel on *Climate, Oceanographic Variability and Ecosystems* (COVE-AP) to understand climate change impacts on marine ecosystems in the PICES region. With retrospective analyses of existing data, key parameters and the key environmental factors affecting these will also be identified and useful for forecasting population changes. Thus, further efforts will also provide useful information for the task of the FUTURE Advisory Panel on *Status, Outlooks, Forecasts, and Engagement* (SOFE-AP) to forecast future ecosystem change.

MBM-AP will: 1) provide a retrospective review of climate/anthropogenic affects on MBMs, in order to identify the important factors or mechanisms; and 2) hold a workshop on the analysis of the effects of climate change/variability on MBMs. The workshop would focus on which metrics and analytical approaches should be used, relating MBM metrics to climate metrics, and recognizing non-linear change.

MARINE MAMMALS AND SEABIRDS AS INDICATORS OF TEMPORAL AND SPATIAL VARIATIONS OF POLLUTANTS

Leader: Peter Ross (Canada)

Pollution levels in MBMs are the highest among marine organism (and environment) as a result of biomagnification. MBMs have long been used as an indicator of marine pollution (heavy metal, POPs, plastics, Tanabe *et al.* 1994, Furness 1993, Day 1980). With information on diet (stable isotope ratio and fatty acid profile) and annual movements, MBMs can be useful indicators of spatial and temporal variations of marine pollutants and debris (Blais *et al.* 2005, Finkelstein *et al.* 2006, Young *et al.* 2009, Roscales *et al.* 2010.).

Pollution is one of the primary anthropogenic impacts in the sea. Understanding the status and effects of pollution on the marine ecosystem (and the consumers that rely on these ecosystems, including humans) is increasingly important, and is a focus of the FUTURE Advisory Panel on *Anthropogenic Influences on Coastal Ecosystems* (AICE-AP). Numerous studies of pollutants in MBMs have been carried out (pollutant levels of whales has been monitored by Japanese agency, Aono *et al.* 1997, for example) in PICES region, but there has been no integration or compilation of the data.

MBM-AP will: 1) collect existing and new data on pollutants in MBMs in the PICES region; 2) integrate these with published information on variation of pollutants found in other marine organisms; and 3) discuss the source, transport, fate and effects of these pollutants in the PICES region.

Other potential topics include:

MBMS AS A PREDICTIVE INDICATOR OF FORAGE PREY

Forage species including krill, forage fish, lantern fish and squids are key components of marine food webs. Understanding the present status and predicting changes in abundance and distribution of forage species is one of the central topics of the study of marine ecosystems. Substantial efforts including acoustic surveys, net sampling and cohort analyses have been made, though these efforts do not always incorporate the biologically important hot-spots located outside of commercially important fishing areas. Recent studies show that the breeding success and diet information of MBMs are sometimes useful for understanding the status of forage fish around their breeding ground.

MBM-AP will: 1) review existing studies and collect data on forage fish species in the diet, breeding performance of MBMs, and status of prey stocks; and 2) model their relationships for using these information as predictive indicator.

MBMS AS CONSUMERS AND THEIR ROLE AS A TRIGGER OF TROPHIC CASCADE

Marine mammals and seabirds are the second and third most important marine consumers, on average (Bax 1991, Yodzis 2001). Hunt *et al.* 2000 (PICES Scientific report 14) summarized predator density, metabolic rate, body size, diet, prey energy value. Several workshops on this topic have been carried out. Hunt *et al.* covered half of the PICES region during the summer season (92 days for birds, 122 days for mammals). Identify important problems, scientific questions, and knowledge gaps in assessing the roles of marine mammals and seabirds in marine ecosystems, and providing basic data for ecosystem modeling is an important role of MBM-AP.

Changes in abundance of marine mammals (through over-fishing, harvest patterns, by-catch, climate change) are suspected or known to trigger trophic cascades (Laws 1977, May 1979, Estes *et al.* 1988, Springer *et al.* 2003). A decrease (by 60-80%) of whale biomass during 1950-1980 was apparent (Laws 1977, Croll *et al.* 2006). There was evidence of the release (progress of age at maturity, improvement of growth) of intra-specific and inter-specific competition by the whale population decline (Ohsumi 1986, Kato 1987, Kasuya 1991, Kato and Sakuramoto 1991). However, its impact on marine communities or ecosystem is still controversial (Trites *et al.* 1999, Croll *et al.* 2006, Balance *et al.* 2006). Further decrease of large predatory fish (either via over-fishing or climate change, Pauly *et al.* 1998, Mayer and Worm 2003, Lotze and Worm 2009) may impact MBMs via the decrease of the size of forage fish (Osterbrom *et al.* 2006) or the decrease of the abundance of competitors (cods etc) (Springer 2001, Frank *et al.* 2005). Thus, marine mammals can be a key component to understanding the trophic effects of the decrease of marine top predators via overfishing. Understanding anthropogenic impacts, including the effects of fishing, on marine ecosystems is a primary objective of AICE (FUTURE advisory panel).

MBM-AP will: 1) review any information available from winter seasons (including migrants) as well as summer, and from 6-8 missing areas in the PICES region, and update the MBM prey consumption data; and 2) discuss the effects of the decrease of MBMs (via over-fishing and climate change) and the roles of trophic cascades.