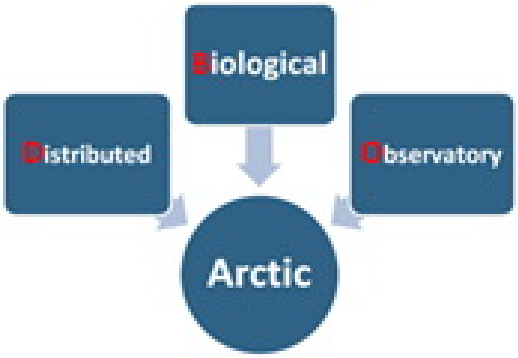

The Distributed Biological Observatory (DBO) 3rd Data Workshop Final Report

March 9-10, 2016
NOAA / PMEL
Seattle, Washington, USA

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https://www.pmel.noaa.gov/dbo/

Introduction

Since 2010 the Pacific Arctic Group (PAG) has endorsed the Distributed Biological Observatory (DBO) that is focused on ship-based research in the northern Bering and Chukchi Seas. The PAG established the DBO as the organizing framework for research that consists of standard stations and transect lines for consistent sampling of select physical, chemical and biological measurements as a "change detection array" along a latitudinal gradient extending from the northern Bering Sea to the Barrow Arc. DBO sampling is focused on stations centered on locations of high productivity, biodiversity and rates of biological change. Research cruises networked by PAG members through national support include collection of standardized measurements of physical, hydrochemical and biological measurements at set station locations.

The DBO sampling framework was initially tested during the successful 2010 Pilot Study, which consisted of international ship occupations of two of the DBO sites, one in the SE Chukchi Sea and one across upper Barrow Canyon in the NE Chukchi Sea. Provisional results of the 2010 Pilot Study were the central topic at the December 2010 PAG meeting in Tokyo, Japan, and at the March 2011 DBO

workshop in Seoul, Korea, held immediately prior to the international Arctic Science Summit Week (ASSW). Subsequently, the 1st DBO data workshop was held February 27-March 1 2013 at the US National Oceanic and Atmospheric Administration (NOAA)/Pacific Marine Environmental Laboratory (PMEL) facility in Seattle, Washington. The purpose of the meeting was to discuss the results from the 2010-2012 DBO effort under PAG leadership, share data sets, develop a draft international data policy for this observing effort, and organize collaborative publications.

The 2nd DBO data workshop was held October 29-31, 2014 at the USA.NOAA/PMEL in Seattle, Washington, USA. The 2nd DBO data workshop continued development and implementation of the DBO through presentation of data results, breakout group discussion on measurement protocols and findings, development of visualization products for disseminating of the DBO findings to the science community, science managers and the general public. We also discussed proposed new DBO lines in the western and eastern Beaufort Sea and development of collaborative-type DBO lines in the northern Barents Sea through input from Norwegian collaborators. During the 3rd DBO data work held March 9-13, 2016 at the US NOAA/PMEL in Seattle, Washington we discussed the results from the DBO efforts for the DBO1-5 sites, results from the new Beaufort Sea lines DBO6-8, and developing plans for an Atlantic-DBO network. We also identified manuscript topics for a special issue of the DBO results. The 3rd workshop consisted of over 50 international participants, with financial support for participants from national and international agencies. In the USA, support for the workshop logistics were provided by US NOAA and NSF.

The following report provides a detailed summary of the 3rd DBO data workshop results. More information on the DBO is available at: https://www.pmel.noaa.gov/dbo/

Wednesday-9 March 2016

Welcome & Logistics

Welcome (Chris Sabine, NOAA/PMEL Director)
Chris Sabine welcomed the group to the workshop and noted the PMEL (Pacific Marine Environmental Laboratory) is most of proud of their research approach. He felt that this hub of research provides a long-term, sustained infrastructure that other researchers can build on – such as the DBO. He emphasized a strong belief in the multi-disciplined approach of the DBO and the fact that is sets a gold standard for a synthesized approach to research.

Logistics (Sue Moore, NOAA/NMFS)
Sue provided information on local logistics, including informing all participants to have their NOAA id's with them at all times and that they must be accompanied by a NOAA employee when walking about the building.

Introduction (Jackie Grebmeier, CBL/UMCES) ppt1
Jackie provided an overview of the 3rd DBO workshop including the 3 main objectives as well as the agenda:

- Present results from the 2010-2015 DBO field program and commit to multidisciplinary papers to showcase results of the DBO international effort

- Evaluate the DBO data submission effort through the Earth Observing Laboratory (EOL) DBO Metadata site and linkage to other national archives
- Overview of US-Interagency Arctic Research Policy Committee (IARPC) Draft DBO Implementation Plan + International 10-year future efforts

She provided the workshop agenda as well as a summary for the rational and goals of the DBO. Part of the rationale for the DBO is that tracking biological responses to physical drivers in the Arctic requires coordinated, multidisciplinary field sampling. In addition, many developing observation systems in the Arctic are focused on physical sensors, but biological sampling across a range of spatio-temporal scales is required to detect ecological shifts in response to environmental forcing. Jackie showed an example of how high chla values in the SE Chukchi that were collected from ship-based data match well with NASA satellite data for 2013. She also showed the most recent NOAA DBO map that includes the locations of DBO transects 6,7, and 8 in the Beaufort Sea. Standardized sampling protocols that are used by national and international programs continue to be developed, and the DBO includes core ship-based sampling for: temperature and salinity using a Conductivity, Temperature, and depth data (CTD), currents via Acoustic Doppler Current Profiler data (ADCP) measurements, chlorophyll, nutrients, ice algae/phytoplankton, zooplankton, benthos, seabirds, and mammals. Second tier sampling includes fish acoustics and bottom trawling. Finally, a coordinated ship-based sampling, coincident with data streams from satellites and moorings, will provide an early detection system for biological shifts in the Arctic.

Physical Oceanography (Discussion lead: Bob Pickart)-ppt2

Bob Pickart (WHOI) provided a general overview of the Woods Hole Oceanographic Institute (WHOI) assembly line of data and wanted to discuss where to ultimately put the data (e.g. publish on the EOL site only). Bob showed a trend graph of data coverage per year which seems good overall but the best coverage is for DBO3 and 5. He noted that the ADCP data is more complex to process so he is not sure about line distribution or coverage. Bob is encouraging people to really use the data. Slides were presented for DBO5 showing mean unforced upwelling of salinity up Barrow Canyon suggesting that warmer water is moving north with the overall flow north of the Canyon.

Svein Vagle (Fisheries and Oceans Canada, ppt3) provided a summary of data collection from the Sir Wilfred Laurier (SWL) cruises that have been sampling every July from 2008-2015. The most recent cruise was from July 12 to July 23, 2015 from Dutch Harbor to Barrow and the following scientific data was collected:

- Continuous sea surface water monitoring (T,S,F,O_2,weather)
- Bird and mammal observations (Mammals from Victoria)
- 54 CTD science stations (All planned stations completed this year)
- 41 Rosette casts (Nutrients, Ba, O18, DIC/Alk, Chlorophyll)
- 41, 150 kHz ADCP over the side deployments (Backscatter and currents)
- 41 Bongo plankton net hauls to 100 m or 10 m above seafloor (Stantek)
- 40 Benthic sampling stations (U. of Maryland)
- 12 C-OPS stations (Clark University)
- 4 Phytoplankton incubation experiments (UVIC)

- 20 Stations where water was collected for Methane and C13 analysis.

He noted that it is difficult sorting the data into different DBO stations. A summary of ship tracks from 2010-2015 show these areas are filled in with data over time. A series of profile graphs for each of the DBO regions showed latitudinal patterns of variability In water column temperature, salinity, fluorescence, and oxygen from Dutch Harbor to Barrow for the July 2015 cruise and included: DBO1, 3, 4 and 5. Svein also showed a summary of some methane (CH_4) work and noted that there is a lot of methane in the Chukchi. He questioned why this would be mostly in the coastal waters and noted a similar pattern with nitrous oxide (N_2O).

Shige Nishino (JAMSTEC, ppt4) presented a summary of patterns for the DBO3 moorings from July 2012 to July 2014. He was particularly interested in the biological hotspot in the center of the southern Chukchi Sea and noted the he found two blooms (turbidity high and low oxygen). He said this corresponds with the signal that Grebmeier/Cooper found as well as the signal being mapped in the satellite data. This suggests that satellite collection should be done in this area. See: Nishino, et al 2015b

Mike Steele (UW, ppt5) noted that he was mostly at the workshop to learn more about the DBO with particular interest in the Chukchi. He is looking at ice retreat and ocean warming relationships (Steele, et al, GRL, 2008). His team is deploying upper water buoys focused on the seasonal ice zone. For example, they deployed buoys in the Chukchi in 2015 via the Healy, collecting hourly data. Also, they are developing a "warm" buoy in order to develop a heat budget and have an NSF proposal to continue this research. He noted that ice retreat is affecting ocean warming, but ocean warming also affects ice retreat. They are working on areas where the ice edge tends to retreat early and refer to the phenomenon as "ice edge loitering" which allows the water to warm up (Steele and Emold, JGR, 2015). He showed loitering frequency maps from 1989-2013.

Mooring Data Results

Phyllis Stabeno (NOAA/PMEL, ppt6) provided a status report of 2016 Arctic moorings. There are approximately 80 moorings. She showed a map that included the following moorings that span the DBO region provided by DBO PIs and programs: Woodgate, Russian-American Long-term Census of the Arctic (RUSACLA); Nishino, Japan Agency for Marine-Earth Science and Technology (JAMSTEC); Danielson, Stabeno, Bureau of Ocean Energy Management (BOEM)/National Oceanic and Atmospheric Administration (NOAA), and Pickart (NSF). She provided some of the results for temperature and salinity collected over time for mooring M8 in the DBO 1 region and, as an example, showed 2005 data that seemed like a particularly warm year in the northern Bering Sea. She noted that a delay in the freezing of the Chukchi Sea also affects the Bering Sea further south.

Flow patterns were provided comparing advective and less advective areas, including temperature and chl a levels. There is fall bloom (chl a) and a lot of ammonia (3-6 µM) with a steady increase of ammonium over time that doesn't seem to be correlated to advection. Calvin Mordy is doing work on estimating bottom productivity.

Water properties (Carol Ladd) – how often do we see Atlantic water? Data from upper Barrow Canyon north to the shelf shows a progression of how long it takes on the shelf along the moorings (advective speed approximately 40cm/s). There is an implication of heat entering the surface waters and keeping the polynya open in the NE Chukchi Sea.

Takashi Kikuchi (JAMSTEC, ppt7, ppt8) provided mooring observations at DBO3 (SE Chukchi Sea hotspot) and DBO 5 (Barrow Canyon hotspot). JAMSTEC has been monitoring ice thickness since 2009 (Itoh, et al, DSR-1, 2015; Hirano et al, JGR, 2016).

Rebecca Woodgate (UW) provided an overview of the Bering Strait that is the Pacific gateway to the Arctic**, including mooring results from** 1990-to present that are year round moorings. The presentation included key findings from the Woodgate et al 2015 – RUSALCA special issue. The highlights included:

- 50% increase in annual Bering Strait throughflow from 2001-2011. What drives the change?
- 70% increase in annual Bering Strait throughflow from 2001-2014. What drives the change?

There are significant shifts from 1990. They are quantifying ice thickness and fluorescence interannually including annual maximum and annual sea ice flux, as well as identifying properties of annual Alaskan Coastal Current (ACC) parameters. See: http://psc.apl.washington.edu/BeringStrait.html for further information.

Biogeochemistry

Lee Cooper (CBL/UMCES, ppt9) used 2004, 2009, and 2012 RUSALCA (including DBO3 data) to show the progression of increasing influence of melted sea ice relative to runoff (i.e. increasingly shallower slope in $\delta^{18}O$ versus salinity relationship). The results are summarized in Cooper et al., in press, 2016, Deep Sea Research II (DSR). Lee also showed examples of $\delta^{18}O$ profiles produced in Ocean Data View for each DBO transect for SWL 2015 data including interpretations of the patterns:

DBO1: There was no ice melt and the water mass gradient was only between Anadyr and Bering Shelf Water

DBO2: Was influenced by Anadyr Water

DBO3: There was no sea ice melt water mass gradient from Anadyr to Bering Shelf Water to Alaska Coastal left (left to right)

DBO4: Sea ice was present in the Alaska Coastal water to the right (particularly noted in the orange colors at the surface)

DBO5: Sea ice melt was present mid transect noted by greenish colors at the surface.

Monika Kedra (IOPAN, ppt9) presented results related to a benthic food-web study using compound-specific isotopic analysis of amino acids. These preliminary results were based on SWL 2012-2014 data benthic sampling. In Barrow Canyon, larger differences between bivalves and polychaetes in trophic amino acids than source amino acids were noted. Also, there was a 13.8‰ difference for the $\delta^{15}N$ value of alanine between the polychaete *Maldane sarsi* and the bivalve *Macoma calcarea* and only 0.05‰ difference for phenylalanine.

Lisa Eisner (NOAA/AFSC, ppt9) provided a summary of results related to Barrow Canyon transport for 2012 and 2013. Water mass properties were explored in Danielson et al, in press 2016, DSR-II. HF Radar Surface Currents were used to explore patterns in the Alaska Coastal Current (ACC) which were strong in 2012 and week in 2013. Additionally, satellite-tracked drifter were used in the study. Patterns related to the Arctic Ecosystem Integrated Survey (EIS) project surface (10 m) and near bottom 2012 and 2013 nutrients were also shown including: nitrate, ammonium, silicic acid, and phosphate. A water mass property comparison matrix was shown that summarized surface and bottom water layer water masses by property for 2012 and 2013. For example, for the Melt Water (MW) water mass, salinity, NO_3, NH_4, Si, and PO_4 were significantly lower in 2013 than 2012. Also related to the Arctic EIS, integrated chla total,

including small (<10µm) and large (>10µm) size fractionated chla maps comparing 2012 and 2013 were shown.

Biological Oceanography (Lower Trophics, ppt10)

Karina Giesbrecht (University of Victoria) presented results on patterns of biogenic silica ($bSiO_2$) for DBO1 (Bering Sea) and DBO3 (Chukchi Sea). It was noted that the Chukchi Sea was more productive with a greater contribution of >5µm cells. A decreasing trend from 2013 was noted and the question was posed as to why such a dramatic change seems to be occurring. Could it possibly be a response to the 2012 sea-ice minimum? Phytoplankton community composition (chlorophyll max) was also examined. For the SWL2013 cruise, it was found that diatoms tend to be most abundant, especially when cell counts are high. There was also a notable abundance of coccolithophores on the DBO3 and DBO4 lines. For the SWL 2015 cruise, it was noted that cell numbers don't tell the whole story and quantified diatom contribution to $bSiO_2$ was examined using the fluorescent tracer PDMPO. This tracer work showed the contribution of different diatom species.

Jackie Grebmeier (CBL/UMCES) provided information on plankton and DBO data products. These include integrated chla, nitrate/nitrite and ammonium. An example of phytoplankton taxonomy illustrated the dominance of diatoms in the western side of the DBO research area maintained by nutrient rich Anadyr and Bering Shelf waters. Zooplankton abundances (per Carin Ashjian, WHOI) varied interannually by taxa/species. Copepods had greater abundances in 2008 and 2010 than in 2005-2006. Also, 2011 had very high abundances of meroplankton, cnidarians, and krill furcilia. Arctic Nearshore Impact Monitoring in the Development Area (ANIMIDA) III 2015 sampling stations were also shown for Ken Dunton.

Lisa Eisner (NOAA/AFSC) presented updates on the Chukchi Acoustic, Oceanographic, and Zooplankton Study (CHOAZ) program. In 2010 the influence of Alaska Coastal Waters (ACW) was noted by an assemblage characterized by greater numbers of cladocerans and thecosomata, and fewer larvaceans. Greater heterogeneity in the Calanus zooplankton species assemblages in 2012 reflects the additional complexity in circulation. For mean abundance of major taxa: the cold year (2012) had higher mean abundances of larger copepods (*Calanus glacialis*) and gammarid amphipods; 2010 & 2011 had higher mean abundances of small copepods and larvaceans; 2010 (warmer conditions) had a higher abundance of smaller zooplankton; and, 2010 had the highest abundance of calyptopis stage euphausiids. Are these larval stage euphausiids a result of reproduction in the Chukchi, or are they advected from the northern Bering Sea? Results suggest euphausiid reproduction in the Chukchi (local reproduction) during warmer years (2010), given the number of days for particle transport from the northern Bering Sea determined from mooring current velocities, and the development rates of *Thysanoessa spp* (Teglhus et al., 2015). Results from the large scale Arctic Ecosystem Integrated Survey (EIS) survey conducted in late summer 2012-2013 were also summarized. The distribution of temperature above the pycnocline appears to be in close correspondence to Alaska Coastal Current (ACC) variations and ice edge locations. The Pacific Species Complex comparison between 2012 and 2013 show strong positive correlations to salinity that indicate a link to the Bering/Chukchi Summer Water. The Arctic Species Complex comparison between 2012 and 2013 show strong negative correlations to temperature and salinity above the pycnocline and indicate a link to MW. Patterns of *Limanda* spp. (yellowfin sole) and *Hippoglossoides robustus* (Bering flounder) egg concentrations of both species suggest the presence of aggregations of spawning adults in those immediate areas. *Limanda aspera* (yellowfin sole) larvae were the most abundant species collected overall in both the Chukchi Sea and northern Bering Sea. Cluster analyses showed *L. aspera* to be the dominant component of a southern, nearshore assemblage strongly

associated with the northward moving ACC characterized by comparatively warm, low-salinity water. Note that inflow of Pacific zooplankton taxa were also greater in 2012 than 2013. In 2013 *Boreogadus saida* (Arctic cod) larvae and juveniles were more abundant than in 2012 but were distributed similarly in the northeastern Chukchi Sea near the ice edge in both years. *B. saida* larvae dominated a more northern assemblage in close proximity to the ice edge and were more abundant in 2013 than 2012. Note that Arctic zooplankton taxa were more abundant in 2013 than in 2012.

Jackie Grebmeier (CBL/UMCEL) presented types of data maps that represent different parameters for SWL2015 and the Arctic Marine Biodiversity Observing Network 2015 (AMBON) project. These parameters include: water column chla, and surface sediment chla, $\delta^{13}C$, TOC, and C/N. A regional decline in the dominant bivalve (*N. radiata*), with a potential shift to a smaller bivalve (*E. tenuis*) in SLIP-DBO1 was also shown. Distribution of benthic biomass and dominant fauna in the northern Bering and Chukchi Seas with the diversity index on DBO3 were also shown. Diversity values were highest in coarse, nearshore sediments, with lower values in finer, silt and clay sediment. Results for DBO3, a RUSALCA time series and macrofaunal similarity clustering analysis show that an overall decline in biomass has occurred at two DBO3 stations from 2004 to 2012 (Grebmeier et al. 2015, Oceanography).

Monika Kedra (IOPAN) presented results based on benthic samples collected from the SWL cruises in 2007, 2010, 2011, and 2012 (note that faunal analyses for cruises in 2008, 2013, 2014, and 2015 are in progress). The highest species richness was found in Barrow Canyon. South of St. Lawrence Island (SLIP) is dominated by subsurface deposit feeding *Nuculana radiata, Ennucula tenuis,* and surface feeding cirratulids. A BIO-ENV analysis revealed that benthic communities are related to sediment structure in the SLIP/DBO1 region. The best variable combinations included: 1 variable – fine sand (0.417), 2 variables – sand and fine sand (0.419), and 3 variables – very coarse sand, sand and fine sand (0.416). In the Chirikov Basin/DBO2, diversity is high and currents fast. The area is dominated by surface deposit feeding amphipods *Protomedeia* spp. and the polychaete *Ampharete* spp. Suspension feeders included the amphipod *Ampelisca macrocephala.* A BIO-ENV analysis revealed the best variable combinations to be: 1 variable – fine sand (0.392), 2 variables – find sand and silt (0.406), and 3 variables – fine sand, silt, and TOC (0.412). In the southern Chukchi Sea/DBO3 more sand dollars in the southern region indicate hydrologic stress. A BIO-ENV analysis revealed that benthic community structure seems to be more influenced by C/N ratios in the surface sediments. The best variables combinations included: 1 variable – very fine sand (0.462); 2 variables – very fine sand and gravel (0.579); and, 3 variables – sand, gravel, coarse sand, depth, and C/N (0.567). There are more species and higher densities of animals, but the biomass remains the same indicating an increase in the "wrong species" in food quality. DBO5 in Barrow Canyon has high numbers of diverse suspension feeders. There is a more complicated set of variables contributing to community structure. Spearman coefficients were calculated for species richness and other variables. There were significant relationships between species richness and: bottom water salinity (0.55*), chla (0.59*), and TOC (0.4*). Similar correlations were found for abundance and biomass. Also, a website of Pacific Arctic Benthic Species is available at: http://www.iopan.gda.pl/projects/DBO/.

Upper Trophics (ppt11)

Janet Clarke (Leidos) summarized results from the Aerial Surveys of Arctic Marine Mammals (ASAMM) from July-October 2010 to 2015. ASAMM completely encompasses DBO 4,5,6, and 7 and the eastern half of DBO3. DBO3 was sampled south 68°N only in 2014 and 2015 with limited effort. DBO4 and 5 had fairly equivalent coverage from July through October 2010-2015. Sightings included: bowhead, gray and beluga whales, but no subarctic species. DBO6 and 7 coverage was from September and October

from 2010-2011 and mid-July through early October from 2012-2015. Bowhead and beluga whales were sited, but no subarctic species. In DBO4, gray whales were observed in the SW quadrant, mainly in July and August. Bowhead whales were broadly distributed, mainly in September and October. Belugas were few and far between. In DBO5, gray whales were seen shoreward of Barrow Canyon and bowheads and belugas were mainly in Barrow Canyon. In DBO6 and 7, bowheads were observed on the slope and shelf in summer and shelf in fall. Belugas were only observed on the slope with very few on the shelf. Walruses were sighted in DBO4 and 5 only. Largest groups were in Hanna Shoal in the summer (July and August) when ice is still present (largest groups are hauled out on ice). Smaller groups occur in water when ice is absent in the fall (September and October). Note that this data is available to download as a publicly available Access database from: http://www.afsc.noaa.gov/NMML/cetacean/bwasp/. Janet encourages people to use the data but strongly suggests that you please contact Megan Ferguson (megan.ferguson@noaa.gov) or Janet Clarke (janet.clarke@leidos.com) for any questions about the data.

Catherine Berchock (NOAA/AFSC/NMML) provided summary of marine mammal observations including visual survey and passive acoustic monitoring from 2010-2015 for DBO1-6. DBO3 was noted to be a gray whale hotspot. She also presented updates on the Arctic Long-Term Integrated Mooring Array (ALTIMA) Project which is a continuation of moorings from BOEM-funded interdisciplinary projects, including: the Bowhead Whale Feeding Ecology Study (BOWFEST), CHAOZ, Arctic Whale Ecology Study (ARCWEST), CHAOZ-X, and NPRW. Summaries of offshore, midshore and inshore acoustic measurements were presented for bowheads, belugas, gray whales as well as bearded seals and walrus from 2010-2012 for DBO4. A similar summary was done for the M8 mooring located in DBO1 for multiple whale species and walruses. Note that any sightings from the annual SWL cruises, particularly of the Pacific Arctic Northern Right whale (only 30 individuals left in the Bering Sea), would be valuable.

Yoko Mitani – Catherine showed Yoko's slide of a paper that has been published entitled: "The migration of fin whales into the southern Chukchi Sea as monitored by passive acoustics".

Kate Stafford (UW) provided a summary of the Woodgate, et al 2015 paper: "A synthesis of year-round interdisciplinary mooring measurements in Bering Sea (1990-2014) and the RUSALCA years (2004-2011)" (http://dx.doi.org/10.5670/). It was noted that there is a lot of interannual variability due to physical ocean variability.

Sue Moore (NOAA/NMFS) provided a summary SWL 2014 Marine Mammal Watch. She noted that this data is based on data collection from one person watching with binoculars so it is different from other surveys. Sighting maps and data are available on AOOS/AXIOM DBO Workspace (https://workspace.aoos.org/).

Cathy Coon (DOI/BOEM) discussed the ADFG Walrus tagging work by Lori Quakenbush and Justin Crawford for 2010, and 2013-2015. She also presented results from Jay et al. 2012 which mapped walrus seasonal distribution and habitat in the eastern Chukchi Sea for 2008-2011 as related to sea ice extent. She noted that even though the utilization density estimates (UDE) are based on older data, the newer data show similar and expected patterns. She posed the question: Are the areas that walruses haul out on land rich enough for them to forage (near Point Lay for example).

Amy Kennedy (NOAA) presented a summary of research done on fine-scale movement and dive behavior of gray whales satellite-tracked in the Northern Bering and Chukchi Seas (DBO1, 3, and 4). This work was done by opportunistic tagging of gray whales. Average tag duration was 44 days with a range of 12-67 days. It was noted that in DBO4 during 2012 there was very localized foraging over two months

based on kernel density home range maps. The tag duration was 57 days ranging from August 25th to October 11th. The maximum distance from the tagging location was 140km. Results from DBO3 2013 overlap with ASAMM aerial gray whale sightings, but the visual surveys are limited by international borders. The home range (also based on kernel density) overlaps nicely with wet biomass of amphipods mapped between 1984-2006. The "Switching State-Space Model" results suggest two behavioral modes: Travel and Area Restricted Search (ARS). There are at least three main regions of ARS that include DBO1, 3 and 4.

Kathy Kuletz (USFWS) presented summaries of at-sea sea bird surveys. Data collection depends on available ship opportunities and these efforts participate in 3-8 cruises per year in the Arctic. The goals of Kathy's presentation were to: describe spatial and season distribution of species composition and to identify physical and biological factors that drive seabird distribution and abundance. In 2015: 15,506 km were surveyed in Alaska waters; 10,160 km were surveyed in the northern Bering Sea and the Arctic; and, 2,601 km were surveyed within the DBO boxes. For 2015, examples of distribution (raw) counts for three prominent species' groups were presented which represent range of breeders and migrants as well as dietary preferences. These included shearwaters (likely all short-tailed shearwaters) which breed in the Southern Hemisphere and are omnivores who may mainly eat krill in the north. Also included in the survey were murres (common thick billed murres) that breed in the northern Bering and Chukchi Seas. They are piscivores, but also eat krill, and are abundant local breeders. The third group included auklets (least and crested). Note that parakeet auklets are much lower in numbers that breed in the northern Bering Sea and are planktivores as well abundant "local migrants". Kathy examined what type of coverage they have for the DBO sites between 2010-2015 by km surveyed by month, year, and site. During those 6 years, most of the surveys occurred between July and September, with peak effort in August. Mid-August through mid-September have the highest seabird densities. The DBO sites with the greatest coverage overall were DBO3 and DBO4, although smaller "boxes", such as DBO2 and DBO5 had the highest density of survey transects. It was noted that in earlier years, 2006-2009, there were also spring and early summer surveys in DBO1 and DBO2 regions, with high sea ice cover and low bird densities (except for spectacled eiders). She noted that water masses (physical and water column properties) seem to be more helpful at predicting seabird distribution than zooplankton and Barrow Canyon would be a good place for analysis related to these properties. There are challenges to future analyses. Species composition shows high interannual variability, but that is sometimes due to temporal/spatial differences in survey coverage. Species composition can also be very different within different DBO box coordinates so there is a need for consistency. There was also concern about missing the bigger pictures by only looking in the DBO boxes.

Libby Logerwell (NOAA/AFSC) presented updates on the Shelf Habitat and EcoLogy of Fish and Zooplankton (SHELFZ) Chukchi Sea August 17 – September 5, 2013 ship surveys. Concurrent surveys were conducted nearshore (<20m) with 6km spacing and offshore (>20m) with 12 km spacing. Transects were 26 km apart and were conducted in the DBO5 region and Barrow Canyon runs through the study area. Bottom trawl collections were used for fish and invertebrate catch. Arctic cod distribution seems to be associated with winter water and is highest through Barrow Canyon. A principal components analysis suggested significant relationships (PC2 scores) with greater depth and salinity (lower depth and low salinity). Pie charts of benthic groups collected from the survey show that this is an area of high diversity.

Cathy Coon (DOI/BOEM) presented some findings related to the Arctic EIS project. Three surveys were done using a sampling grid size of 30x30 miles. Surface trawl (top 65'), mid-water trawl, and acoustic surveys were conducted on the F/V *Bristol Explorer* to collect data on ocean circulation and physics,

water chemistry, plankton, and fishes. The F/V *Alaskan Knight* conducted bottom trawl surveys in the Chukchi Sea only to collect demersal fishes and invertebrates. All surveys collect tissue samples and whole fish to study the biology of salmon, Arctic cod, saffron cod, snow crab, capelin, and other fish and invertebrates. There is an interest in looking at climate impacts on the marine ecosystem and what to expect in the future (in terms of fish distribution and fishery potential). Integrated ecosystem surveys were conducted by scientists within the Alaska Fisheries Science Center (AFSC)/NOAA during August-September 2013 to investigate summer bottom distribution and abundance of older Arctic cod and saffron cod in relationship to DBOs using acoustic estimates. The two take home messages where that: 1) Arctic cod are two orders of magnitude more abundant than saffron cod; and, 2) Arctic cod are distributed in cooler water temperatures (4-7 °C). Also, integrated ecosystem surveys were conducted by scientists within the AFSC during August-September 2013 to investigate summer bottom distribution and abundance of young Arctic and saffron cod. The two take home messages were that: 1) Arctic cod are 2 orders of magnitude more abundant than saffron cod; and, 2) Arctic cod are distributed in cooler water temperature (4-7 °C) and saffron cod were distributed nearshore in warmer water (8-12 °C). It was noted that Arctic cod have a significantly higher lipid (fat) content than saffron cod. In order to get equal amounts of lipid from the two fish species, a seal would have to eat 2.7 times the mass of saffron cod as they would from Arctic cod. Cathy showed a figure of growth response of 4 cod species in relation to temperature. From this figure, one can see that the more southerly cod species have higher growth rates than the Arctic species, and consequently they are larger fish as adults. This is a typical phenomenon we see with all Arctic fish species, which grow slower and are smaller than their southern counter parts. When the growth rates of the two Arctic species are compared, we see that the temperature at which Arctic cod maximize their growth (7.3 °C) is considerably colder than all the other species, indicating they are adapted for significantly colder conditions. In comparison, saffron cod maximize their growth at twice the temperature (14.8 °C). These temperature-dependent growth responses indicate how warming ocean temperatures may affect the two Arctic species very differently, and that saffron cod may be more resilient to warming ocean temperatures than Arctic cod. If the warming trend continues we may see “winners” and “losers”.

Remote Sensing

Jackie Grebmeier (CBL/UMCES) [for Karen Frey (Clark University); ppt12] presented summaries of remote sensing products. These included monthly mean curves of DBO climatologies over an annual cycle for the following parameters: Sea Surface Temperature, Sea Ice Concentration, Timing of Sea Ice Breakup/Formation, Chlorophyll-a, Surface Nitrate (World Ocean Atlas) and Solar Insolation (NASA). Currently she only have these prepared for DBO1-5, but is planning to do the same for DBO6-8. Also shown were trends in Annual Sea Ice Persistence for DBO1-8 from 1979-2012 and 2000-2012. Hatching areas on the map indicate statistically significant trends (Mann-Kendall $p<0.1$) and show that trends in annual sea ice persistence have accelerated since 2000. There have been recent gains in annual sea ice persistence in the south (DBO1-2) with a transition to loss in the north (DBO3-8). Mean monthly sea ice concentrations for 2013, 2014, and 2015 (which correspond to the NSF/AON DBO Laurier cruises) show significantly less ice in 2015 as compared to 2013 and 2014. Mean monthly chlorophyll-*a* concentrations collected from Moderate Resolution Imaging Spectroradiometer (MODIS-Aqua) data from 2013, 2014, and 2015 show more extensive blooms in the northern Chukchi Sea in 2015 where sea ice broke up earlier. Patterns of field observations for satellite validation for DBO1, DBO2, BRS (Bering Strait(), and DBO3 in July 2013 and July 2014 were shown for: chlorophyll-*a*, pheophytin, and suspended particulate matter. The stronger bloom during July 2014 was highlighted in an Ocean Data View graohuc for the DBO3 region for all the parameters. Also, patterns of field observations for satellite validation for DBO1, DBO2, BRS, and DBO3 in July 2013 and July 2014 were shown for Colored Dissolved Organic Matter

(CDOM) parameters: a_{254}, a_{440}, and $S_{275-279}$. The terrestrial influence in the CDOM signal a_{254} was highlighted in July 2013 and July 2014 Ocean Data View maps for the DBO3 region. Finally a comparison of NASA-generated DBO-surface chlorophyll and field collected integrated chlorophyll values was shown. Highest chl-*a* via satellites and field data are seen in the Bering Strait and offshore southeast Chukchi Sea within the DBO3 hotspot. It was emphasized that Joey Comiso should be contacted for NASA-generated DBO products (see this link: http://neptune.gsfc.nasa.gov/csb/index.php?section=270).

Sue Moore (NOAA/NMFS; ppt13) presented for Muyin Wang (NOAA) who is modeling the length of sea ice presence from 2004-2013. These results have been published in the 2015 SOAR special issue and more results will also be in the SOAR II special issue which is in progress. Twelve climate models out of 35 that best hind-cast ice presence are evaluated. The findings project 3-4 –and perhaps >5 month open, ice-free season in 2040. Also, zonal mean curves of ice free months for the Chukchi and Beaufort Seas were generated to show number of months that will be ice free by latitude (2010-2090).

Discussion of Potential Papers

It was suggested that authors consider submitting them by late fall 2016/early winter 2017 (November-January) so a special issue of Deep could be published by summer 2017.

Upper trophics (ppt14)

Janet Clarke (Leidos) suggested two potential papers. The topic of one paper would be an analysis of cetacean (bowhead whale, gray whale, and beluga) distribution and abundance per year, 2010-2015, per DBO areas 4,5,6, and 7 to search for anomalies between years. The other topic was to use DBO datasets to correlated anomalies with differences in annual oceanographic variables, including currents, nutrients, primary productivity, zooplankton, benthic fauna, and fish. They would need help with this in particular as they are unfamiliar with DBO datasets and are marine mammal scientists. The questions would be: what datasets are most appropriate, where do we start, and who can we team with?

Catherine Berchock (NOAA/AFSC/NMML) suggested taking a multidisciplinary look at DBO3. She noted datasets collected from an oceanographic/zooplankton sampling line, long term passive acoustic records, and long term oceanographic instruments. They also have marine mammal survey sightings/detection and tagging results. There is also a long-term time series based on moorings which they could look at via GAM modeling for factors affecting marine mammal presence and quantitate, statistical analyses on positive/negative associations. There are short term sampling surveys on transect lines showing high zooplankton concentrations indicative of secondary productivity (with similar results inshore at Barrow Canyon, ammonium/nitrate, and high benthic biomass (visually sighted).

Kathy Kuletz (USFWS)/Adrian Gall (ABR, Inc) presented the titles for two papers to be submitted to MEPS within the next month or two:

- The influence of foraging strategy and prey preference on habitat associations of seabirds in the northeastern Chukchi Sea. Adrian E. Gall, T. Morgan, R. Day, A. Blanchard, R. Hopcroft, T. Weingartner
- Relationships between oceanography & the distribution & abundance of 8 focal taxa of seabirds in NE Chukchi Sea (DBO4) during 2011–2012

Ideas for addition papers combining USFWS and ABR data included:

- Influence of ACC on seabird distributions, nearshore to offshore in NE Chukchi Sea (mostly DBO 4, 5; could include DBO 3; ideally entire area)

- Physical & biological influences on seabird distribution between DBO4,5. How different wind/current regimes impact seabird distributions seasonally, inter-annually; 2010-2015, July-Sept
- Latitudinal (DBOs 1-5) and Longitudinal (DBOs 6-8) distribution of seabirds with respect to physical/biological prevailing conditions (and what do DBO boxes 'capture' with respect to total observations?)

Manolo Castellote (NOAA) proposed a topic related to visual and passive acoustic mammal data integration. This would integrate two methods of data collection that differ in spatial and temporal coverage. One method of collection includes visual sightings from aerial surveys that offer quantified sightings and broad spatial coverage within a limited time frame. The other data collection method includes acoustic detections from moorings which quantify vocalizations with limited spatial coverage and a broad time range. It was proposed that the two datasets could be brought together to produce: detections per time unit over a broad spatial and temporal frame. As an example, in DBO4 they have acoustic detections and visual sighting in time bins, then they can integrate both results with geospatial statistics producing, for instance, spatial density of positive time units by month or season.

Bob Pickart (WHOI; ppt15) suggested a paper examining the characteristics of upwelling in the Alaskan Beaufort Sea based on 6 years of mooring data (Lin, Pickart, and Hu). The outline is:

1. Wind-driven upwelling events: definition, numbers
2. Comparison of Atlantic-type upwelling and Pacific-type upwelling
3. Atmosphere conditions including behavior of storms
4. Evolution of density field during upwelling

Other potential topics include: ice conditions, upwelling which is not wind-driven and storm behavior.

Carolina Nobre (WHOI; ppt16) suggested a paper titled: Seasonal to mesoscale variability of water masses and atmospheric forcing in Barrow Canyon, Chukchi sea (Carolina Nobre, Robert Pickart, Kevin Arrigo, Carin Ashjian, Catherine Berchok, Lee Cooper, Jacqueline Grebmeier, Ian Hartwell, Jiangheng He, Motoyo Itoh, Takashi Kikuchi, Kent Moore, Phyllis Stabeno, Svein Vagle). The objectives would be to:

- Quantify the seasonal evolution of the water masses
- Determine the nature of the mesoscale variability
- Investigate atmospheric forcing of upwelling events

The conclusions were that:

- There is pronounced seasonal variability in the water masses passing through Barrow Canyon, with Pacific Winter Water being the most prevalent water mass throughout the summer.
- All upwelling events were characterized by the presence of Atlantic water in the deep part of the canyon and decreased amounts of Alaskan Coastal water.
- The strongest upwelling events occurred in September.
- Upwelling is associated with a deepened Aleutian Low that extends farther to the northeast, likely associated with a preferred storm track that progresses into the Bering Sea.

Bob Pickart (WHOI) [for Maria Pisavera (WHOI; ppt17)] presented the topic: On the nature of upwelling in Barrow Canyon (Maria Pisareva, Robert S. Pickart and, and Paula Fratantoni). The outline of the study is to explore:

- Mean state at the head of Barrow Canyon during the study period and seasonal variability (water masses and currents)
- Characteristics and trends of the upwelling events

- Atmospheric conditions associated with the observed upwelling through the course of the year

Other suggested topics include exploring:

- different types of upwelling at the head of Barrow Canyon
- ice concentration at mooring position and polynya region to the south
- track different water masses by sea surface temperature over the period
- Hydrographic sections in the region during the study period
- storm tracking

Thursday-10 March 2016

Discussion about proposed papers continued Thursday morning.

Jackie Grebmeier (CBL/UMCES; ppt18) suggested a benthic and sediment paper for 5 DBO lines, or at least DBO1-3 and would like the benthic scientists to be involved (e.g. Japan and Korea). She emphasized the need for time series data.

Monika Kedra (IOPAN, ppt19) proposed the topic: biodiversity, community structure and functioning of benthic macrofauna on DBO lines (Kedra, Grebmeier, and Cooper). The goals would be to:

- examine the biodiversity, structure and functioning of benthic macroinfaunal organisms in the diversity and biomass "hot spot" areas of the Bering and Chukchi Seas
- explore how benthic diversity, community structure, function (in relation to densities, biomass, productivity and environmental factors) vary across latitudinal gradient
- evaluate their vulnerability to increasing temperatures and sea ice reduction, as well as to predict potential changes to marine food webs

DBO Data Archive

Carolina Nobre (WHOI) would like to move WHOI data archive to EOL since people aren't using the WHOI site anyway. She would still QA/QC the CTD data though. Svein noted that a google search takes you to the NOAA DBO site but not to links for the WHOI/ EOL data sites. Sue noted that she will make those links available from the NOAA DBO site. Cathy Coon noted that BOEM has language with broad agreements about use of data. Lee Cooper noted that there is a shortage of people power to get data into data archives and that it is almost a full time job to be a point of contact to encourage people to follow up and add metadata to the EOL archive. Svein Vagle noted that not all countries have to give their data to an agency as does the U.S. and the data is often kept by the PI. Jim Moore suggested that Shelf-Basin Interaction (SBI) project was a good template for data archiving and synthesis. The draft manuscript titles just discussed canhelp guide us to what datasets are available or linked to the DBO effort, and how to manage them long-term.

Don Stott (NCAR/EOL; ppt20) provided an explanation of the EOL DBO site, how to use it, the data policy, and the MetaArch form. Based on filling out and submitting the metafile form there will be a matrix that shows who collected what parameters at each DBO line for each year. It was noted that it would be nice to get an ISO formatted metadata file from Don that would help when people have to submit elsewhere. Also it would be good to have a template for each metafile submission mode. Note that there is currently a template for submitting a transect-based metafile available for download from

the EOL DBO website. People can use it to fill in the spreadsheet and to then copy/paste into the online form (just in case changes on the website don't get saved). Note that drafts of templates for the other three modes will be available from the EOL DBO website soon. Also, it was emphasized that people can email Don with any questions.

Jim Moore (NCAR/EOL; ppt20) presented on a broad perspective of DBO data management and future considerations. He noted that there is a strong international collaboration in a data policy for sharing and access as well as for data collection in 8 sampling transects. The metadata profile acts as a standard to facilitate exchange and synthesize activities and he emphasized that international distributed archive centers rely on the metadata for exchange and access. Future considerations include leaving a DBO data legacy discoverable and accessible by the community. Development of some specialized products that facilitate synthesis of activities would be useful such as development of a DBO Geographic Information Systems (GIS) Tool for visualization and integration as well as creating GIS kml layers to draw synthesis information out of diverse datasets. Jim suggested that a prototype for a GIS product could be developed using data from the DBO archive for one transect (such DBO3).

Kyoung-Ho Cho (KOPRI; ppt21) discussed sustained DBO sampling and data access. They have data from 2010 to 2015 from the IB R/ARAON Arctic Cruises and noted that the metadata has been submitted to the EOL DBO data archive. DBO3 was used as an example of parameters that were collected as well as data products that were generated. Collected parameters included:

- Temperature, salinity, DO, fluorescence
- PAR, transmission, backscatter, pressure
- water velocity
- Primary production and new production
- Phytoplankton composition
- Chlorophyll-a and HPLC
- Zooplankton composition and abundance
- Bacterial and virus biomass
- Micro-zooplankton biomass, composition, and grazing
- Nutrients, POC, PON, DOC, DON, DOP
- N2O gas, pCO2, DIC , pH, SS, TA
- Atmospheric components

For DBO3 2014, CTD observations showed that there was relatively cool, saline water on the bottom from station 3 to station 6 and relatively warm and fresh water nearshore (station 8). For DBO3 2015, water was warmer and less saline on the bottom for station 3 to station 6. Water was relatively warm and fresher nearshore for station 8. Also, surface fresh water had expanded to station 7. DBO3 water sampling comparisons for 2014 and 2015 were compared for salinity, temperature, nitrite+nitrate, DOC, and DON. A map of the 2016 summer cruise plan was also shown.

Hyun-cheol Kim (KOPRI; ppt22) presented their Polar Ocean Web GIS called the Korea-Polar Ocean in Rapid Transition (K-PORT). Polar Ocean survey by the IBR ARAON has been collected since 2009. This is a massive in-situ data archiving effort and requires high quality-controlled data. The web GIS will promote efficient utilization of field data and provide easy access to the database for any time and place. It includes fast and easy data analysis, systematic data management and multidisciplinary collaboration which will facilitate understanding of environmental changes in the Polar Ocean related to climate change. Progression of the first stage of creation of the p-WebGIS over 3 years was explained

from a prototype, an advanced online system, and finally as an offline field support system. Plans for the second stage for 2016-2020 include development of a sophisticated system with a user-friendly design. Hyun-cheol then provided snapshots of the tool layout, options, and functions. Future plans over the next five years include: standardizing the architecture of the ocean database, focus on a better field support system (i.e. data upload/download, more analysis functions), and providing a web-based system for public users. They would like to share all the data produced in the Arctic Ocean to research collaborators. This tool offers the ability to analyze the data interactively without expensive commercial GIS software (i.e. open source based GIS engine).

Jackie Grebmeier (CBL/UMCES) gave a brief updated on RUSALCA data noting that although currently RUSALCA data is available on the AOOS site, final data will be updated soon. She also noted that there are datasets in Russia and they are working to get these datasets. She explained the AOOS "workspaces" and noted that there are various U.S. data archives (such as AOOS and Chukchi Sea Offshore Monitoring in Drilling Area [COMIDA]), but each has DBO data. Also provided was an update about Norway's effort to examine how changes in ice pulling back from the Bering Sea has impacted the ecology. They are trying to collect standard measurements offshore on the shelf, some to upper slope, similar to DBO, but she has not seen the data yet.

Shigeto Nishino (JAMSTEC) provided information on two websites that allow uses to search for data (e.g. CTD). Currently the website that has data available is: http://www.godac.jamstec.go.jp/darwin/e The other website will be a data archive for mooring data, but there is no data available quite yet.

China will have data available within their DBO efforts.

Sue Moore (NOAA/NMFS; ppt23) provided an outline DBO timeline for 2009 to 2024:

- 2009 – Biology-Sea Ice Workshop, leads to development of Pilot DBO plan
- 2010-2014 – Pilot Phase, DBO sampling coordinated by the Pacific Arctic Group
- 2012 – NSF Arctic Observing Network (AON) program provides 5-years of support for sampling initial 5 DBO regions
- 2012 – IARPC, 5-year plan =12 Teams; 7 themes; DBO Collaboration Team focused on *Sea Ice and Marine Ecosystems* theme
- 2012-2015 – IARPC DBO CT completes 9 of 10 Milestones; remaining milestone = *establish guidelines for the periodic assessment of the physical and ecological state of the Pacific Arctic marine environment*
- 2015-2024 – Implementation Phase: expansion to 8 DBO sampling regions (5 Chukchi + 3 Beaufort); formalize DBO 'annual cycle'; build connections with existing Community-based Observation programs; outline steps towards a decadal Pacific Arctic Regional Marine Assessment (PARMA) (See the NOAA DBO website at: https://www.pmel.noaa.gov/dbo/).

Sue also provided information about the collaboration team (CT):

- DBO CT: one of 12 teams of the U.S. Interagency Arctic Research Policy Committee (IARPC)
- PURPOSE: Support the development of the DBO, designed to detect biological responses to physical drivers in the Pacific Arctic marine ecosystem
- Participants: Program managers from U.S. federal agencies, academics, state, and local governments
- FORMAT: Monthly/bimonthly teleconferences reporting on milestone status and featuring CT and outside speakers on topics related to the development of the DBO

For more information about the DBO CT, see: http://www.iarpccollaborations.org/teams/Distributed-Biological-Observatory. Sue emphasized that the IARPC Collaborations website is the primary tool for federal and non-federal entities including 12 thematic research collaboration teams with hundreds of outside partners. See http://www.iarpccollaborations.org/index.html for more information. DBO interagency partners include: NSF (AON, EOL), AOOS (DBO Workspace, IOOS, and GOOS), NASA (Cryosphere Research Portal), BOEM (Ecosystem Studies Alaska Region, NOPP) and NOAA (OAR, NMFS, and NOS). Academic partners include: Clark University, FIT, ODU, OSU, Stanford, UAF, UCAR, UMCES, URI, UT, UW, and WHOI. The DBO implementation plan is on an annual cycle and includes: the PAG spring meeting cruise planning and identifying Auxiliary Projects; DBO Cruises that include ship-based sampling and auxiliary project sampling; PAG fall meeting where provisional results from cruises and auxiliary projects are presented and preliminary cruise planning and metadata submissions are provided; DBO data workshop the includes status of data integration, analysis, and data archiving; and, finally DBO products in the form of science presentation, community connections, and contributions to the NSAR.

Jackie Grebmeier (CBL/UMCES) provided a summary o**f Action Items,** including:

1. Post listing of all DBO station locations and bounding box information on the DBO EOL data site to facilitate DBO participants access DBO data for the same areas can utilize the same coordinates.
2. Develop data template for other 3 data parameter files for offline completion for submission on DBO data website, similar to DBO transect template; also work on common statement of submission DBO data parameter file.
3. Load the meeting ppts to PAG document file
4. Bob Pickart's team will summarize DBO physical oceonagraphy data submission to the WHOI DBO data site for continued data coordination.
5. Update the list of manuscripts to be submitted to the planned DBO Deep Sea Research II special issue.
6. Work with EOL to develop open web data matrix summary for all to see and download as a separate file

Jackie also emphasized that she would like a strong PAG/international component for Gordon Research Conference Polar Marine Science in March 2017 for which she is chairing. She provided the abstract that has been submitted.

Meeting closed end of day.

Appendix A

AGENDA

3rd DBO WORKSHOP: Data Synthesis and 10-year plan
March 9-10, 2016
PMEL/NOAA, Bldg. 3, Oceanographer Room
7600 Sand Point Way NE, Seattle, Washington, USA
WIRELESS username = DBO workshop; password = workshop2016

Workshop Overview - We have 3 objectives for this workshop:

1. Present results from the 2010-2015 DBO field program and commit to multidisciplinary papers to showcase results of the DBO international effort
2. Evaluate the DBO data submission effort through the EOL DBO Metadata site and linkage to other national archives
3. Overview of US-IARPC Draft DBO Implementation Plan + International 10-year plans

March 9, 2015 – Wednesday (0815 – van transport from Silver Cloud Hotel to PMEL)

0900 Welcome and Logistics: **Chris Sabine, PMEL Director** and **Sue Moore**

0910 Meeting Objectives and Overview of the DBO: **Jackie Grebmeier**

0930 Highlights of DBO2010-2015 data time series (~20 min each; **BOLD is discussion Lead**)
- Physical oceanography: **Bob Pickart**
- Mooring data results: **Phyllis Stabeno**
- Biochemical oceanography and export production: **Lee Cooper**

10:30 Coffee Break

11:00 Continue Morning Highlight Presentations
- Biological oceanography
  - Lower trophics: **Jackie Grebmeier**
  - Upper trophics: **Catherine Berchok**
- Remote Sensing: sea Ice, SST, chl-a: **Jackie Grebmeier** (Karen Frey slides or call-in), NASA website connection
- Modeling: **Sue Moore** for Muyin Wang; others?

1220 Lunch (NOAA Cafeteria, no host)

1330 Papers for DBO Special Issue: Outlines & Figures, by Lead Authors

1500 Coffee break

1530 Continue Presentations Lead Authors for DBO Special Issue (if needed)

1630 Discussion & wrap up

1700 End day and van transport to hotel - **Group Dinner (7 pm)**

March 10, 2015 – Thursday (0815 van transport from Silver Cloud Hotel to PMEL)

0900 Overview of Day 1 (data review + papers) and plan for Day 2 (data archive and 10-y plan) **(Jackie Grebmeier)**

0930 DBO Data Archive – EOL DBO Metafile (**Don Stott/Jim Moore**)

1030 Coffee break

1100 National and International Data Access: WHOI DBO (**Carolina Nobre**), RUSALCA (**Jackie Grebmeier**), JAMSTEC, KOPRI, PRC, Canada (C3O), others?

1200 Lunch (NOAA Cafeteria, no host)

1330 Sustained DBO sampling: National & International/Pan-Arctic colleagues, e.g. Norway (**Jackie Grebmeier** provide update), US-IARPC DBO CT and Draft Implementation Plan (**Sue Moore**), others?

1500 Coffee break

1530 Overview of 10-y DBO Sampling & Data Access Plan: IARPC + Other National plans

1600 Action Items & Timeline: DBO Special Issue, future plans, 2017 Gordon Research Conference *"Understanding Ecosystem Change through Time Series Observations, Technological Advances, and Biophysical Coupled Models"* (March 26-31, 2017) (**Jackie Grebmeier**)

1630 End day and van transport to hotel

Appendix B-3rd DBO Data Workshop Participants

First Name	Last Name	Affiliation	Email Address
Alynne	Bayard	CBL/UMCES	bayard@umces.edu
Catherine	Berchok	AFSC/NMML	catherine.berchok@noaa.gov
Amelia	Brower	NOAA/JISAO/ASAMM	amelia.brower@noaa.gov
Kyung-Ho	Cho	KOPRI	kcho@kopri.re.kr
Janet	Clarke	Leidos	janet.clarke@leidos.com
Cathy	Coon	DOI/BOEM	catherine.coon@boem.gov
Lee	Cooper	CBL/UMCES	cooper@umces.edu
Jessica	Crance	NOAA/NMML	Jessica.Crance@noaa.gov
Lisa	Eisner	NOAA/AFSC	lisa.eisner@noaa.gov
Megan	Ferguson	NOAA/AFSC	megan.ferguson@noaa.gov
Karina	Giesbrecht	University of Victoria	karinag@uvic.ca
Stephanie	Grassia	NOAA	stephanie.grassia@noaa.gov
Jackie	Grebmeier	CBL/UMCES	jgrebmei@umces.edu
Sun Yong	Ha	KOPRI	syha@kopri.re.kr
Jianfeng	He	Polar Research Institute of China	hejianfeng@pric.org.cn
Eliza	Ives	NOAA/NMML	eliza.ives@noaa.gov
Hyoung Min	Joo	KOPRI	hmjoo77@kopri.re.kr
Jin Young	Jung	KOPRI	jinyoungjung@kopri.re.kr
Somang	Jung	KOPRI	somanghjung@kopri.re.kr
Sung-Ho	Kang	KOPRI	shkang@kopri.re.kr
Monika	Kedra	IOPAN	kedra@iopan.gda.pl
Amy	Kennedy	NOAA/PMEL	Amy.Kennedy@noaa.gov
Takashi	Kikuchi	JAMSTEC	takashik@jamstec.go.jp
Hyun-cheol	Kim	KOPRI	kimhc@kopri.re.kr
Hyoung Sul	La	KOPRI	hsla@kopri.re.kr
Julie	Lawrence	NOAA/NMML	julie.mocklin@noaa.gov
Libby	Logerwell	NOAA/AFSC	libby.logerwell@noaa.gov
Jim	Moore	NCR/EOL	jmoore@ucar.edu
Sue	Moore	NOAA/NMFS ST7	sue.moore@noaa.gov
Shigeto	Nishino	JAMSTEC	nishinos@jamstec.go.jp
Carolina	Nobre	WHOI	cnobre@whoi.edu
Ji Soo	Park	KOPRI	jspark@kopri.re.kr
Ji Soo	Park	KOPRI	jspark@kopri.re.kr
Key Hong	Park	KOPRI	keyhongpark@kopri.re.kr
Robert	Pickart	WHOI	rpickart@whoi.edu
Kimberly	Rand	NOAA/AFSC	kimberly.rand@noaa.gov
Phyllis	Stabeno	NOAA/PMEL	phyllis.stabeno@noaa.gov
Kate	Stafford	University of Washington	kate2@uw.edu
Michael	Steele	University of Washington	mas@apl.washington.edu
Don	Stott	NCAR/EOL	stott@ucar.edu
Heather	Tabisola	NOAA/PMEL	heather.tabisola@noaa.gov
Svein	Vagle	Fisheries and Oceans Canada	Svein.Vagle@dfo-mpo.gc.ca
Tiffany	Vance	NOAA/NMFS/AFSC	tiffany.c.vance@noaa.gov
Amy	Willoughby	NOAA/NMML	amy.willoughby@noaa.gov
Rebecca	Woodgate	University of Washington	woodgate@apl.washington.edu
Dana	Wright	NOAA/NMML	dana.wright@noaa.gov
Eun Jin	Yang	KOPRI	ejyang@kopri.re.kr

Appendix D-List of Abbreviations

Abbreviations for DBO-related institutions, agencies and programs.

Abbreviation	Institution / Agency
ACC	Alaska Coastal Current
ACW	Alaska Coastal Water
ADCP	Acoustic Doppler Current Profiler
ADFG	Alaska Department of Fish & Game
Arctic EIS	Arctic Ecosystem Integrated Study
AFSC	Alaska Fisheries Science Center (NOAA)
AKMAP	Alaska Monitoring and Assessment Program
ALTIMA	Arctic Long-term Integrated Mooring Array
AMBON	Arctic Marine Biodiversity Observing Network
ANIMIDA	Arctic Nearshore Impact Monitoring in the Development Area
AOOS	Alaska Ocean Observing System
AON	Arctic Observing Network
ARC	Division of Arctic Sciences (NSF)
ARCWEST	Arctic Whale Ecology Study
ASAMM	Aerial Surveys of Arctic Marine Mammals
ASSW	Arctic Science Summit Week
BOEM	Bureau of Ocean Energy Management
BOWFEST	Bowhead Whale Feeding Ecology Study
cANIMIDA	Continuation of the Arctic Nearshore Impact Monitoring in the Development Area
C3O	Canada's Three Oceans
CBL	Chesapeake Biological Laboratory (UMCES)
CCGS	Canadian Coast Guard Ship
CDOM	Colored Dissolved Organic Matter
CHAOZ	Chukchi Acoustics, Oceanography and Zooplankton Study
CHINARE	Chinese National Arctic Research Expedition
COMIDA-CAB	Chukchi Sea Offshore Monitoring in Drilling Area – Chemical and Benthos
COMIDA-HS	Chukchi Sea Offshore Monitoring in Drilling Area – Hannah Shoal
CSESP	Chukchi Sea Environmental Studies Program
CTD	Conductivity, Temperature and Depth
DBO	Distributed Biological Observatory
DFO	Department of Fisheries and Oceans, Canada
DOC	Dissolved Organic Oxygen
DON	Dissolved Organic Nitrogen
DOI	Department of the Interior, US
DSR	Deep Sea Research
EcoFOCI	Ecosystems and Fisheries-Oceanography Coordinated Investigations

EOL	Earth Observing Laboratory
FIT	Florida Institute of Technology
GIS	Geographic Information System
GOOS	Global Ocean Observing System
GRENE	Japanese Arctic Climate Change Research Program
IARPC	Interagency Arctic Research Policy Committee
IASC	International Arctic Science Committee
ICESCAPE	Impacts of Climate on the Eco-Systems and Chemistry of the Arctic Pacific Environment
IOPAN	Institute of Oceanology of the Polish Academy of Sciences
IOOS	Integrated Ocean Observing System
JAMSTEC	Japan Agency for Marine-Earth Science and Technology
KOPRI	Korean Polar Research Institute
MODIS	Moderate Resolution Imaging Spectroradiometer
MW	Melt Water
MWG	Marine Working Group of IASC
NASA	National Aeronautics and Space Administration
NCAR	National Center for Atmospheric Research (EOL)
NMFS	National Marine Fisheries Service (NOAA)
NMML	National Marine Mammal Laboratory (NOAA)
NOAA	National Oceanic and Atmospheric Administration
NOPP	National Oceanographic Partnership Program (BOEM)
NOS	National Ocean Service (NOAA)
NSF	National Science Foundation
PDMPO	2-(4-pyridyl)-5-((4-(2-dimethylaminoethylaminocarbamoyl)methoxy)phenyl)oxazole
PMEL	Pacific Marine Environmental Laboratory (NOAA)
NSF	National Science Foundation
ODU	Old Dominion University
OAR	Office of Oceanic and Atmospheric Research (NOAA)
OPP	Office of Polar Programs (now Division of Polar Programs)
PAG	Pacific Arctic Group
PRIC	Polar Research Institute of China
RUSALCA	Russian-American Long-term Census of the Arctic
R/V	Research Vessel
SCAR	Scientific Committee for Antarctic Research
SHELFZ	Shelf Habitat and Ecology of Fish and Zooplankton
SLI(P)	St. Lawrence Island Polynya
SWL	Sir Wilfred Laurier
UAF	University of Alaska Fairbanks
UCAR	University Corporation for Atmospheric Research

UMCES	University of Maryland Center for Environmental Science
URI	University of Rhode Island
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
UT	University of Texas Austin
UW	University of Washington
WHOI	Woods Hole Oceanographic Institution