1. PROJECT INFORMATION

NPMRI Project Number:	A01/T2201–T2207
Title:	Pacific Marine Arctic Synthesis of the Northern Bering, Chukchi and Beaufort Seas
Subaward period	June 15, 2012 to June 14, 2014
Amount of funding	$1,449,997
Report period	December 21, 2012 to March 15, 2013
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Lead Author of Report*	Dr. Jacqueline Grebmeier

*Although there may be only one lead author of the report, all PIs and co-PIs of the project, as identified in the approved statement of work and listed below, are responsible for the content of the Semiannual Progress report in terms of completeness and accuracy.

Principal Investigator(s), Co-Principal Investigators and Recipient Organization(s):

No.	First Name	Last Name	Email Address	Institution
1	Jacqueline	Grebmeier*	jgrebmei@umces.edu	UMCES-CBL
2	Lee	Cooper*	cooper@umces.edu	UMCES-CBL
3	Carin	Ashjian	cashjian@whoi.edu	WHOI
4	Robert	Campbell	campbell@gso.uri.edu	URI
5	Gay	Sheffield	ggsheffield@alaska.edu	UAF
6	Bodil	Bluhm	babluhm@alaska.edu	UAF
7	Jim	Moore	jmoore@ucar.edu	NCAR
8	Ken	Dunton	ken.dunton@mail.utexas.edu	UT
9	John	Trefry	jtrefry@fit.edu	FIT
10	Steve	Okkonen	okkonen@alaska.net	UAF
11	Sveta	Yamin-Pasternak	syamin@alaska.edu	UAF

* Research Lead.

Abbreviation	Institution
UMCES-CBL	University of Maryland Center for Environmental Science, Chesapeake Biological Laboratory
WHOI	Woods Hole Oceanographic Institution
URI	University of Rhode Island
UAF	University of Alaska Fairbanks
NCAR/EOL	National Center for Atmospheric Research - Earth Observing Laboratory
UT	University of Texas at Austin
FIT	Florida Institute of Technology

2. PROJECT OVERVIEW

A. **Briefly (4-5 sentences) describe both the research purpose and the underlying need for this research:** The Pacific Marine Arctic Regional Synthesis (**PacMARS**) effort will facilitate new synergies in understanding of the marine ecosystem in the greater Bering Strait region, including the northern Bering, Chukchi and Beaufort seas. This synthesis effort will contribute to NPRB's overall mission by promoting understanding of north Pacific ecosystems in order to help enable effective management and sustainable use of marine resources, from subsistence use to fisheries to industrial exploration and development.

The PacMARS research team and collaborators will:

1. **Identify and synthesize existing data sets** that are critical for evaluating the current state of knowledge of this marine ecosystem, including human dimensions.

2. **Define the high-priority, overarching scientific themes and research needs** for the next decade or more of marine ecosystem studies in the Pacific Arctic Region.

B. **List the objective(s) of the research project, exactly as described in your approved Statement of Work.**

1. **Identify and link existing data sets**, tabulate data archive sites and provide value-added annotated metadata for existing data that promote understanding of the marine ecosystem extending from north of St. Lawrence Island in the Bering Sea to the Chukchi and Beaufort seas, including traditional ecological knowledge where it can be readily transferred (Data synthesis).

2. **Synthesize existing scientific and traditional knowledge of the marine ecosystem**, with a focus on territorial waters of the United States and its adjoining Exclusive Economic Zone, but to also include input from beyond this region through collaborations with both Russian [e.g. Russian-American Long-term Census of the Arctic (RUSALCA)] and Canadian [e.g. Canada's Three Oceans program (C3O)] scientists who will cooperate with our effort. Other internationally generated data within the Pacific Arctic Group (PAG) international framework will also be contributed, including from Japan (point of contact, Dr. Takashi Kikuchi), Korea (point of contact, Dr. Sung Ho Kang), and China (point of contact, Dr. Jianfeng He) (Data synthesis)

3. **Develop overarching scientific themes and research needs** to facilitate the design of the next iteration of integrated marine ecosystem studies in the Pacific-influenced Arctic, including the appropriate temporal and spatial scales of data needed for ecosystem-level assessment. (Research Needs).

4. **Emphasize system-wide, synoptic understanding**, in addition to discipline-specific syntheses of the northern Bering, Chukchi and Beaufort ecosystems. Given time and resource limitations, we will prioritize our efforts towards integrating across disciplines and we will use geographical and habitat-scaled approaches to achieve linkages among biophysical observations and human communities (Research Needs).

5. **Undertake a social-ecological science synthesis** of (1) major research initiatives, (2) emerging research approaches and methods, and (3) related documented research needs and concerns. Each of these approaches will be geared toward identifying current research directions and gaps in knowledge concerning the maritime societies living within the marine ecosystems of the Northern Bering,

Chukchi, and Beaufort Seas. Cumulatively, this contribution will results in an interdisciplinary socio-ecological synopsis of these marine ecosystems (Research Needs).

C. Provide a table showing the timeline and milestones for the entire project.

Table 1. Timeline and milestones for the PacMARS project.

Date	Milestones
2012	
2012	Notification of support
July	Funds allocated; PI coordination conference call; initiated preparation of templates and data submission protocols, identify new data sets, envision synthesis products
Sept 24-26	PacMARS PI meeting, Annapolis, MD; Sue Moore participated to provide linkage to SOAR program
Oct 22	*Quarterly Report to NPRB #1: revised status report*
Dec 10-11	Data workshop at Boulder, CO; invitees and PIs utilized computer-aided networking of data sets already preloaded via the EOL-ACADIS website; initiated development of synthesis products, maps, and discussed progress on making data available as well as future products that will meet synthesis needs.
Dec 21	*Quarterly Report to NPRB #2 (completed 01/18/13 so that Data Meeting (Boulder, CO) material could be included)*
2013	
Jan 20	1-day open community workshop on Sun. Jan 20, 2013 in collaboration with SOAR (Synthesis of Arctic Research) prior to the AMSS in Anchorage; purpose to give update on preliminary synthesis results, solicit community input, and open discussion of developing themes for science direction
Jan - Mar	Alaska community "Town Hall" input meetings at 3 "hub" communities to entrain local comments from 17 local villages from St. Lawrence Island to Kaktovik; attended by designated members of the PacMARS team. Meetings were held in Barrow (Feb. 11), Kotzebue (Feb. 22), and Nome (Feb. 25). In addition, two separate pilot-scale meetings were held in the individual villages of Savoonga (Jan. 28) and Gambell (Jan. 29) to explore the cost-benefits of obtaining village-based input in local communities.
Mar 15	*Quarterly Report to NPRB #3*
Apr-June	Draft chapters for interim report
June 15	*Quarterly Report #4-submission of PacMARS interim report*
June-Sept	Finalize draft interim report for NPRB; continue drafting synthesis publications and provide feedback to local Alaska communities via no-cost by PIs during field season community outreach
Sept 15	*Quarterly Report #5-report on community interactions; status publications*
Sept –Dec	Continuation of synthesis analyses and draft manuscript preparations
Dec 15	*Quarterly Report #6-update on synthesis products, book preparation*
2014	
Jan	PacMARS presentations at the AMSS 2014; recommendation for another PacMARS-SOAR open community meeting, with focus on social community feedback
Mar 15	*Quarterly Report #7-report from 2nd open community PacMARS-SOAR workshop, finalize all synthesis publications and submission for polar PacMARS book*
June 15	Final report to NPRB; PacMARS book/special issue in ready to publish stage

3. PROGRESS SUMMARY

A. Describe report period progress.

1. *General Project Progress:*
   a) *Action Items:*

An initial number of actions have been completed and others identified that affect all themes of the project and are outlined below:

In progress:
- Periodic PacMARS-NPRB conference calls to assess opportunities and challenges
- Continued submission of point source and composite synthesis data sets to the EOL archive
- Continued input and development of the relevant existing data table (formerly Appendix A on prior progress reports) that is being developed into a narrative document that documents all studies considered and key multidisciplinary projects in the Chukchi and Beaufort seas with listing of process studies and citations

Completed:
- EOL developed and implemented the PacMARS data portal (http://pacmars.eol.ucar.edu/)
- Gay Sheffield, Carin Ashjian, Lee Cooper, Sveta Yamin-Pasternak, Sue Moore and Jackie Grebmeier were among those who shared the necessary efforts to coordinate travel plans for the PacMARS community meetings in various locations in Alaska, including soliciting community and other organizational representation, securing meeting space and housing, and overcoming logistical and severe weather challenges. PacMARS team PIs led and coordinated community meetings in Savoonga (Jan. 28), Gambell (Jan. 29), Barrow (Feb. 11), Kotzebue (Feb. 22) and Nome (Feb. 25). The meetings in Gambell and Savoonga were individual Alaska community "Town Hall" input meetings used to explore village-based input on a more local scale while the other three were "hub" meetings attended by representatives selected by tribal village councils from nearby coastal villages in order to entrain local comments from 17 villages from St. Lawrence Island to Kaktovik. PacMARS team PIs led and coordinated all the meetings. Gay Sheffield and Sveta Yamin-Pasternak guided the meeting presentations and participated in all of them. Carin Ashjian and Steve Okkonen participated in the Barrow meeting. Lee Cooper participated in all meetings except for the Barrow meeting while Jackie Grebmeier participated in the Savoonga and Gambell village meetings and the Kotzebue hub meeting. Danielle Dickson (NPRB) and Ellen Tyler (AOOS) attended the three hub meetings in Barrow, Kotzebue and Nome. Separate meeting reports are being complied with details from each community meeting.
- All PIs prepared one-page biographical sheets for the Alaskan community meetings, following a template developed by Sveta Yamin-Pasternak.
- A PacMARS draft data policy was developed that includes templates for data submission and template metafile descriptions (available on the EOL website)
- A formal letter of explanation for inviting traditional knowledge collaborators was developed (Lead responsibility: Sheffield and Yamin-Pasternak).
- The EOL data archive investigators generated a data questionnaire used by the PI's and collaborators to identify what data that will be submitted and in what format it will be provided to the EOL PacMARS site. This questionnaire was also used by other collaborators who attended the data meeting in Boulder. (Lead Responsibility: Jim Moore and Jackie Grebmeier)
- Geographic Information System (GIS) coordination: Developed agreement on shapefiles, projections, fonts and a road map for uploading files to NCAR; Generated examples of data analysis for each theme using the same GIS standards (e.g. projections, boundaries, font usage,

symbols, mapping standards, shared shape files where appropriate) including those to be used at the Open Science Meeting with SOAR project. Leads: Jim Moore, GIS personnel for Grebmeier/Cooper, Dunton and Trefry groups coordinated as the PacMARS GIS "tiger team".

- Alynne Bayard (UMCES GIS specialist) has been working with several PIs to prepare and submit data to the PacMARS server. Project PIs who have been assisted include: Steve Okkonen, Bodil Bluhm, Jackie Grebmeier and Lee Cooper. Data preparation includes updating spreadsheets so that they conform to the required data structure (including field headings, order and format) that were agreed upon by the PacMARS Data Management Team. Bayard has also worked closely with members of the PacMARS GIS Tiger Team, including Don Stott, Tim Whiteaker, and Janet Scannell, to troubleshoot issues with re-formatting different data sources as well as preparing shapefiles and associated metadata in ArcGIS to ensure standardization.
- Developed a generic single page PacMARS description for distribution to Alaska villages.
- The PacMARS/SOAR joint meeting, led by J. Grebmeier and S. Moore (SOAR) was held on January 20, 2013 in Anchorage AK just prior to the Alaska Marine Science Symposium.

b) *Website Maintenance and Tracking*: During this reporting period, the PacMARS co-PI team has been accumulating data sets and preparing data spreadsheets and in most cases shape files for submission to the PacMARS EOL data sites (http://pacmars.eol.ucar.edu/). Jim Moore's team prepared the PacMARS EOL data website that is linked to the PacMARS home project portal at CBL (http://pacmars.cbl.umces.edu/). Google Analytics tracking (Figure 1) shows that the website at CBL is being accessed regularly. Tracking of the PacMARS website at EOL has just been initiated.

Figure 1. Google Analytics chart showing number of accessions to the CBL PacMARS website through March 11, 2013.
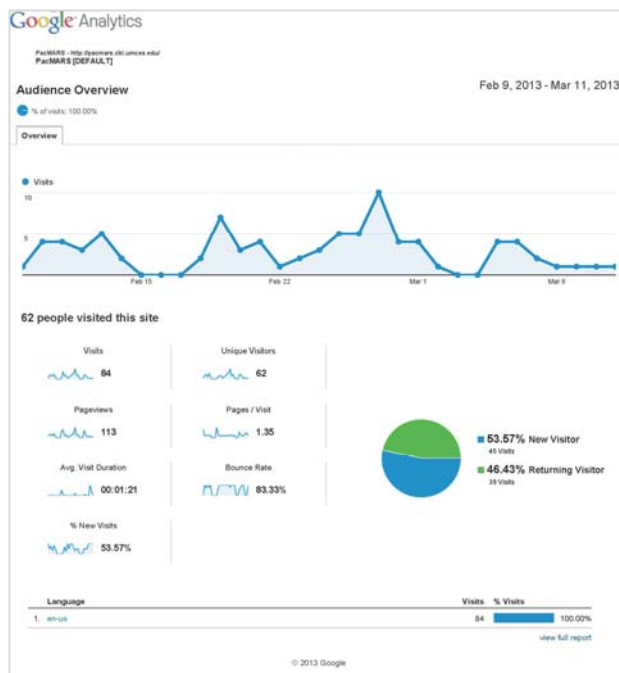
SOAR-PacMARS Meeting Summary. The PacMARS-SOAR Open Workshop was held January 20, 2013 immediately prior to the Alaska Marine Science Symposium in Anchorage, AK and was well attended with approximately 50 participants. An announcement of the workshop was posted on the NPRB AMSS website and was announced on the Arctic listserver Dec. 13, 2012. This announcement and the agenda for the meeting are also posted on the PacMARS home page. The format for the workshop was jointly formulated with the SOAR project to have PacMARS investigators give three 20 min talks covering the 6 themes of the PacMARS synthesis activity, followed by 4-15 minute talks highlighting SOAR research papers. A meeting report is in preparation and will be posted on the PacMARS website when completed. The following is a brief summary of the outcomes of this workshop.

The purpose of the PacMARS-SOAR Open Workshop was to provide an update of activities and to solicit input on themes for future research initiatives in the region. The agenda for the PacMARS-SOAR workshop included highlight presentations of activities from both synthesis projects, followed by break-out sessions with the workshop participants to identify additional data synthesis activities being undertaken, and to develop a composite of scientific themes for future interdisciplinary and Inter-agency efforts in the Chukchi and Beaufort seas.

The PacMARS theme overview presentations included:
- Physics, hydrography and contaminants (Lee Cooper-presenter)
- Lower trophics, biodiversity and phenology of biological production (Bodil Bluhm-presenter)
- Subsistence (Sveta Yamin Pasternak-presenter)

The SOAR project case study presentations included:
- Physics / Hotspots (Jackie Grebmeier for Robert Pickart-presenter)
- Lower Trophics / Upper Trophics Prey (Carin Ashjian-presenter)
- Upper Trophics / Hotspots (Mega Ferguson and Kathy Kuletz-presenters)
- Acoustic Ecology (Chris Clark-presenter)

The breakout sessions were designed with four tables captained by one person each from PacMARS and SOAR to focus on future directions for research. Participants chose a table and could stay there the entire time or switch tables every 30 minutes. At the end of the break-out sessions each group gave a presentation summarizing the topics of discussion, data and data issues and topics each group felt were the most important for future research.

The tables were divided into three groups and the main results of the discussion are given on the following pages. Additional details will be provided in a meeting report under preparation.

Physics, hydrography and contaminants: led by **Lee Cooper (UMCES-CBL)** for PacMARS and **Heather Crowley (BOEM)** for SOAR.
One of the main conclusions of the physics, hydrography and contaminants discussion was that a biophysical model (either conceptual or working) is needed for the Chukchi/Beaufort Sea region. Key variables to be measured and synthesized (using available and new data) included coastal sea level (tide gauges), sea ice conditions, primary production, sediment transport and contaminants. It was discussed that while physics is well monitored, contaminants are not and that more monitoring needs to be done in ice covered areas.

2. Lower Trophic Levels, Biodiversity and Phenology: led by **Bodil Bluhm (UAF)** for PacMARS and **Carin Ashjian (WHOI)** for SOAR.
The lower trophic group discussed the quality and access to data more than new data needs. The main results of this breakout discussion included the following points:

- It is critical to characterize the data sets even if we don't have the full content.
- The data sets to which the PacMARS EOL site link to should be in permanent archives.
- Other syntheses to include in our project: RUSALCA, CSESP
- The access to international data was unclear.
- Data is needed for:
  - o Rate measurements (growth rates, respiration, feeding, reproduction)
  - o Physiology (adaptability of organisms to new environmental conditions)
  - o Seasonality (logistic requirements to adequately gather data to resolve seasonality and to measure rates in range of temperatures)
  - o Transferability of rates to modeling efforts (are the measurements the same as what is being modeled?)

3. Subsistence: led by **Sveta Yamin-Pasternak (UAF)** for PacMARS and **Lisa Guy (NOAA)** for SOAR.

The subsistence group discussed the social science study needs for the next 5 years of research in the region. Specific attention was given to the socioeconomic effects of climate change on local people. Issues discussed included:

- Coastal erosion
- Changes in hunting and harvest
- Social impacts (adaptive, destructive or multidirectional)

4. Upper Trophic Levels and Acoustic Ecology: led by **Gay Sheffield (UAF)** for PacMARS and **Megan Ferguson (BOEM)** and **Chris Clark (Cornell)** for SOAR.

The upper trophic level and acoustic ecology group came up with three challenge questions to address the topic of how to use hypothetically unlimited funding for the next 5 years:

- How do we "think" the Chukchi-Beaufort Seas (US) is operating as a system?
- What are the key questions, key data and data collection needs?
- Are there any model examples to use as a template for this process?

Key questions / topics included:

- Use of passive acoustics - identify species, behaviors (reproduction, migration, foraging)
- Use of active acoustics – abundance, density of fishes, invertebrates
- Anthropogenic effects on marine mammals and other vertebrates
  - o Need for awareness that many invertebrates are acoustically active and have acoustic perception mechanisms
  - o Regional bias driven by economic and regulatory drivers
  - o Acoustic data sets could be mined for insights on other species; synthesis and integration with a systems approach needed
- Changing ecosystems
  - o Questions will be different for different regions (ice, open water, etc.)
  - o Changes in productivity and capacity for fish and marine mammals
  - o Large ship traffic
  - o Oil and gas development
- Connectivity
  - o Does the system between Bering Strait to the Beaufort Sea region consist of a single connective ecosystem?
  - o Do fish overwinter in the Chukchi Sea or do they migrate?
  - o There are data out there, but we don't know if they have been used for a mechanistic understanding of the ecosystem
- How to pull historical and ongoing data to achieve a more predictive, responsive model

- o   Connectivity is important – flows between regions and organisms
- o   Possibility of progression of ecosystems northward
- o   Discussed bottom up system (benthic organisms), but also have many benthic feeders so need to look at top down influences on the systems
- Wind
  - o   Ice movement
  - o   Distribution of organic matter
- Current Models
  - o   USGS modeling of polar bears
  - o   Ocean acidification
  - o   Walrus models
  - o   Need more comprehensive understanding to develop working models
- Key Locations
  - o   Bering Strait (chokepoint)
  - o   Point Hope
  - o   Barrow Canyon
  - o   Peard Bay
  - o   Hannah Shoal
  - o   Kaktovik and Mackenzie River

2. *Specific Objective Progress*

a)   **Identify and link existing data sets**: During this reporting period, each funded group relayed information on relevant activities, including data set and additional collaborators identification. Most of the effort has been put into compiling information on what data sets each research group can contribute, links to other already available databases and identifying gaps needed for projected analysis and synthesis. PacMARS generated synthesis data sets continue to be populated on the PacMARS EOL website site, although a target date of March 1, 2013 was set for completion of this task. We expect some additional data set submission to occur over the next reporting period.

Action items related to **data sets** included:
- Based on discussions at the Boulder data workshop, access to the PacMARS MapServer and data sets were password protected. Access will be limited to PacMARS investigators and collaborators until June 2013, when derived data (e.g. maps) will be publicly available. Some raw data, as needed, will be password protected until completion of the final PacMARS synthesis report.
- A workflow process was also developed for data submissions to the PacMARS data archive, with branching in the workflow dependent on whether shapefiles were needed, and the extent of the metadata. The workflow discussion includes members of the EOL data management team and Alynne Bayard of UMCES. Once the workflow process was finalized, an email was sent out to all PacMARS PIs and collaborators with instructions on how to submit data to the data archive, and shapefiles for the MapServer, along with the recommendations for format and naming conventions of data.
- A metadata template detailing requirements for metadata in shapefiles was finalized by the GIS "Tiger" team. These metadata may be exported from ArcGIS in XML files that meet the FGDC metadata standard. Instructions on exporting metadata from ArcGIS meeting the FGDC standard were circulated among the GIS data providers.

The following links and pages were added to the PacMARS Data Archive site to provide instructions to data providers and information on the site:
1) an "About" page with background information on PacMARS
2) a "Detailed Submission Instructions" page for data providers

3) a "Documentation and Format Guidelines" page for data providers
4) a link to the "PacMARS Data Policy" page
5) a "Submit Data" link to the online metadata form and upload tool for data providers
6) activated the "Data Access" link to display the PacMARS Master Lists of data sets
7) also, fonts used on the PacMARS MapServer were standardized to improve readability

The following updates and features have been added to the online metadata submission tool for PacMARS:
1) emails are automatically sent out when data is submitted, or updated
2) the "owner" of a data set is tracked now, as well as the "point of contact"
3) registration for new users is accomplished online (but requests from individuals can also be handled by us, as before)
4) various fixes to improve the resetting of passwords and saving of platforms to the database, among other minor updates

The PacMARS data archive at the Earth Observing Laboratory at NCAR has archived these data from the following PIs.

In the Mapserver--
- Carin Ashjian
  - Matrai Data - Integrated Chlorophyll Concentrations
  - Canadian Three Oceans and related projects (from Lee Cooper)
- Ken Dunton
  - Sediment raster image (Not currently displayed in mapserver)
  - Sediment control points - Control points used to produce the Sediment raster image
  - Arctic Isotope synthesis
  - Chukchi Isotope data from 2004
- Jackie Grebmeier/Lee Cooper
  - Infaunal abundance and biomass data, total taxa numbers
  - Seawater nutrients
  - Sediment grain size, total organic carbon/nitrogen, and C/N ratios
  - Sediment chlorophyll a
  - Integrated chlorophyll a
  - Sediment community oxygen uptake
- Sue Moore
  - NMML Data - Taken from Sue's list of data sets - Historical BWASP and COMIDA database (1979 to 2010)
- Yamin-Pasternak (all of these data are in the Western Siberian region and not in the PacMARS study area and were provided as pilot demonstration data sets)
  - Nenets Autonomous Okrug (NAO) Reindeer Herder Annual Migration Routes
  - Subsistence Uses
  - Hydrology data from 2004 through 2009 showing permanent open surface water areas.
  - NAO Study Area
- Steve Okkonen
  - CTD data (temperature, salinity, stratification indices)
- Oil industry (first phase submissions from CSESP)
  - Benthic ecology data
    - Epifaunal species
    - Epifaunal specimens
    - Infauna
    - Particulate organic matter

- ▪ Sediment chemistry
- Jay
  - - Walrus foraging data

The following datasets have data available for order from the PacMARS Data Archive:

- Biomass Data [Grebmeier-Cooper] - Preliminary
- Integrated Chlorophyll Concentration 1980-1999 [Ashjian] - Preliminary
- Integrated Chlorophyll Concentration 2000-2004 [Ashjian] - Preliminary
- Permanent open surface water areas in Nenets Autonomous Okrug, Russian Federation [Yamin-Pasternak]
- Environmental data for Macrobenthic sampling stations in Prudhoe Bay, Beaufort Sea 1974 [Blanchard]
- Environmental data for Macrobenthic sampling stations in the Chukchi Sea [Blanchard]
- Macrobenthic data from Nearshore Prudhoe Bay [Blanchard]
- Macrobenthic data from the Chukchi Sea [Blanchard]
- Macrobenthic data from Bering to Chukchi Sea 1970 to 1974 [Blanchard]
- Bowhead Whale Abundance [George]
- Infaunal station biomass Data [Grebmeier] - Preliminary
- CTD Summary Data [Okkonen]
- Walrus Monthly Foraging Utilization Distribution in the Chukchi Sea: 2008-2011 [Jay]
- Animida and cAnimida data [Battelle]
- COMIDA CAB project data

The following data are in process:

- Bodil Bluhm: shapefiles being processed from spreadsheet data
- Industry datasets, second phase of submissions: shapefiles from the industry datasets have been downloaded and are being prepared for the Mapserver, with links to the data
- CTD and water column data from cruises on the CCGS Sir Wilfrid Laurier icebreaker cruises, 1998-2012 [Cooper]
- All station benthic abundance and sediment files-multiple years [Grebmeier]
- Shapefiles and data files for all station benthic abundance and sediment data-multiple years [Grebmeier]
- MODIS imagery of shoreline change around St. Lawrence Island [Philippe Amstislavski]

Specific coordination was undertaken with the AOOS Project and Axiom, Inc. to better integrate the new industry data now being made available to the PacMARS project. Axiom is providing support to ingest the industry data into the AOOS archive, generate GIS shapefiles and provide access to them for inclusion in the EOL MapServer. We think that this collaboration with industry provides for an unprecedented opportunity for sharing data that will be fully integrated into the scientific analysis efforts.

b)   **Synthesize existing scientific and traditional knowledge of the marine ecosystem:** During the reporting period individual PacMARS PIs have continued to contact individuals, project leads, archives, agencies and associations in Alaska and elsewhere to help identify available environmental data sets as well as traditional knowledge data publically available that could be integrated with existing scientific knowledge. More specifics about these activities are outlined below in the themes section of this progress report.

c)   **Develop overarching scientific themes and research needs:** During the reporting period the PIs collected data that will be evaluated in the context of the overarching scientific themes and research needs

discussed in our original proposal, at the PI meeting in Annapolis, and reiterated at the Boulder data meeting December 10-11, 2012.

The completed and new action item(s) related to **overarching themes** considered during the Jan-Mar 2013 period include:

Completed:
- Generated a PacMARS/SOAR theme table that helps illustrate the differences in scope and approach of the two separate programs**,** available on PacMARS and SOAR websites (http://pacmars.cbl.umces.edu/PacMARSSOAROpenScienceMeeting.html)
- Drafted a PacMARS-SOAR schematic, available on PacMARS website (http://pacmars.cbl.umces.edu/PacMARSSOAROpenScienceMeeting.html)
- Provided written guidance to Brendan Kelly at his request on the usability of the National Ocean Data Center archive to assist with a reporting requirement at the Office of Science and Technology Policy.
- Jointly developed the announcement and coordination for the January 20, 2013 PacMARS-SOAR open science workshop just prior to the AMSS with Sue Moore; also developed agenda for the workshop. The agenda was publicized through posting on the Arctic Info listserver and was also sent out to the Pacific Arctic Group listserver (~160 international arctic scientists). The PacMARS project provided logistics and refreshments for the meeting, including arranging room rental with the Captain Cook Hotel, meeting badges, provision of an LCD projector, and note taking and recording of discussions.

Ongoing:
- Updates to the PacMARS data table (formerly Appendix A, now being developed as a narrative document); this is an ongoing effort with expanded descriptions of data sets that were considered in the PacMARS analysis and annotations on perceived strengths and weaknesses. This appendix is posted on the CBL PacMARS website (http://pacmars.cbl.umces.edu).
- Input of point source and composite data sets to the EOL PacMARS data portal; upload of metafiles for both types of data. This is continuing beyond the project target date of March 1.

d) **Emphasize system-wide, synoptic understanding:** We are prioritizing our efforts towards integrating across disciplines and we are using geographical and habitat-scaled approaches to achieve linkages among biophysical observations and human communities. Our data collections are linked to the proposal themes and questions via schematics drafted during the Boulder data meeting.

e) **Undertake a synthesis of social-ecological interactions:** The understanding of our study region as a social-ecological system, an approach that regards humans as integrated component of the natural environment, is a principal framework for the PacMARS assessment of studies relating the course of subsistence livelihoods in the time of change. Some brief comments are provided here on how we are approaching the importance of incorporating social-ecological interactions and how some of the many available social science and traditional knowledge sources are being evaluated. Additional text, and research examples are being compiled for the interim final report for PacMARS.

We start with the observation that the human communities within the study area live in close proximity and everyday contact with the sea and land. They derive their livelihood from the local ecological resources, either through direct harvesting practices or through local exchange networks. The ecosystem within which they operate, albeit one that has not been transformed as visibly as vast urban or agricultural zones, is an anthropogenic environment. Such features as trails, waterways, sea ice pathways, year-round homes, familial campsite structures, temporary shelters used while traveling and/or gathering food, ice

cellars, and various landmarks are part of the toolset that facilitates the knowledge and use of that environment. The so-called permanent infrastructure, such as village post offices and schools, brought in through the workings of various colonial and legal processes, now also functions as part of that toolset. The latter helps foster the idea of permanent residence and, alongside ancestral ties to a more geographically dispersed area, adds a dimension of a legal and cognitive attachment to a locale, with a strong fidelity to the local geography.

Numerous subsistence and land use studies continue to be reviewed within the scope of the PacMARS study of subsistence livelihoods. To date, report reviews have included land use studies, and in some cases multi-year subsistence data reports for the villages of Kaktovik, Nuiqsut, Barrow, Wainwright, Kotzebue, Kivalina, Shishmareff, Diomede, Savoonga, and Gambell. One outcome of this review has shown that the residents of the coastal communities in the northern Bering, Chukchi, and Beaufort regions derive at least 50% and sometimes up to 90% of the products they consume from the local ecological resources.

The compilation and exploration of traditional knowledge sets that are used in subsistence activities can be categorized into several topical themes that are primarily being addressed by PacMARS cultural anthropologist Sveta Yamin-Pasternak:

- A "benthos LTK," centered on the relatively undocumented utilization of marine benthic food sources. An example from the PacMARS study area is the recent synthesis "Combining Inupiaq and Scientific Knowledge: Ecology in Northern Kotzebue Sound, Alaska," that was published by Alaska Sea Grant, but other examples from other areas may prove illuminating, such as a survey from 19 fishing villages in Brazil (Teiheira et al 2013, Traditional Ecological Knowledge and the mapping of benthic marine habitats, Journal of Environmental Management).

- Sea Ice LTK, of which local and traditional knowledge of sea ice constitutes one of the most developed, to date, domains of the documented Yupik and Inupiaq understanding of the "ice as home" perspective among the Inuit, who regard the ice-scape as a mere extension of the human settlement and overland travel routes. The two major data products for representing this domain within the PacMARS study area are the St. Lawrence Island Yupik and Wales Inupiaq Sea Ice dictionaries, documenting, defining, and depicting myriad morphological, seasonal, and situational conditions of sea ice that are recognized, studied, and used by the Gambell, Savoonga, and Wales residents.

- Subsistence Mapping, of which MMS/BOEM studies are prominent examples, and allow cartographic visualization of both harvest and use areas for every species and seasons pertaining to Nuiqsut, Kaktovik, and Barrow. The final mapping data products are available publically, but the actual GIS shape files and metadata are confidential. A comprehensive subsistence mapping project is also currently underway in the Northwest Arctic Borough. Kawerak, Inc. has an ongoing project mapping the walrus and ice seals LTK for the Bering Strait region. Some data products for these projects may become available within the timeline of PacMARS, but some interpretation will be limited by the conditions placed upon the use of these data provided by local subsistence hunters.

- Community based observations, which are reported in such forums as SIWO (Sea Ice for Walrus Outlook) and LEO (Local Ecological Observer) exemplify some of the most easily accessible and publically available knowledge sources. LTK data that will be incorporated in the ultimate synthesis, including concerns that are being brought forward by the Bering Sea Sub-Network, including the impacts of shipping noise on key subsistence species. Overlays of the St. Lawrence

Island marine subsistence maps with shipping lanes data may be one simple example to illustrate the value of this input.

3. Progress on PacMARS research themes

As mentioned above, we organized our PacMARS proposal around **6 research themes,** which we identified as foci for specific synthetic questions that would improve our understanding of the Pacific Arctic region. We provide a brief summary below of these themes and actions that have been undertaken that would contribute to that effort initially. Data sources that we have identified to help address these specific questions and themes (many are appropriate for multiple themes) are tabulated online at http://pacmars.cbl.umces.edu/). (As noted above, this document is being converted into a narrative, annotated form).

a) **Ice Cover (primary production relationships, currents, winds, bathymetry):**

We have and continue to compile data sets to common format, develop GIS mapping protocols, upload appropriate data to ACADIS website, interact with AOOS, and will use the PacMARS synthesis and community input to feed into development of a multi-agency 5-year field program, including the following elements consistent with this theme:

- Bathymetry+Seasonal and interannual changes in T, S (river discharge), winds, currents

- Regional and spatial distributions (GIS or krigged gridded data) of pelagic standing stocks (phytoplankton, zooplankton), and where possible, phenology of biological production cycles

- Phytoplankton: We have made good progress in obtaining data sets from colleagues working in this region for the post-2004 years. We are still waiting for one important data set before finalizing our compilation. We have made maps of the data distribution, separated out by decades and by seasons and find that we have good coverage of the Chukchi Sea if we consider data collected prior to and post 2000 separately. Most data have been collected during July-September. We have produced preliminary gridded maps of integrated chlorophyll. Our next step will be to disseminate the gridded maps to our collaborators for their input. We also will compare our gridded maps to the distributions of physical attributes (Okkonen CTD data set) and of other biological variables (e.g., benthic biomass, copepod biomass).

- Zooplankton: We have continued to make good progress in identifying and collating zooplankton data sets, although the work is labor intensive due to the inconsistent formats of data sets and the large number of different variable types (species) in each. Collaborator R. Hopcroft kindly provided us with the stage specific data collected during the CSESP project.

We will produce maps showing the distribution of the data sets, sorted by decade and by season, in the reporting period. We presently are separating out the abundances of key copepod species that may be used as indicators for an assessment of change over the period that data are available. Once the abundances are isolated, we can make a determination regarding which data sets we can use based on mesh size and will then calculate the stage specific biomass for each species and the total population biomass. Toward this end, we have measured the minimum dimension (maximum width) for all of the copepodid life stages of the key species from archived samples to allow us to determine the net mesh sizes that quantitatively collect each stage/species. We are in the process of collating stage-specific carbon weight data for all key species for estimating biomass from abundance data. Gridded data then will be generated for those species that can be compared to maps of chlorophyll, hydrography, and benthic biomass/abundance. The extent to which these data will be made public will depend on the extent to which that might compromise student dissertations; however, the PacMARS team can use this information in considering recommendations for further studies.

Aside from the sheer enormity of the task of compiling the data, our biggest obstacle continues to be how to successfully integrate and coordinate with Dr. Russ Hopcroft (University of Alaska Fairbanks) and his students to avoid compromising the students' independent theses and dissertations that have some of the

same objectives for zooplankton synthetic analyses. This topic is discussed in additional detail on the next page. As we produce preliminary products, discussions with Dr. Hopcroft will enable us to better identify how we can proceed to avoid conflict.

We anticipate that we can make recommendations for current and future collections based on our review of what has been collected to date (or not collected, e.g., rate studies) and our understanding, and the limitations to understanding of the ecology of these seas both at present and under future climate change.

Other composite data sets are being prepared by PacMARS PIs for:
- Sediment grain size, carbon content, and potential chemical and radioactive contaminants
- GIS maps of stable isotopic signatures for end-member sources of C and N over the western Arctic
- Geostatistical GIS overlays among stable isotopic signatures and water

b) **Phenology of Biological Production Cycles in Relation to Physical Environment:**
We are preparing regionally specific temporal and spatial distributions (GIS or krigged gridded data) of benthic standing stocks (infauna and epifauna), temporal/spatial variations in stratification (T, S), nutrients, winds, and currents. We are using direct links with SOAR to achieve synthesis of data sets specific to higher trophic organism parameters and link to people and we will request input from SOAR for the interim report. The zooplankton team has identified zooplankton data sets and has developed an annotated list (including details of the sampling methodology) of those sets. We have also downloaded several data sets to explore synthesis strategies to make composite files for the EOL PacMARS data site.

As mentioned previously, we are working with Dr. Hopcroft at UAF regarding the best way to accomplish our goals without compromising the dissertation of his graduate student, Imme Ruizen, funded through the National Science Foundation. The goals of her research are almost identical to some of the goals of the PacMARS zooplankton effort and include developing GIS maps of both total zooplankton and specific species abundances. Discussions at the data meeting in Boulder centered on some approaches that will protect the student's rights to protect her intellectual contributions. For example, the public metadata files associated with this effort will include links to the individual data files that are publically available. Additional data sharing is anticipated and there are plans to use some of these data products in preliminary plots that can be used for demonstration and not formally published without the student's participation. We are compiling meta-data on the data sets that will be included in our table showing the information on zooplankton data sets from this region. There are also plans to produce maps of station locations with the assumption that there should not pose any problems.

c) **Benthic-Pelagic Coupling in Relation to Physical-Chemical Environment:**
Several important data sets are being examined for completeness so that they can be transferred to public archives. These include data collected during annual cruises of the CCGS Sir Wilfrid Laurier through the Bering and Chukchi Seas from 1998-2012 that are jointly supported by US and Canadian collaborators under different data archiving protocols and locations. These cruises have sampled water column, sediments and biological systems, but limited funding has not permitted the collected data to be delivered to accessible archives or made otherwise publicly available. The Canadian sourced data (1998-2012 annual cruises) was transferred to the EOL archive during the Boulder meeting. Similar organizational efforts are being accomplished with data collected with other individual researchers that have not been migrated into publicly accessible archives.

d) **Current State of Lower Trophic Prey-Base and Higher Trophic Feeding Hot Spots:**
During the reporting period, key coordinating activities were undertaken with higher trophic level researchers who are involved in the SOAR project. These researchers included Sue Moore (NOAA, whales, SOAR lead), Chad Jay (USCS, walrus), Brenda Norcross (UAF, fish), and Kathy Kuletz (US Fish

and Wildlife Service, seabirds). All our higher trophic collaborators participated in the December 2012 PacMARS data meeting in Boulder, CO and provided updates to data links and data sets for the PacMARS project.

Dunton compiled 4719 data entries of isotopic nitrogen and carbon isotope values for the Pacific Arctic (Table 2). These data were entered on the PacMARS secure database web server. The data entries reflect contributions from 55 projects that span the Chukchi and Beaufort Seas. Included are records of 2500 benthic biota samples, 695 surface sediments, 1173 pelagic samples, 39 phytoplankton, 303 particulate organic matter samples (POM), and 9 miscellaneous records. Shapefiles of both the carbon and nitrogen isotope values have been submitted to the PacMARS web site. Data were collected from studies funded under projects led primarily by scientists from UAF, UT, and UMCES over the past four decades. Sponsors included NSF, Shell, BP, Conoco/Philips, Alaska, OCSEAP, USFWS, and BOEM. Stable isotopic data from pioneering work by Don Schell and his students at UAF since the 1980s were contributed by Norma Haubenstock (UAF).

Dunton sincerely appreciates the contributions from Bodil Bluhm and Katrin Iken (RUSALCA data), Lee Cooper (numerous sediment data), and Norma Haubenstock (vintage UAF data). Some of these older data sets are missing metadata information so we are still working to learn more about these data. We are also determining if any useable trophic information is available from various stomach content records for marine mammals. Our synthesis efforts include close collaboration with GIS experts at UT-Austin to produce spatial maps of isotopic distributions among the key trophic groups. Other spatial distribution analyses are being undertaken of feeding locations of marine mammals, seabirds, and fish to coordinate and link data collections with PacMARS collaborators (Jay, Kuletz, Moore).

Bluhm continued to identify and load benthic epifaunal invertebrate data for the lower trophic prey base and biodiversity-productivity objectives of PacMARS with data sets outlined in Progress Report #1 in Kotzebue Sound from 1978 and the Russian and US Chukchi Sea from 2004, 2007, 2008. Norton Sound trawl data has also been collected by NMFS/ADF&G every three years since 1976. Additional epifauna data that just became available to PacMARS are from the NE Chukchi Sea that were collected during CSESP studies in 2008-2010 were just released through AOOS and will be added to the PacMARS data archive. Eventually data will also become available from the Herald Valley and the S. Chukchi Sea that were collected during RUSALCA 2012, the US Beaufort Sea collected during OCSEAP, and the US Beaufort Sea collected during WEBSEC. Data from the NE Chukchi (COMIDA-CAB, 2009 and 2010) are now available at NODC. A UAF graduate student (under co-PI Konar) has submitted and revised an article based on these data and Konar has indicated that there should not be a problem including the data in the PacMARS synthesis. Data from the US Beaufort Sea (BeauFish, BOEM, 2011) are part of the same Konar UAF graduate student thesis and might not be available for the PacMARS synthesis because the student's second manuscript (based on the 2011 BeauFish epifauna data) is currently in preparation. Bluhm will have a conversation with the project officer of the funding agency about the data archiving plan and the potential availability of the data before the project end. Trawl data from the N Bering Sea that are part of a thesis at Southern Illinois University (Jim Lovvorn, advisor), for species richness have also been added to the data archive. Dr. Lovvorn kindly provided data on species richness, but not total abundance and biomass because his graduate student is currently analyzing those data. The synthesis map will include the station locations and a web link or other pointer to the status of this data set.

Table 2. Summary of files included in the stable isotope database compiled for PacMARS, February 2013.

DATA SOURCE CRUISE ID	NUMBER RECORDS	DATA TYPES
Aumack, SBI RV Palmer summer 2003	57	pelagic, POM
BERPAC 1993	85	pelagic
Casey Boulder Patch, Beaufort Sea	37	benthic, pelagic
Cooper HX189	55	sediment
Cooper NOAA	31	sediment
Cooper RUSALCA 2004	13	sediment
Cooper SLIP99 1999	24	sediment
Dunton Beaufort Sea 2003	3	sediment, POM
Dunton Boulder Patch, Prudhoe Bay 1980	47	benthic
Dunton Boulder Patch, Prudhoe Bay 2006	12	benthic, POM
Dunton Camden Bay 2007	4	benthic, pelagic
Dunton COMIDA RV Alpha Helix 2009	594	benthic, pelagic, POM, phytoplankon, sediments
Dunton COMIDA RV Moana Wave 2010	220	benthic, pelagic, POM, phytoplankon, sediments
Dunton Eastern Beaufort 2003	9	pelagic, POM, sediment
Dunton Eastern Beaufort 2007	5	benthic, pelagic
Dunton Eastern Beaufort lagoons 2004	92	benthic, pelagic, POM, phytoplankon, sediments
Dunton Eastern Beaufort lagoons 2007	66	benthic, pelagic, POM, phytoplankon, sediments, terrestrial
Dunton Eastern Beaufort lagoons 2008	1	benthic
Dunton Harrison Bay, Beaufort Sea 2010	87	benthic, pelagic, POM, phytoplankon, sediments
Dunton Prudhoe Bay	4	benthic, pelagic
Dunton Prudhoe Bay 1980	17	benthic, pelagic
Dunton Prudhoe Bay 2004	4	benthic, pelagic
Dunton Prudhoe Bay 2006	5	pelagic
Dunton RV Discoverer	28	benthic
Dunton Shell Camden Bay 2008	407	benthic, pelagic, POM, phytoplankon, sediments
Feder SE Chukchi 1987	174	benthic, pelagic
Golikov Russia 1989	12	benthic
Grebmeier RV Laurier 2000	102	benthic
Horner RV Glacier 1997	28	pelagic
Iken Rusalca 2004	220	benthic
Iken, Bluhm Rusalca 2004	364	benthic, pelagic, POM
McTigue Shell Chukchi 2009	187	benthic, pelagic, POM, sediments
McTigue Shell Chukchi 2010	149	benthic, pelagic, POM, phytoplankon, sediments
Naidu	218	sediments
Naidu published paper	111	sediments
NP 1994	2	pelagic
Polar Star 1986	17	pelagic
Polar Star Beaufort Sea 1986	90	benthic, pelagic
RV Akademic Korolev 1988	67	pelagic
RV Alpha Helix 1987	28	pelagic
RV Annika Marie 1985	7	pelagic
RV Annika Marie 1986	35	pelagic
RV Sequel 1985	6	pelagic
RV Surveyor 1987	25	pelagic

DATA SOURCE CRUISE ID	NUMBER RECORDS	DATA TYPES
RV Surveyor 1989	37	pelagic
RV Surveyor 1990	32	pelagic
RV Surveyor 1991	33	pelagic
RV Thompson 1987	16	pelagic
RV Thompson 1988	33	pelagic
RV Tully 1986	6	pelagic
Schonberg SBI RV Healy spring 2002	226	benthic, pelagic, POM
Schonberg SBI RV Healy spring 2004	114	benthic, pelagic, POM
Schonberg SBI RV Healy summer 2002	239	benthic, pelagic, POM
Schonberg SBI RV Healy summer 2004	201	benthic, pelagic, POM

Bluhm has worked, under a BOEM grant, on revising and correcting the taxonomy of an epifaunal data set from the western Beaufort Sea from 2008 so that abundance, biomass and species richness data can be included in the PacMARS synthesis files and maps. She was also able to locate, with the help of B. Holladay from UAF, epifaunal data (albeit with coarse taxonomic resolution) from three Japanese cruises to the Chukchi Sea from the early 1990s. These data are in printed reports and Bluhm is working on digitizing these data. In addition, an epifaunal data set from a US cruise to the northeastern Chukchi Sea from 1990, led by W. Barber, was finally located. Epifaunal invertebrate trawl data from various cruises in the Canadian Beaufort Sea are currently being compiled and analyzed by a Canadian PhD student in Philippe Archambault's lab at the University of Québec, and will, therefore, not be included in the PacMARS synthesis. These efforts are now considered largely completed and conclude the search for epifaunal invertebrate data sets from the PacMARS region.

Most, but not all, surveys mentioned here primarily resolve taxa to the species level with the exception of difficult groups. Different trawls, trawl duration and mesh size can also bias comparability for standing stock estimates as well as species richness/biodiversity indices.

Bluhm has started identifying macrofaunal invertebrate data from the Pacific Arctic that are identified mostly to species level. These include (in no particular order) (1) a data set from 1976 by Feder (UAF, retired) collected in Kotzebue Sound, (2) the CSESP data (2008-2012) from the Northeastern Chukchi Sea collected by Blanchard (UAF), (3) COMIDA CAB data collected by Dunton and Schonberg in 2009/2010, (4) data from the 1970s from the US Beaufort Sea shelf collected during OCSEAP by Carey (formerly Oregon State University); Bluhm, Schonberg and Dunton are collaborating on this effort, (5) two data sets from the Canada Basin Ocean Exploration expeditions in 2002 and 2005 (Bluhm collected those data), and (6) Canadian data primarily from the 1970s and 1980s compiled by Cusson et al. 2007 Mar. Ecol. Prog. Ser. 331:281-290 (held by P. Archambault at U. Québec). It yet remains to be clarified which data can be uploaded to the EOL site and which we can link to.

Grebmeier has extensive macroinfauna data from the PacMARS region, resolved to the family level, with dominant fauna to species level in many cases, some that are already at EOL from past projects as well as other data archives. For PacMARS she is migrating other data sets into synthetic "all station" files from other published data to be loaded at the PacMARS EOL data site through collaboration with Arny Blanchard (UAF) and Russian and Chinese scientists. These synthetic data files contain benthic station abundance and biomass data, including dominant macroinfauna, for cruises collected from the 1970s-2010. The associated metadata file for these data will list links to individual cruise data submission locations, when available, including an updated version of the table of source data published in Grebmeier et al. 2006. In addition, associated environmental data are also being combined into "all station" files, including sediment grain size, total organic carbon content, sediment chlorophyll and sediment oxygen uptake rates. Water column nutrient and integrated chlorophyll a data files are also near completion for

submission to EOL. The metadata files for these composite datasets will also include links to individual cruise data archive sites as well as associated publication lists.

Selected sets of the compiled infaunal and epifaunal data in conjunction with the aggregated chlorophyll data sets form the basis for the analysis of biodiversity-productivity relationships which is one of the cross-cutting objectives of PacMARS. Biodiversity data sets will be selected based on their geographic and temporal match with the chlorophyll data coverage and by their taxonomic resolution, consistency and quality.

e) **Subsistence Livelihoods in Times of Climate Change:**

Sveta Yamin-Pasternak worked with Philippe Amstislavski (Department of Environmental and Occupational Health Sciences, School of Public Health, State University of New York, Downstate Medical Center) defining the scope of MODIS-based survey of coastal change (which is now completed); assisted Eva Bailey and the other PacMARS PIs on the project information binder for the coastal communities in the study region; continued to review MMS/BOEM subsistence literature, databases of relevant theses and dissertations, LTK sea ice studies, BLM National Petroleum Reserve Alaska Subsistence Advisory Panel Archive, Sea Ice for Walrus Outlook archive, Local Environmental Observer archive, and updates from the Bering Sea SubNetwork project.

This overall approach is also discussed previously in the Specific Objective Progress section of the progress report (Section 2e). In many respects the social science elements of PacMARS pose challenges that are not common to our other data compilation efforts, including confidential data sources, and additional efforts to involve local communities organically in procuring and evaluation of traditional knowledge. Nevertheless we are pleased that the community meetings were successful and that a number of areas of progress are being made. We expect that social scientific insights will be successfully integrated into the overall PacMARS synthesis.

f) **Chemical Contaminants in Sediment and Biota:**

Data for trace metals, PAH and petroleum hydrocarbons in surface sediments from the Chukchi Sea (n = 204 stations) and the Beaufort Sea (n = 291 stations) have been put in the PacMARS database. These samples were collected during the period of 1984-2012; however, >90% of the samples were collected between 2000 and 2012. Data for contaminants in age-dated sediment cores from the Chukchi Sea (n = 230 samples in 16 cores) and the Beaufort Sea (n = 185 samples in 22 cores) also have been added to the PacMARS database.

Sediment stations will be displayed on the PacMARS maps with sampling dates. Data for contaminants in surface sediments will be presented on GIS contour maps where appropriate. An example for total mercury (THg) in the northeastern Chukchi Sea (Figure 1) shows a patchy distribution with low THg concentrations nearshore and on Hanna Shoal. Mercury contamination was identified at just two locations where drilling mud and cuttings were discharged in 1989 during oils and gas exploration. The areal extent of these anomalies is too small to be shown on the regional map (Figure 2). The other contaminants will be treated similarly using the PacMARS maps.
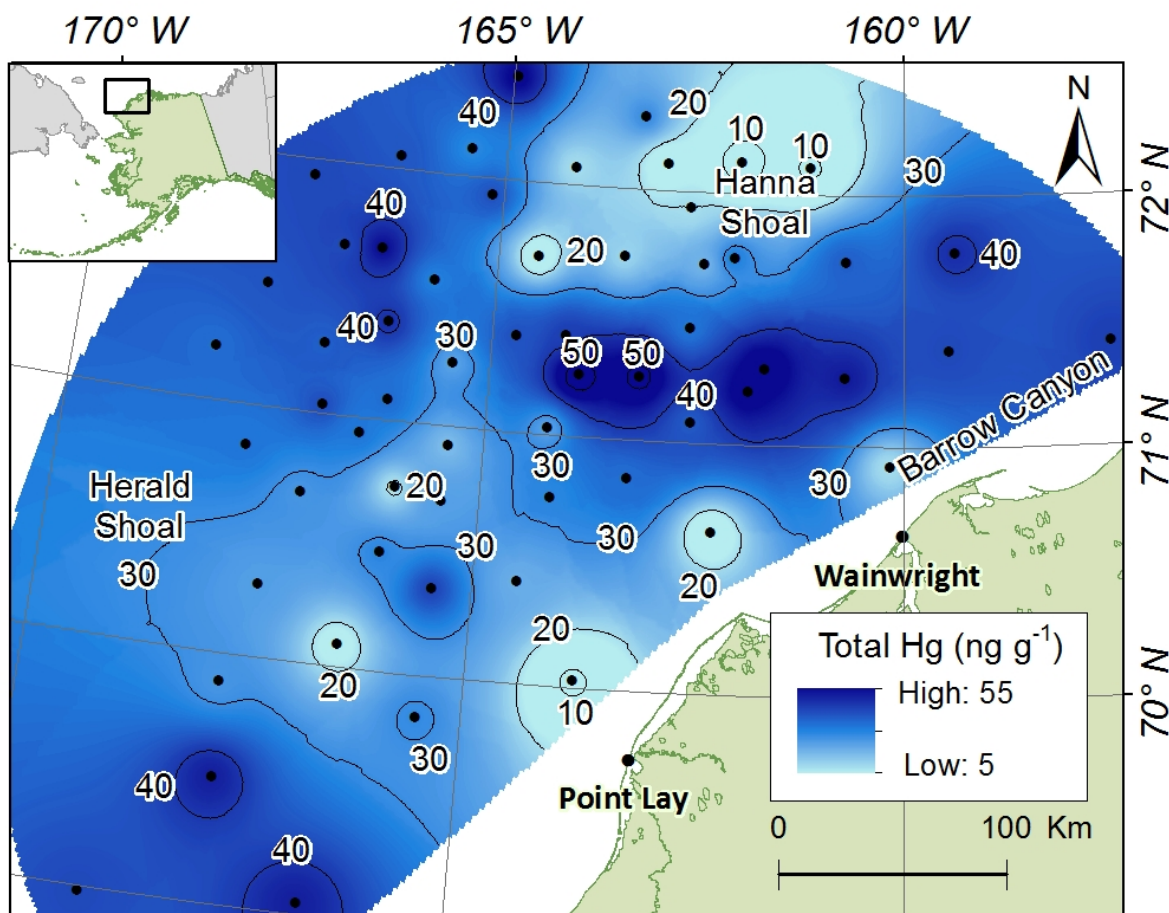
Figure 2. Concentrations of total mercury in surface sediments from the Chukchi Sea.

Data for contaminants in benthic infauna/epifauna (clams, amphipods, whelks, crabs) from the Chukchi Sea (n = 149) and the Beaufort Sea (n = 156) have been added to the PacMARS database. Samples from the Chukchi and Beaufort seas were collected from 2009-2102 and 1984-2012), respectively. Contaminant data for fish have been added to the PacMARS database with 25 samples from the Chukchi Sea and 88 samples from the Beaufort Sea. Data for seals, whales, birds and polar bears have been identified and are being subjected to QA/QC evaluation before adding to the PacMARS database.

Overall, trace metal and PAH data are available for sediments and biota. No data have been found for PCBs or other persistent organic pollutants (POPS) in marine sediments or benthic fauna. Data for a variety of POPs have been identified for upper trophic level organisms. Synthesis data for contaminants in biota will be tabulated based on collection date and location and will displayed on graphs and maps.

We have had considerable discussion about the content of the synthesis product(s) for this project component. The present plan is to focus on a manuscript on the following three contaminants of concern: Hg (including methylmercury), cadmium (Cd) and PAH (for sediment, benthic biota and upper trophic level organisms) and possibly PCBs in upper trophic level organisms. Development of the paper will be from the perspective of differences in the sources of the contaminants and pathways for delivery of those contaminants to target organisms. For example, Hg is derived from atmospheric and coastal sources, Cd comes from deep ocean water and riverine sources, PCBs are introduced by atmospheric and some coastal sources, and PAH are derived from atmospheric, fossil fuel and coastal sources. Knowledge gained from

focusing on pathways for the selected contaminants may then be applied to other contaminants.

Our advisors noted that both the sociological and contaminant components of the synthesis appear to be somewhat isolated from the ecosystem integration. We are working on a means to better integrate the contaminants aspects of the PacMARS synthesis.

4. *Describe preliminary results*

Grebmeier has submitted preliminary "all station" synthetic files for GIS plotting in spatial mode. The data and shape files include dates and spatial location for time series and regional analyses. Files submitted or in progress to submit include station summary values for:

1) benthic macroinfaunal abundance, g wet weight biomass, gC biomass, and taxa number.
2) sediment grain size composition (% phi), total organic carbon content (%TOC) and nitrogen (%TON), C/N values
3) surface sediment chlorophyll content (mg/m^2)
4) sediment community oxygen consumption (mmol $O_2/m^2/d$)
5) water column nutrient data
6) integrated chlorophyll a data

Okkonen has produced an updated version (v2) of the CTD summary data file and uploaded it to the PacMARS Data Archive. Representative characteristics of 12000+ CTD casts from BASIS, COMIDA, UAF-Institute of Marine Science, JODC, Mirai, NODC/WOD, RUSALCA, SBI, Shell, SNACS/BOWFEST, and HLY1104 project/data archives are included in this most recent version of the summary data file. Figure 3 provides a spatial distribution and density of these data within 0.2 degree longitude x 0.1 degree latitude (~8 km x 11 km) grid cells. Additional data from post-2000 years are still being collected and will be incorporated in a version 3 update.

In the compilation of epifaunal invertebrate data Bluhm documents some interesting temporal and spatial trends in sampling coverage which have implications for potential future analyses of any temporal trends. The Beaufort Sea was trawled twice in the 1970s and then again a few times since 2008 with some spatial overlap. The Chukchi Sea was trawled in all decades from the 1970 to present, but spatial overlap is limited to parts of the US southern and northeastern Chukchi. To our knowledge, the northern Bering Sea has only been trawled during two projects that were both conducted after 2005. Trawl and mesh sizes differs substantially between studies which complicates synthetic analysis. Photographic surveys were sporadic in time and space and not standardized.
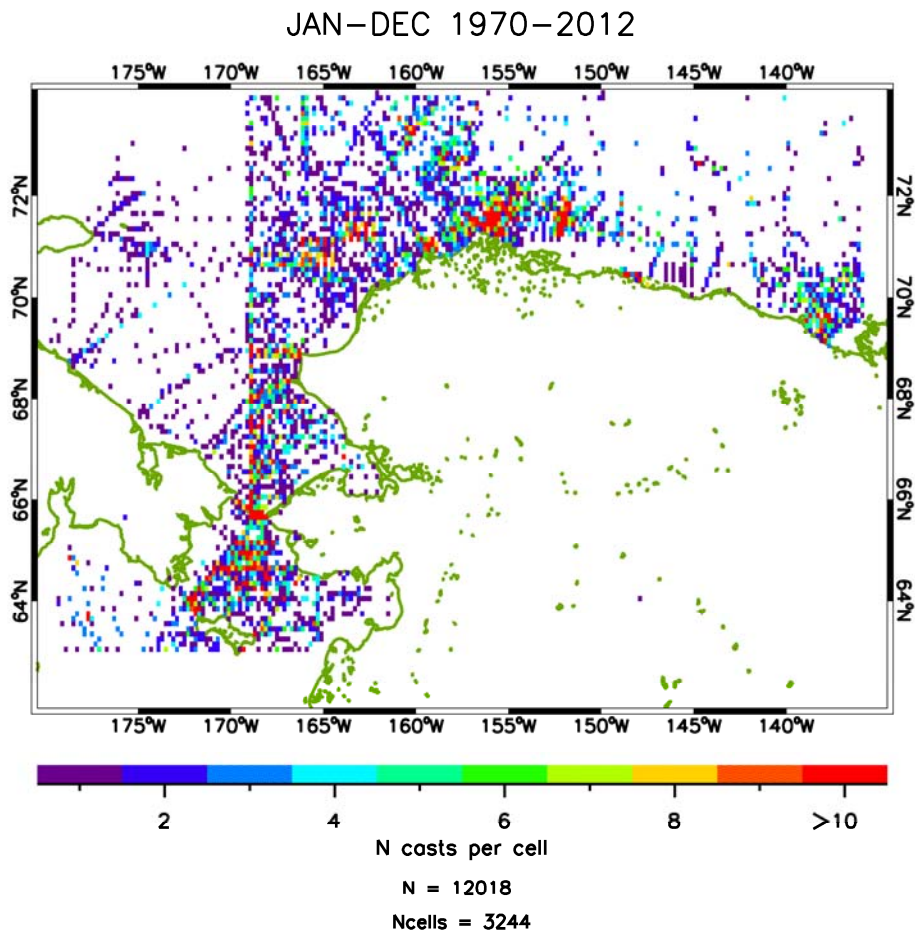
Figure 3. Distribution and density of 12000+ CTD casts from BASIS, Comida, UAF-Institute of Marine Science, JODC, Mirai, NODC/WOD, Rusalca, SBI, Shell, SNACS/BOWFEST, and Hly1104data within 0.2 degree longitude x 0.1 degree latitude (~8 km x 11 km) grid cells.

5. *Describe any concerns you may have about your project's progress*

   a) The principal investigators continue to be concerned that the scope of work and performance period is ambitious, but have recognized this constraint since beginning to prepare the proposal. We are trying to work within the funded requirements of the project and time frame, including the amount of effort that is actually budgeted, while continuing to make progress on other independently funded projects. At the data meeting we developed a time line that has the end of February 2013 as the date for submission of individual natural science cruise data or links in order to allow the PIs to prepare, analyze and describe results for the June interim report, although additions to already prepared products can be undertaken through early spring. We note elsewhere in this report that submission of data sets are continuing now and we will continue to accept data into the EOL data archive as time permits but these data may not make a significant contribution to the interim report. In addition, we recognize that the social science/hub meeting results will come into the EOL site through April. We will utilize those data in the interim report (see summary of December 2012 data meeting for further information).

b) The synthetic epifauna file is still being worked on as Bluhm has found more data sets that need to be integrated (see description of progress under status of lower trophics above). Several small data sets are being prepared for archiving at EOL as this report is written. These stem from projects that either had not specific archiving requirements or repositories or are rescued historic data from paper-only sources.

c) Notably some data are currently in ongoing student theses, although the core data sets may already be released for public use (e.g., OCEAP, industry data). Since the synthetic composite files may contain some of these data, we will password protect the underlying data associated with the produced figures until the end of the PacMARS project (June 2014). However, the publically-available metafile on the PacMARS data site for these synthesis products will list the available location of the individual data sets. This compromise was agreed to at the data meeting in order to let the students and other recently collected data sets by national and international collaborators be included in the composite maps for the PacMARS project, yet allow the authors of these synthetic products to publish the composite data in year 2 of the PacMARS project.

d) Our social science subprogram does not include any human subject research. Only publically available data and/or comments from the community meetings, without attribution, will be available for this synthesis effort. We are concerned that differences in the protocols guiding the use of human subjects data vs. most other data, create differences in social and natural science perspectives on intellectual property rights. These differences in the awareness of the community perspectives surrounding the sharing and use of human subjects data, are sensitive issues that require continuous attention of all PIs as we assemble the synthesis resources.

6. *Describe integration activity*
Both the open PacMARS-SOAR workshop in Anchorage, Alaska and the data meeting in Boulder, Colorado, encompassing both PacMARS PIs, collaborators, and invited participants, provided an illustration of the rich data sets coming into the PacMARS effort as well as others. Even the initial PI meeting in Annapolis was helpful for encouraging integration activities that have accelerate over the subsequent reporting periods. Each PI presented examples of data sets that they have begun to work with and much of the ensuing discussion concerned ways that individual PIs could collaborate with each other to produce a synergistic result.

7. *List poster and oral presentations at scientific conferences or seminars*

Jim Moore and **Don Stott** attended the PacMARS-SOAR workshop preceding the AMSS meeting in Anchorage on January 20th, where they participated in discussions on arctic data sources, their archiving and accessibility. Updates from PIs were noted from the data management perspective as these related to the synthesis efforts of both PacMARS and SOAR. Long term stewardship of the data being utilized for the syntheses, and access to the data was a point of discussion, with agreement that the PacMARS Data Archive/ACADIS will provide such stewardship for the data submitted to it. Also, links from the data to intermediate steps in the process of synthesis was discussed--not just the beginning or end point for the data--with agreement that this would be a valuable addition to the archive, if time and funds are available.

EOL presented a poster at AMSS titled "The Pacific Marine Arctic Regional Synthesis (PacMARS) Data Management and Visualization Strategy". On poster nights at the conference it proved quite valuable for sparking conversations related to PacMARS and the data being utilized in the synthesis efforts.

Jacke Grebmeier presented a PacMARS team poster at the AMSS in Anchorage, AK entitled: "The Pacific Marine Arctic Regional Synthesis (PacMARS)" in January 2013 as well as at the Gordon Research Conference in March 2013 in Ventura, California.

Bodil Bluhm gave an oral PacMARS overview presentation at a meeting of the North Slope Science Initiative on 19 February 2013 in Fairbanks, Alaska.

Sveta Yamin-Pasternak participated in the PacMARS hub and community meetings in Nome, Kotzebue, Barrow, Gambell and Savoonga; participated in the PacMARS SOAR Open science workshop and contributed a presentation "Who Eats Whom and by How Much' Is Important but Not Enough: Why It Is Critical for the Arctic Research Synthesis Efforts to Consider the Social Impacts of Climate Change."

8. Communication and coordination
We are coordinating with the SOAR project that is NOAA-BOEM supported. PIs Jacqueline Grebmeier and Carin Ashjian serve on the SOAR steering committee, and Sue Moore, a SOAR PI, is the lead liaison in our cooperative efforts and attended the Annapolis PI meeting. Yamin-Pasternak has addressed questions from Kawerak on how the ethnographic data will be used and how the region communities will benefit from the PacMARS effort.

Grebmeier and Bluhm will co-lead a one-day SOAR benthic hotspot workshop March 25, 2013, an example of a cross-fertilization effort with PacMARS.

4. PROGRESS STATUS

We think the project is proceeding according to our expectations. Again, as expressed elsewhere, the pace and ambition of the work effort may require some adjustment of practical goals and approaches as we continue our work. Almost without exception, and based upon time budgeted by each PI in the original proposal, everyone involved in the project is expending extensive and extraordinary efforts with the goal of producing a significantly useful synthesis of available knowledge. The local community meetings, while extraordinarily valuable in communicating the project goals and obtaining community input, are examples of the time-consuming requirements for this project to succeed. We are pleased that through the combined efforts of a number of project team members, these meetings were successfully held on a cost-effective basis and within travel budget constraints. We are also cognizant of the challenges associated with integrating social science insights into the overall project synthesis and we will be continuing to focus attention on the need to produce an integrated synthesis that addresses local stakeholder needs, as well as those of agencies, and the scientific community.

5. EXPECTED WORKPLAN FOR NEXT REPORTING PERIOD

- A meeting report is being finalized from the Boulder data meeting summarizing the individual presentations, including goals and approaches to be used over the coming months (Lead Responsibility: Grebmeier, Cooper and E. Bailey). Currently we have uploaded all the presentations to the PacMARS website, along with the minutes from the workshop (http://pacmars.cbl.umces.edu/PacMARSDataMeetingMaterials.html).
- A meeting report is being finalized from the PacMARS-SOAR workshop (AMSS 2013). This report will include summaries of the break-out sessions. The meeting report and presentations will be available on the CBL PacMARS website. Currently we are receiving updated web-ready versions of presentations and producing summaries based on notes and audio files of the workshop.
- Although individual data sets were transferred to the EOL data archive by March 1, we are continuing to supplement the archives with additional data as quality assurance is completed. (Responsibility: All PIs, as stipulated by theme; see below).

- Jackie Grebmeier is going to provide presentations on PacMARS at the Wakefield Symposium in March 2013 in Anchorage (http://seagrant.uaf.edu/conferences/2013/wakefield-arctic-ecosystems/index.php) and in Krakow Poland in April at the Arctic Science Summit Week meeting (http://www.assw2013.us.edu.pl/).
- We were asked by the NPRB to provide an outline of the final report, with a plan to incrementally flesh out details. The first version of this outline was provided to the NPRB in January 2013 and it was discussed by the advisory committee in their scheduled teleconference on January 14, 2013. We will continue to provide copies of the report as it is developed upon request.
- Continue progress on interim synthesis report, using data provided to EOL and other sources.

Other Action Items by Theme:

Ice Cover (primary production relationships, currents, winds, bathymetry)
Action Item: Continue identifying appropriate data sets (Table 1 on PacMARS website) and needs through winter and spring 2013 for the interim report (Key responsibilities: Okkonen, Ashjian, Cooper, Dunton, (Collaborators from data workshop); draft more finalized visual products for the interim report.

Phenology of Biological Production Cycles in Relation to Physical Environment
Action Item: Continue to identify appropriate data sets and data needs; begin to develop visual products and text for the final interim report: Ashjian, Campbell, Okkonen; collaborators from data meeting)

Benthic-Pelagic Coupling in Relation to Physical-Chemical Environment
Action Item: Identifying appropriate data sets (Table 1 on PacMARS website) and needs; Updating and incorporating data for CCGS Sir Wilfrid Laurier annual trips 1998-2012 with Canadian partners; summarizing data analysis and synthesizing products for the final interim report.
Key responsibilities: Grebmeier, Cooper, Dunton, Trefry, Okkonen, Ashjian, Campbell, Bluhm

Current State of Lower Trophic Prey-Base and Higher Trophic Feeding Hot Spots
Action Item: Continuing to identify and update appropriate data sets (Table 1 on PacMARS website) and needs; Wilfrid Laurier annual trips 1998-2012 with Canadian partners); development of synthesized tables and figures to use with text in the final interim report
Key responsibilities: Ashjian, Bluhm, Campbell, Cooper, Dunton, Grebmeier, Okkonen,
Collaborators:
   a. via PacMARS letters in proposal: Chad Jay (walrus), Kathy Kuletz (seabirds), Sue Moore (whales and SOAR leadership), Robert Pickart (physical oceanography), Karen Frey
   b. subaward: Molly McCammon (AOSS), with subaward to Rob Bochenek (AXIOM)
   c. small personal support contracts: Arny Blanchard (benthos), John Nelson* (zooplankton), Brenda Norcross (fish), others

Epifaunal data sets are largely finalized, so visual products and text to be incorporated into the interim final report will be key focus areas. Suitable epifaunal and infaunal data sets will be selected to work on the productivity-biodiversity relationships objective.

Subsistence Livelihoods in Times of Climate Change
Action Items: Editing and integration of existing text and findings for the interim final report, coupled to identification of appropriate data sets using the Alaska and Polar Research Collection at UAF Rasmuson Library, Data Resources of the Alaska Center for Climate Assessment and Policy, IPY recommendations, the Subsistence and Climate Change Sections of the North Slope Borough Division of Wildlife Management, the BLM Arctic Field Office subsistence bibliography, among others; Continue to note the stipulations on the sharing and use of data in connection with each dataset considered for the Synthesis,

Continue to address individual questions of the indigenous organizations and agencies about PacMARS, wanting to know about "What kind of engagement will PacMARS have, if any, with indigenous communities? How will the project results benefit regional communities? What will be the products of the PacMARS project? How will ethnographic data be presented? (Lead Responsibility: Yamin-Pasternak). Agendas for each of these hub meetings were developed by Grebmeier. (Lead Responsibility: Sheffield, Yamin-Pasternak, Grebmeier, Cooper, Ashjian, Campbell).

Chemical Contaminants in Sediment and Biota
Action Items: Identifying appropriate data sets (Table 1 on PacMARS website) and needs, preparation of appropriate graphics and maps to be coupled with text in the final interim report. Key responsibilities: Trefry, Sheffield, Cooper

Higher Level Synthesis by Carmack and Ulanowicz
Both senior advisors Carmack and Ulanowicz attended the AMSS meeting and the joint PacMARS-SOAR workshop. They continued to be enthusiastic about the project and hope to collaborate on a creative synthetic book chapter or manuscript involving network and ecosystem understanding that will be derived from some of the other data to be synthesized during the project. They have provided a high-level summary based upon their attendance at the meetings in Annapolis and Anchorage (see Appendix A).

6. OTHER RELEVANT INFORMATION