

Annual Report for Period:05/2001 - 05/2002

Submitted on: 06/13/2002

Principal Investigator: Smith, Raymond C.

Award ID: 9632763

Organization: U of Cal Santa Barbara

Title:

Long-Term Ecological Research on the Antarctic Marine Ecosystem: An Ice-Dominated Environment

Project Participants

Senior Personnel

Name: Smith, Raymond

Worked for more than 160 Hours: Yes

Contribution to Project:

Lead PI for PAL, PI for Optics, Remote Sensing & SeaIce component

Name: Ross, Robin

Worked for more than 160 Hours: Yes

Contribution to Project:

Prey

Name: Quetin, Langdon

Worked for more than 160 Hours: Yes

Contribution to Project:

Prey

Name: Christensen, My

Worked for more than 160 Hours: Yes

Contribution to Project:

Post-doc

Name: Karner, Markus

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Dierssen, Heidi

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Gasc, Ann

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Karasti, Helena

Worked for more than 160 Hours: Yes

Contribution to Project:

Graduate Student

Name: Carrillo, Christopher

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Patterson, Karen
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: White, Stephanie
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Bjorkman, Karin
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Colee, Michael
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Cassar, Nicolas
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Garibotti, Irene
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Hamm, David
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Oakes, Stephanie
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Thomson-Bulldis, Angie
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Chiuchiolo, Amy
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Daniels, Robert
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Walker, Shelby
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Becker, Elizabeth
Worked for more than 160 Hours: Yes

Contribution to Project:**Undergraduate Student****Name:** King, Andrew**Worked for more than 160 Hours:** Yes**Contribution to Project:****Name:** Mardien, Brent**Worked for more than 160 Hours:** Yes**Contribution to Project:****Name:** Poehls, Diane**Worked for more than 160 Hours:** Yes**Contribution to Project:****Name:** Caldwell, Michael**Worked for more than 160 Hours:** Yes**Contribution to Project:**

Volunteer

Technician, Programmer**Name:** Batie, Ronald**Worked for more than 160 Hours:** Yes**Contribution to Project:****Name:** Grimm, Kimberly**Worked for more than 160 Hours:** Yes**Contribution to Project:****Name:** Houlihan, Terrance**Worked for more than 160 Hours:** Yes**Contribution to Project:****Name:** Jones, Janice**Worked for more than 160 Hours:** Yes**Contribution to Project:****Name:** Kneebone, Jared**Worked for more than 160 Hours:** Yes**Contribution to Project:****Name:** Kozlowski, Wendy**Worked for more than 160 Hours:** Yes**Contribution to Project:****Name:** Martin, Daniel**Worked for more than 160 Hours:** Yes**Contribution to Project:**

Name: Menzies, David
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Pohlman, Eric
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Shaw, Caroline
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Stammerjohn, Sharon
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Tupas, Luis
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Weinbaum, Karen
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: White, Jennifer
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Burke, Laurie
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Duffy, Meghan
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Duley, Peter
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Glass, Jill
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Hebel, Dale
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Iannuzzi, Rich

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Kerr, Sara

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Milner, John

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Newberger, Tim

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Rosenshield, Michele

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Sadler, Dan

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Sines, Karie

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Vigilante, Veronica

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Zierbel, Marnie

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Velez, Edgar

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Boch, Charlie

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Feber, Lisa

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Morris, Paul

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Vanderlugt, Kyle
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Wu, Kevin
Worked for more than 160 Hours: Yes
Contribution to Project:

Other Participant

Name: Fraser, William
Worked for more than 160 Hours: Yes
Contribution to Project:
 Seabirds

Name: Hofmann, Eileen
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Klinck, John
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Karl, David
Worked for more than 160 Hours: Yes
Contribution to Project:
 Microbial Processes

Name: Vernet, Maria
Worked for more than 160 Hours: Yes
Contribution to Project:
 Phytoplankton

Name: Martinson, Douglas
Worked for more than 160 Hours: Yes
Contribution to Project:
 Modeling/Physical Oceanography

Name: Baker, Karen
Worked for more than 160 Hours: Yes
Contribution to Project:
 Website, Data Manager

Name: Johnson, Charleen
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Woehler, Eric
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Patterson, Donna

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Coe, Laurel

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Kozlowski, Robert

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Smith, Justin

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Fujieki, Lance

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Ireson, Kirk

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Ferrario, Martha

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Smith, Dominique

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Wallace, Mary Ann (Mimi)

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Altieri, Andrew

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Bradshaw, Brian

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Flaherty, James

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Holmes, Christopher

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Sadler, Mary Jane
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Scott, Matthew
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Ukita, Jinro
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Ducklow, Hugh
Worked for more than 160 Hours: Yes
Contribution to Project:
 Microbial & Network Analysis

Name: Brum, Jenn
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Chapman, Eric
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Church, Matt
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Denker, Christopher
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Pelletreau, Karen
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Searson, Sara
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Thimgan, Michael
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Rodriques, Holly
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Rodriguez, Silvia

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Fredin, Brian

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Geisz, Heidi

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Hover, Daniel

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Martin, Dan

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Irinaga, Matt

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Macri, Erin

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Watson, Jordan

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Swanson, Bill

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Pickering, Brett

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Cheng, Brian

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Couture, Sam

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Kushner, David

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Cheng, Brian

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Coronesi, Stephanie

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Christensen, My

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Curchitser, Enrique

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Massom, Robert

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Kawano, Yuko

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Yeh, Pamela Jean

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Hooper, Meredith

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Cowles, Susan

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Brox, Timothy

Worked for more than 160 Hours: Yes

Contribution to Project:

Research Experience for Undergraduates

Name: Johnston, Karina

Worked for more than 160 Hours: Yes

Contribution to Project:

Years of schooling completed: Freshman

Home Institution: Other than Research Site

Home Institution if Other: UCSB

Home Institution Highest Degree Granted(in fields supported by NSF): Doctoral Degree

Fiscal year(s) REU Participant supported: 2002

REU Funding: REU supplement

Name: Kaiser, Amy

Worked for more than 160 Hours: Yes

Contribution to Project:

Organizational Partners

National Space and Aeronautics Administr

Division of Environmental Biology

Long-Term Ecological Research Program

Antarctic Marine Living Resources

Convention for the Conservation of Antar

Joint Global Ocean Flux Meetings

Teachers Experiencing Antarctica or Arti

Hawaii Ocean Time-Series

British Antarctic Survey

Scientific Committee on Antarctic Resear

Scientific Committee on Oceanic Research (SCOR)

Smithsonian Institution, National Museum

USGS Center for Coastal Geology & Regional Studies

San Diego Supercomputer Center

Raytheon Polar Service Company

NOAA Office of Oceanic & Atmospheric Research

University of Oslo

University of La Plata

Partnership Observation-Global Oceans

POGO - Partnership for Observation of the Global Oceans

URL Site:

College of William and Mary

Location of Co-PI - Hugh Ducklow

ICESS, UCSB**Marine Research Division, SIO, UCSD****Argentinian Natl.Council,Sci.&Tech.Res.****IAA Argentinian Antarctic Institute****Other Collaborators or Contacts**

David Ainley(H.T. Harvey & Assoc.)-seabird ecology
 Penny Allen (British Broadcasting) - krill filming at Palmer
 Geoffrey Bowker, Communications Dept., UCSD
 Kim Baldridge, San Diego Supercomputer Center, UCSD
 David Blankman, LTER Network Office
 James Brunt, LTER Network Office
 Andrew Clarke (BAS) - carotenoids in krill; Palmer Steering Comm.
 Enrique Curchister, LDEO, Palisades, NY
 Douglas DeMaster (NMML) - fisheries; Palmer Steering Comm.
 Mark Drinkwater (JPL) - sea ice dynamics
 Eugene Domack (Hamilton College) - sedimentology, paleoecology
 Steve Emslie (U North Carolina) - seabird archeology, paleoecology
 Martha Ferrario, University of La Plata, Phytoplankton taxonomy
 Gustavo Ferreyra, Argentinian Antarctic Institute, UVR effects on phytoplankton
 Tom Fisher (HPEL) - ecology, nutrients; Palmer Steering Comm.
 Thomas K. Frazer (University of Florida) - Krill Energetics
 Chris Fritsen, Desert Research Institute (DRI), Reno, NV
 Anna Gold, UCSD Library, UCSD
 Bruce Hayden (U Of Virginia - climatology & climate change, ecology, coastal geomorphology; Palmer Steering Comm.
 John Hobbie (MBL) - microbial processes; Palmer Steering Comm.
 George Hunt (UCI) - seabird ecology; Palmer Steering Comm.
 Eileen Hofman (ODU) - phy/biol models
 James Kennett (UCSB) - marine paleoceanography, paleoecology
 Amy Leventer (Colgate U) - paleobiology, paleoecology
 Xiang Liu (JPL) - sea ice dynamics
 Jiping Liu (NASA GISS) - GCM modeling
 Helena Karasti, Communications, Dept., UCSD
 Rob Massom, Antarctic Cooperative Research Center, Hobart, Tasmania, Australia
 Steve Nicol (Australian Dvision of Antarctic Science) - Southern Ocean zooplankton and krill population dynamics
 Ellen Mosley-Thompson (Ohio State U) - ice core records, paleoecology
 Scott Pegau (Oregon State U) - ocean optical properties
 Don Perovich, CRREL, Hanover, NH
 Jim Reichman (NCEAS,UCSB) - mammals, ecology; Palmer Steering Comm.
 Volker Siegel, Seafisheries Research Institute, Palmaille 9, 22767 Hamburg, Germany.
 Christine Ribic (U of Wisconsin) - sea birds
 David Rind (NASA GISS) - GCM modeling
 Jinro Ukita, NASA-Goddard Space Flight Center
 Mike Vildibill, San Diego Supercomputer Center, UCSD
 Bob Whritner- (AARC/SIO) satellite imagery
 Xiaojun Yuan (LDEO) - regional & global modeling

Activities and Findings

Research and Education Activities:

The Palmer LTER sampling strategy combines seasonal time series data from the near shore Palmer stations and seabird observations from nesting sites near Palmer Station with annual cruises covering a regional grid along the western Antarctic Peninsula (WAP). During USAP0102 the Palmer LTER completed an eleventh season at Palmer Station (with field sampling from mid-November to late March) as well as the tenth mesoscale summer time series research cruise (jan02). In addition, as a key component of our 6-year (1996-02) research plan, we completed a late winter sea ice cruise (sep01). The latter, was conducted in collaboration with the Southern Ocean GLOBEC research project. A key objective of this sampling is long-term, integrated studies on ecological processes of the marine ecology of the Southern Ocean. During this period each component assisted in meeting the data policy requirement (data online via the Palmer LTER web page) and continued to build our long-term data legacy.

Winter ice cruise Sep01 (NBP01-05, 7 September - 21 October, 2001)

The Sept01 cruise Winter Sea Ice cruise (R. Smith, Chief Scientist) was a sea ice process cruise during winter/spring to investigate & understand sea ice retreat processes & the relationship of these processes to the biota during this sea ice retreat period. Observations at the ice edge & in the ice were designed to address short-term mechanistic processes & hypothesis linking sea ice, micro algae, krill, penguin & export processes. We also studied processes associated with the deposition of persistent organic pollutants (POP) in Antarctic food webs (Ducklow). Investigations during NBP01-05 included: (1) Revisiting the stations where sea ice buoys were deployed during the winter (SOGLOBEC) cruises and to investigate the sea ice and snow characteristics at the sea ice buoy locations and how these characteristics have evolved over time and recovering the sea ice buoys when work at these time series stations have been completed. We were unable to recover the buoys because of unusually heavy sea ice and loss of time because the NBP became beset in this heavy ice for over a week. (2) Continuing observations in collaboration with the SOGLOBEC research objectives begun during July/Aug including Martinson/Perovich/Smith snow/ice optics research, Ross/Quetin krill and Fraser sea bird research; (3) Making snow & sea ice observations consistent with, and complementary to, our June99 cruise as well as the immediately preceding SOGLOBEC cruise. (4) Studying the degree of coupling between krill and ice and the associated physical characteristics for sea ice. (5) Studying linkages between processes associated with krill, ice algae, nutrients, gases, bacteria & particle flux. (6) Testing hypotheses & mechanisms by which anthropogenic compounds are introduced into, and affect the relatively pristine Antarctic environment. (7) Quantification of the relative contribution of ice-related production compared with production driven by non-ice processes. (8) Obtaining diet samples from tagged and satellite tracked Adelie penguins (with comparison to net tow samples) and studying the relationship of the distribution of Adelies during the sea ice retreat period as they approach their first critical period for breeding. (10) Investigating relationships found during this sea ice retreat period with the various trophic components (ie microalgae, krill, penguin) of the ecosystem (see proposal, esp. Figs. 8,9, & 10).

Annual Palmer LTER Summer cruise Jan02 (LMG02-01 01Jan-01Feb, 2002)

Robin Ross was the Chief Scientist for the 10th annual summer cruise for the Palmer LTER. The goals of LMG02-01 were to: (1) conduct physical and biological sampling and experiments over a mesoscale grid between Anvers and Adelaide I with transect lines 100 km apart and stations along those transect lines 20 km apart, (2) retrieve and redeploy the sediment trap which is south west of Palmer Station about 60 km, (3) conduct a high density sampling of a 10 km by 20 km grid within the foraging range of the Adelie penguins nesting near Palmer Station, (4) continue to sample the seasonal stations near Palmer Station when the ship is in the area, and (5) continue our collaboration with the British Antarctic Survey and their seasonal time-series at Rothera at the southern end of our study region. All field components participated in this cruise which achieved all stated objectives.

The 2001/02 field season (Sep01-Mar02) at Palmer Station included research activities by BP-013 (Fraser), BP-028 (Quetin/Ross), BP-016 (Vernet), BP-032 (Smith) and BP-045 (Ducklow). Researchers from four groups (Fraser, Smith, Ross/Quetin, & Vernet) arrived at Palmer on October 2001. Brash ice prohibited island and water column station visits and core sampling until the first weeks in November. Core sampling included arrival dates and population counts of Adelies as well as physical, optical and biological observations at stations B & E. The LMG02-01 cruise occupied Jan (01Jan-01Feb) early February while the Palmer field season was completed in March.

Individual component research & educational activities were as follows:

Data Management (Karen Baker)

Information management has continued to support data storage and access as well as information flow. There is an emphasis on receipt and storage of data and metadata as well as through facilitation of communications via document coordination and web page work centers. Field data receipt and organization is ongoing along with overview of annual weather and biomass data collection, analysis and storage. There are ongoing efforts with data quality control and quality assurance as well as initiation of metadata transition activity.

A web page redesign was initiated and implementation and testing begun. In support of the web page, investigations into databases including

sqlserver and mysql resulted in a data design to be based on a linux server to augment the project's infrastructure for database work using open software apache, php and MySQL. This work was carried out in collaboration with the Institute for Computational Earth System Science computer systems group in order to insure long-term sustainability and requisite security. Initial database activities include implementation of a glossary with a public web interface and a classification system, a photo gallery making photographs and videos available online and a metadata software project.

Activities aimed at understanding and implementing a transition of metadata and data to interoperable schema using XML have been initiated. Participation in two LTER Ecological Metadata Language workshops (Feb and June 2002) coordinated with activities within the LTER network.

Developing strategies to provide additional IM support has been a high priority requiring establishment of collaborations with new communities. Four recently funded efforts are underway with existing partners (LTER Network Office), developing partners (San Diego Supercomputer Center; the UCSD Library) and new partners (UCSD Communications Department).

Optics, Remote Sensing and Sea Ice (Smith BP-032)

R.C. Smith was chief scientist on the Palmer LTER Sea Ice Cruise - 7 September - 21 October, 2001. The research objectives of NBP01-05 were to investigate and understand sea ice retreat processes and the relationship of these processes to the biota during the sea ice retreat period and to coordinate with the sea ice and optics components of the earlier SOGLOBEC cruises. Observations at the ice edge and in the ice were carried out to address short-term mechanistic processes and to test hypotheses linking sea ice, micro algae, krill, penguin and export processes. Participants on the cruise (Ducklow & Dickhut) also investigated processes associated with the deposition of persistent organic pollutants (POP) in Antarctic food webs. Education activities during this cruise included daily information sent back to Palmer LTER web site for class room activity by Rich Iannuzzi via Karen Baker our Information Manager. Field work was also carried out at Palmer Station (Kirk Ireson) in collaboration with Maria Vernet's phytoplankton group.

Research activities also included work on an LTER Network synthesis volume to be published by Oxford University Press (Greenland, Goodin & Smith). This cross-site synthesis volume, 'Climate Variability and Ecological Response at Long-Term Ecological Research (LTER) Sites', began in the Fall 1997 LTER Coordinating Committee meeting, hosted by the Palmer LTER in Santa Barbara, with the science theme 'Climate variability and ecological response'. Subsequently, three workshops dealing with this overall theme were held at the 2000 All Scientists LTER Meeting lead by Greenland, Goodin and Smith.

Microbial (Karl BP-046)

Major research activities have been field collections and measurements of microbial population structure and metabolic activity including the enumeration of planktonic archaea, measurements of ectoenzymatic activities and measurements of water column microbial respiration and biomass production. Continuous shipboard measurements of the partial pressure of carbon dioxide and the near surface water saturation states of carbon dioxide and oxygen provide data on the net autotrophic-heterotrophic balance of the coastal Antarctica ecosystems. Finally, continuous measurements of the downward flux of particulate organic matter provides a record of the occurrence and intensity of spring and fall season blooms of phototrophs and of winter season production. These field activities collectively define the carbon cycle processes in the LTER region.

Microbial & Network Analysis (Ducklow BP-045)

Ducklow joined PAL-LTER as a new PI in CY 2001, under a subcontract from UCSB, to begin work on constructing network models of the PAL plankton ecosystem. This work is being performed by his student Bob Daniels as part of his MSc thesis. Daniels is in the process of presenting and defending his thesis prospectus, and beginning to assemble data from the PAL data system for input to an inverse model which will recover a foodweb structure for a pre-configured model, and a model custom-designed for PAL.

Ducklow also worked in conjunction with PAL investigators as part of his OPP-funded project on persistent organic pollutants (OPP 0087872). Sampling was accomplished on the PAL-LTER Ice Cruise (NBP 01-05) in September-October, 2001; and at Palmer Station in January-March 2002. We used these opportunities to initiate sampling for bacterial biomass and activity, to expand on ongoing research by PAL-PI D. Karl, and to work out protocols and gather preliminary data for our future work on this topic in the PAL-LTER (commencing in 2002-03). Two grad students, Amy Chiuchiolo and Shelby Walker, worked on this project with Ducklow.

Physical Oceanography (Martinson BP-021)

Martinson has focused on performing a comprehensive cross-grid analysis of the LTER physical system (in terms of its spatial and temporal structure, covariability and relevant characteristics). This work is now well advanced, having established a grid structure for the LTER PAL domain, refining the analysis methodology for analyzing the variables within the grid, and writing the first draft of the paper to present the methodology and results. Thousands of graphs have been generated, and the results are now being consolidated to a manageable number of relevant results.

In addition this component has provided shipboard personnel for the Winter 2001 and Summer 2002 cruise (for CTD and hydrography work). The CTD and related upper ocean physics sampling data have been processed and submitted to the LTER public data base (data and metadata). Some of the older data collected prior to our participation in the LTER program were also re-processed (to conform with our standard data format) and uploaded to the LTER data base. In particular, the 1998 and 1999 summer data were re-processed, and submitted. Only the most

recent data have not been submitted, though we have been performing the post-cruise processing and expect to upload the data shortly.

Phytoplankton (Vernet BP-016)

The phytoplankton (BP-016) and bio-optics (BP-032) groups carried out bi-weekly sampling via Zodiac Mark V within the 2-mile boating limit (Stations B & E) from November 2001 to the end of March 2002. At the beginning of the season (October/November) we conducted several days of ice sampling in Arthur Harbor as well. In addition, we participated in the January 2002 cruise to the continental shelf and the ice cruise in September/October 2001. The phytoplankton group (BP-016) sampled core variables (daily primary production, particulate carbon and nitrogen, nutrients, and photosynthetic pigments), profiles of the upper 100-m water column with a Fast Track Rate Repetition Fluorometer for phytoplankton physiological studies of environmental forcing (i.e. photo-inhibition, nutrient limitation) and experiments on the effect of ultraviolet radiation on daily primary production and phytoplankton composition. Nutrient determinations were done on board, following the updated auto-analyzer set up from Oregon State University (5 analyses). Data analyses during this period was intense. We are pursuing 5 lines of research: (1) A study of the contribution of different taxonomic groups to primary production and biomass. (2) An investigation of phytoplankton dynamics during periods of ice formation and ablation. (3) A study of carbon cycling through the coastal Antarctic food chain. (4) A study of the major drivers to inter-annual variability in primary production and its relationship to climate variability. (5) A study of krill-phytoplankton interactions. During this period we finished three projects: (1) An evaluation of the use of photosynthetic pigments as taxonomic markers by microscopic analysis. (2) The relationship of temporal and spatial variability in primary production to environmental parameters. (3) Determination of the main phytoplankton communities within the study area. This work is being done in collaboration with all PAL PI's. In particular, there are 2 synthesis efforts: (1) A statistical analysis of physical, chemical and biological parameters through EOF and CCA analyses, and (2) the estimation of carbon cycling through the food chain.

Krill (Ross & Quetin BP-028)

Scientific meetings attended: VII SCAR Biology Symposium in September 2001, Amsterdam. (Haberman, presenter) Haberman, Karen L., (Western Oregon University, Monmouth, OR 97361), Ross, Robin M. and Quetin, Langdon B., Marine Science Institute, University of California, Santa Barbara, Santa Barbara, CA 93106 Title: Grazing by the Antarctic krill, *Euphausia superba*, with a focus on *Phaeocystis antarctica* as a food resource.

Krill component specific efforts during 2001/02 included: (1) LTER -ice cruise in Sept/Oct. Our research team focused on interactions between larval krill and the under ice habitat. SCUBA divers collected krill for growth and feeding experiments. A graduate student conducted experiments on selective grazing in Antarctic krill. (2) Palmer 0102 season - Prior to the arrival of the 2nd diver, our 1-person research team in conjunction with other LTER personnel undertook to 'sample' krill by drilling holes in the ice near Palmer Station. This successful effort also documented that the larval krill were in the most complex areas with overrafting. During the austral spring, divers collected krill from under the ice for growth experiments and later analysis for condition. Once there was enough open water, twice weekly we ran two acoustic transects, one on the outside of the islands surrounding Arthur Harbor, and one from Arthur Harbor to the 200 m bathymetric contour. These activities ceased during January and the annual cruise, but began again in late January and continued until the middle of March. If euphausiids were seen on the bioacoustics, they were collected with a net and used in growth experiments. (3) On the summer cruise, the zooplankton team did two net tows with simultaneous acoustic transects at each station along the standard lines. We also did acoustic transects for two fine-scale grids, one of 10 x 20 km in the same place as previous surveys during the time series, and one 5 x 10 km located where gps packs on the Adelie penguins indicated the birds were foraging. Growth experiments were conducted with krill collected from the inner and outer shelf stations on all 5 lines, and spawning frequency and egg production experiments conducted on the outer shelf stations on all 5 lines.

Sea Bird (Fraser BP-013)

Apart from the general objectives outlined in previous reports, PAL-LTER Seabird Component efforts this season focused especially on continuing: (1) the year-round sampling of Adelie penguin diets in the Palmer Station and Marguerite Bay regions that began with the October 2000 season, and (2) the expanded sampling of Adelie penguin reproductive parameters and chick fledging weights that began with the October 1997 season. To meet these objectives, personnel movements and activities were closely coordinated with the austral 2001 autumn and winter GLOBEC program cruises (Fraser and Denker were participants), the PAL-LTER Ice Cruise (NBP 01-05) in September 2001 and the Palmer Station October-March field season, which included the January PAL-LTER cruise (LMG 02-01). Although no students were members of the field team this season, the field program continued to attract recent graduates interested in field experience and pursuing advanced degrees (see Training and Development below).

Findings:

Information management (Baker) findings from these activities include: (1) The use of new technological approaches anchored in technology are best approached with caution and in partnership with the computational infrastructure in order to maintain sustainability. (2) The creation of interoperable data through normalization of structures and adoption of XML is a long-term strategy but involves a commitment in terms of support and time to support the transition. (3) That there is tension in the balance of information management between providing maintenance of existing databases and services with the need for exploring, testing and implementing new technology and tasks. For example, a redesigned

web page which invites public browsing also creates the need for updated content and new delivery mechanisms.

Optics, remote sensing and sea ice (Smith) findings include the following. The annual advance and retreat of sea ice has been considered a major physical determinant of spatial and temporal changes in the structure of the Antarctic coastal marine ecosystem. Dierssen, Smith & Vernet (2002) show that the freshening and warming of the coastal surface water over the summer months is influenced not solely by sea ice melt, as suggested by earlier literature, but largely by the influx of glacial meltwater. Glacial meltwater plumes are shown to play a critical role in the functioning of the biota and the presence of this meltwater is likely to become more prevalent in these surface waters if the warming trend along the western Antarctic Peninsula (WAP) continues.

Smith and Stammerjohn (2001) extend earlier observations on the variations of surface air temperature and sea-ice extent in the WAP region to include the past decade. The ecological influence of these trends has already been demonstrated at all trophic levels. The most recent years have seen an increasing maritime influence in the WAP region, with corresponding effects on the marine ecosystem. These results have stimulated new PAL hypothesis associated with the concept of ecosystem migration along the western Antarctic Peninsula.

Smith and co-workers (2001) have summarized nearly a decade of work to describe the variability of primary production in the WAP marine ecosystem as estimated using a multi-scale sampling strategy. Even though this marine ecosystem displays extreme interannual variability in both phytoplankton biomass and primary production, persistent spatial patterns have been observed over the many years of study (e.g., an on to offshore gradient in biomass and a growing season characterized by episodic phytoplankton blooms). This high interannual variability at the base of the food chain influences organisms at all trophic levels.

Several chapters for an LTER synthesis volume have been accepted for publication (see publication list below). This volume, edited by David Greenland, Doug Goodin and Raymond Smith, examines the theme of how ecosystems respond to climate variability. A timely subject in light of the recent IPCC 2001 report on Climate Change, these authors have examined this theme for most of the LTER sites and across a variety of time scales. With increasing attention to possible ecological consequences of global climate change it is essential that we understand how climate varies and the potential for rapid ecological change in response. This synthesis volume addresses this and related questions.

Microbial (Karl)

Major scientific findings to date include the presence of significant seasonal and interannual variations in microbial rate processes in the LTER region that are primarily controlled by the extent and timing of the seasonal ice cover. The major pulses of exported particulate matter can vary nearly two months in time between late Nov and late Jan depending on whether there is ice in the region (ice delays the export event), and a majority of the entire seasonal export load occurs within less than a one month period shortly after the seasonal bloom. During the austral summer season, the water column is a net sink for carbon dioxide due to net biological production of organic matter. Archaea, prokaryotes not even known to occur in the marine environment one decade ago, are now recognized as a major group of microorganisms which tend to increase in relative proportion with increasing water depth. No pure cultures of the planktonic archaea have yet been obtained so it is not clear exactly how they fit into the microbial food webs of the southern ocean.

Physical Oceanography (Martinson)

A number of papers have been published or are in various stages of publication as a direct result of the LTER funding, or through complementary programs. These papers, their status and relationship to LTER are listed below. Submitted papers or those in press by Martinson can be viewed at the following web page: http://www.ldeo.columbia.edu/polar/Publications_Page.html

Phytoplankton (Vernet)

Phytoplankton: This component of the Palmer LTER is studying the spatial and temporal variability of primary production in the Western Antarctic Peninsula and physicochemical parameters that control production and the community structure related to the variability observed. The main findings during the study period are: (1) As originally hypothesized, interannual variability in primary production correlates with ice extent during summer and, to a lesser extent, with the ice during the previous winter. (2) Diatoms are involved in the highly productive periods, followed by cryptomonads and other small (< 5 microns in size) phytoflagellates. (3) Six communities are recurrent within the LTER grid study area, resembling several stages of phytoplankton succession observed at Palmer Station. (4) Different from previously reported for Antarctic waters, not only netplankton (cells > 20 microns) but small nanoplankton also show an onshore-offshore gradient with higher concentrations in the coast. Their growth and accumulation are favored by shallow mixed layers in inshore waters. (5) A comparison of methods revealed that the abundance of HPLC-quantified photosynthetic pigments are good indicators of biomass. (6) Different factors may be controlling phytoplankton community structure in the Northern and Southern part of the grid: krill grazing is prominent in the northern part and, due to selective grazing on diatoms, might be controlling their accumulation in the North. Conversely, diatoms are prominent in the southern part of the area where krill grazing is low. The rate of primary production at Palmer Station in this season was average, with an estimated annual production of 212.4 g C m⁻² year⁻¹ (integrated over 6 months) from a maximum of 354 g C m⁻² year⁻¹ measured in 1995-1996 and a minimum of 54.3 g C m⁻² year⁻¹ in 1998-1999. The grid had an above average daily production, with 817.2 mg C m⁻² d⁻¹, compared to the 10-year mean of 650 mg C m⁻² d⁻¹. These results suggest the coastal Antarctic system is undergoing a second production cycle that started in 1999-2000.

Krill (Ross & Quetin)

Major findings included: (1) During the September/October cruise, overrafting in annual sea ice of up to 65 feet was documented by divers, a

degree of overrafting never seen in previous cruises in winter west of the Antarctic Peninsula. In contrast to larval growth rates documented during several other cruises during this time frame, growth rates in larval krill were very low or negative. (2) During the January cruise, we observed some of the highest spawning activities in this region since 1996, coinciding with high levels of phytoplankton. In addition pictures of nemertean worms found for the first time in our nets have been forwarded to Dr. Frank Crandall at the Smithsonian Institution. He believes we may have discovered 2 or 3 new species. Preserved specimens will be sent to him once they arrive at UCSB.

Sea Bird (Fraser)

The activities resulted in a nearly continuous seasonal record of Adelie penguin diets within and between the Palmer Station and Marguerite Bay regions. Preliminary analyses of the data show that irrespective of season, diets in the former are dominated by krill and in the latter by fish. The activities also added significantly to a longer-term, large-scale record of Adelie penguin chick fledging weights. Preliminary analyses of these data have shown that fledging weight is breeding habitat-specific and quasi-independent of variability in the marine foraging environment.

Training and Development:

There is an in-house training of scientists, technical staff, graduate and undergraduate staff with respect to intradisciplinary ecosystem science as information science. Further, development of education and outreach materials supports a range of training situations from field volunteers to science classrooms. Smith was Committee Chair for a recent PhD (Heidi Dierssen, UCSB), provided data and collaborative interaction for Dave Karl's student (Chris Carrillo, U Hawaii), and is Chair for another PhD student (Elizabeth Becker). Ducklow provided experience for three graduate students (see names above). Chiuchiolo and Walker gained oceanographic cruise experience on NBP 01-05, Chiuchiolo lived and worked with the PAL group at Palmer Station for 3 months, and Daniels is gaining experience in data acquisition, analysis and modelling. Chiuchiolo and Daniels are working on PAL-related MSc theses. Karl's education activities have centered on undergraduate and graduate student training both in the field and his home based laboratories in Hawaii. Ross and Quetin currently have two graduate students. Stephanie Oakes a PhD student in Marine Science at UCSB whose funding has been part LTER and part SO GLOBEC. Stephanie White an MA student in EEMB (Evolution, Ecology and Marine Biology) at UCSB. She is working on hard bottom samples taken immediately after the Bahia Paraiso sinking. Ross and Quetin also have two REUs: (1) Amy Fisher who was on the LTER ice cruise. Amy's independent research project is analyzing a film clip of larval krill behavior under the ice. She has recorded swimming speeds, sinking rates, basket filtration rates and tail flips. (2) Karina Johnston who was on the 02Jan cruise. Karina's independent research project is calorimetry of two euphausiid species, and the comparison of caloric content of *E. superba* from the Ross Sea in Jan 2000 and the Palmer LTER area in Jan 2000. There is also one undergraduate researcher (non-REU) Michael Caldwell who was on the 02Jan cruise. He is currently investigating the relationships between the amphipod community and the dominant taxa for 4 cruises (1999, 2000, 2001, 2002) which include a strong and weak salp year and two krill years. Ongoing through summer. Fraser provided research and data management/analysis experience to two recent graduates interested in pursuing advanced degrees. Pickering is a recent graduate (MSc) of Western Colorado College and is contemplating a PhD. Geisz is a recent graduate (BS) of the University of Colorado and is contemplating an MSc.

Outreach Activities:

The Palmer LTER (PAL) education and outreach activities are diverse. A critical element in creating a sustainable program are our national and local education partnerships. In addition, the allure of the Antarctic ensures that the majority Palmer LTER (PAL) personnel participate in public outreach regularly whether through interface with classroom teachers and reporters or in cooperation with the NSF sponsored Artist and Writer Antarctic projects often focused on video and book production. PAL interfaces with university education through undergraduate and graduate seminars as well as with NSF/Research Experience for Undergraduate projects. Outreach products include an education outreach trunk in addition to digital and outreach material collections. Diversification with respect to products into multimedia and journaling is underway. Presentations are made regularly at community events such as ESA, NSTA, NPACI All-Hands, and the local universities.

A major focus of education and outreach this year has been on establishment of partnership with programs with active national infrastructures including LTER Education and Schoolyard Education (SLTER) programs, collaboration with the Digital Library for Earth System Education, with the San Diego Supercomputer Center (SDSC) and with the NSF/OPP Teacher programs and the Artists and Writers Program as well as the Boy Scouts of America and Girl Scouts of USA to sponsor teachers and students working with research teams in the Antarctic.

Since 1998 Palmer works with a teacher annually in partnership with the national Teacher's Experiencing the Arctic and Antarctica (TEA) program (NSF/OPP/HER). This program creates a multi-year learning framework focusing on inquiry based learning and Antarctic science. Participating teachers intern at a scientist's home institution and in the field as part of the research team. Internship at UCSD/SIO provides a focus on data and multimedia productions as well as interface with the Stephen Birch Aquarium. The Palmer LTER Education and Outreach liaison, Karen Baker, is a TEA Advisory Board Member (1999-ongoing).

Collaboration with University of California Outreach Programs is ongoing with participation planned this summer in the Academic Connections program. This program's goal is to expose high school students to the research experience through participation in university life.

Students live on campus and take courses taught by graduate students from departments across the university. Palmer LTER's experience with marine science, information management and network contributes to program development in cooperation with the teams of SIO graduate student instructors. Another partnership bridges the local and national arena. Collaboration is building with the San Diego county Girl Scout organization and the national Boy Scout program through events such as this year's internship and Antarctic field work of an Eagle Scout (www.scoutonice.org) and sponsorship of a SIO event 'New Age Knowledge in the Digital World' for Girl Scouts to learn about women in science.

Field journaling provided and enrichment of science-classroom outreach with journals serving both as a delivery mechanism for field science to classrooms and as a focus mechanism for educational dialogue via partnering of field participants (teachers, students, volunteers) with individual classrooms.

Ongoing challenges include scaling of local outreach efforts through identification of potential site education activities that can match education funding opportunities in order to provide salary for a Palmer LTER education/outreach coordinator to complement the initial seed program (non-salary) funds provided by NSF/DEB to LTER sites. The upcoming year's focus will be to develop interfaces with local education infrastructures upon which sustainable education programs can be built (dialogues with San Diego and Imperial County Girl Scouts, UCSD Academic Connections, Scripps Institution of Oceanography, San Diego Stephen Birch Aquarium and the San Diego Supercomputer are ongoing).

Smith provided several public talks on Antarctic research including the Santa Barbara Sailing Club and the Santa Barbara Audubon Society as well as several invited science workshop presentations at Ohio State University and Hamilton College.

Ducklow presented an evening public seminar on his research at the Eastern Shore Lab, Wachapreague, VA, in addition to several professional, scientific presentations at Old Dominion, Lamont Doherty and Southampton, UK Oceanographic Centre. Ducklow also hosted and supported an Adult Literacy Educator, Susan Cowles (Corvallis, OR) in the Teacher Experiencing Antarctica (TEA) Program, during his stay at Palmer Station, January-March, 2002.

Ross and Quetin mentored two REUs (see above) and in July 2001 they contributed overheads and preserved Antarctic Krill to an educational workshop for teachers who were participating in this year's JASON project - Biology of Frozen Worlds. They also conducted annual touch tank tours for two groups of pre-school children from the Oaks Parent-Child workshop (May 2002).

Fraser presented an evening public talk on his research in Antarctica at the University of Montana, Western, and two field team members (Patterson, Geisz) gave several talks at K-12 schools. Fraser and Patterson also continued their participation in the Blue Ice program.

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 Editor(s): D. Hansell and C Carlson
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 Collection: The effects of ozone depletion on aquatic ecosystems, 247-265
 Bibliography: R.G. Landes Co., Austin, TX

Web/Internet Site

URL(s):
<http://pal.lternet.edu>
Description:

Other Specific Products

Product Type: Special Report

Product Description:

Foreign Names Committee, Foreign Names Committee Report: The Foreign Names Committee held its 317th meeting on July 28th, adopting the term 'Southern Ocean' as a standard name for the body of water surrounding the continent of Antarctica. Proposal to consider adoption of this name for official use was received from Dr. David M. Karl, Professor of Oceanography at the University of Hawaii, 1999

Sharing Information:

Southern Ocean will be the standard name used in publications, for the body of water surrounding the continent of Antarctica. Proposal to consider adoption of this name for official use was r

Product Type: CD-ROM

Product Description:

Smith, R.C., S.E. Stammerjohn, and K.S. Baker, Palmer LTER: Seasonal Process Sea Ice Cruise June-July 1999 (NBP99-06), SIO Report No. 00-02 (CDROM with photographs), University of California, San Diego, Scripps Institution of Oceanography, La Jolla, California, 2000.

Sharing Information:

As an educational tool for showing experiences at sea on a research vessel; showing them the use of instruments and operations.

Product Type: Trunk

Product Description:

Baker, K.S., Palmer LTER Education Outreach Trunk

Sharing Information:

Collection of books, videos, maps, posters, manuscripts and artifacts relevant to polar research.

Product Type: Audio or video products

Product Description:

Ross, R.M., 00:00:06 seconds of footage of krill swimming under ice, 1999.

Sharing Information:

Supplied Cronkite Ward, Wahsington, D.C with this footage.

Product Type: Journal

Product Description:

Sonier,D, Journal of the LTER Ice Cruise on the R/V Nathaniel B. Palmer; from 17 June 1999 to 17 July 1999.

Sharing Information:

Sharing real-time with her experiences with her students back in the classroom via the www.

Product Type: Audio or video products

Product Description:

Wallace, M.A., and B. Swanson, Video recording: Teachers Experiencing Antarctica (TEA) program - Palmer Station Partnership, Montwood High School, El Paso, Teexas, 1999.

Sharing Information:

Video of pictures from a workshop held at Scripps Institution of Oceanography, La Jolla and NCEAS, Santa Barbara, July to share with students of their classrooms.

Product Type: Brochure - Palmer LTER

Product Description:

This is a Brochure designed by Karen S. Baker, Data Manager, and printed by the LTER Network Office. The brochure depicts the Palmer LTER research at Palmer Station and on research vessels.

Sharing Information:

We distribute the product at all the scientific meetings, workshops and data management meetings as well as those visiting Palmer Station; ie Tourists, NSF, Scientists, Raytheon Personnel, etc. .

Product Type: Teaching aids

Product Description:

Website

<http://pal.lternet.edu/education>

Sharing Information:

Sharing real-time journals with students back in the classroom via the www.
Teacher-on-Board LTER

Contributions

Contributions within Discipline:

Development of the principal disciplines of the project:

The development and maintenance of long-term science within our disciplines is an important contribution as is the tie between information management and environmental science. The multi-scale sampling strategy, particularly as applied to the Antarctic marine ecosystem (Smith et al., 2001), is an important contribution to the discipline of ocean optics. In addition, the LTER synthesis volume (Greenland, Goodin and Smith) is a important contribution to the joint disciplines of ecology and climate. The results to date (Karl) have provided new, novel information about the coupling of organic matter production to the export of organic matter from the surface ocean, about the saturations states of dissolved biogenic gases in polar regions and about the presence of novel microorganisms in the sea. In the (Ross & Quetin) analysis of the Palmer LTER time series of both reproductive output of female krill in summer, and the recruitment of 1-year old krill into the population they are finding that the population in the Palmer LTER region is keyed to the climatology of sea ice, e.g. mean sea ice conditions during the critical time for the process. Timing and duration of mean sea ice conditions are important factors, whereas extremes of sea ice advance are not. For the reproducing females, the critical time is spring. For survival of the larval krill produced by those females, winter and early spring conditions are critical. In this region, mean sea ice extent and area are adequate to provide under-ice habitat for larval krill living in the region. In years of high extent (> 1 SD of the mean) the additional ice occurs in areas where the krill population we are sampling does not live. The importance of these conclusions lies in recognizing that the krill population living on the shelf between Anvers and Adelaide Islands experiences optimal conditions for reproduction and recruitment at mean sea ice conditions and not at the extremes. Understanding the basis of the success of this population means we will be better able to predict the consequences if the warming trend changes the climatology of sea ice in winter and spring.

With the Palmer LTER data set we also are testing the three main hypotheses proposed as to which environmental factors control primary production in Antarctic waters (Vernet). First, we have evidence that the continental shelf behaves as a marginal ice zone through most of the

summer, thus supporting the hypothesis that light limitation through the establishment of a shallow mixed layer is a controlling factor. In addition, offshore phytoplankton physiology supports the hypothesis of nutrient, presumably iron, limitation. Finally, the importance of grazing is being tested. Grazing by microzooplankton will be measured with experiments during the next two field seasons. Grazing by krill and its effect on phytoplankton abundance and community structure is the subject of a complementary proposal submitted to the Office of Polar Programs. Field data suggest that in January the northern part of the grid is impacted by grazing while the phytoplankton communities in the South are not.

Contributions to Other Disciplines:

Ongoing collaborative efforts (Baker) offer opportunity for information science research and address the need for bridge between the realms of information science, digital library science, social science and environmental science. A recent NSF/CISE/BDEI grant 'Designing an Infrastructure for Heterogeneity of Ecosystem Data, Collaborators and Organizations' is opening up new database inquiries tied to the specific problems of biodiversity and ecosystem communities.

Contributions to Human Resource Development:

The LTER through long-term participation in the REU program provides insight to a range of student on the subjects of oceanography, Antarctic marine science, information management and network science. Further, there is an ongoing mentoring of environmental scientists with respect to information management which is an integral and nontrivial part of the Palmer LTER that contributes to the development of data sharing and archival issues. The research activities of this project have provided training for numerous students from undergraduates to post-doctoral trainees including: 2 REUs, 7 graduate students, 1 additional undergraduate with independent research project (see Training and Development) and one mid-career volunteer (employed by the National Park Service, Channel Islands National Park) for the Palmer Station spring research.

Contributions to Resources for Research and Education:

(please see also human resources)

A major strength of our outreach focus is the development of synergistic elements between field science, information management and education through site education activities such as coordination of the Palmer LTER education forum, participation in the LTER Network Education Committee and interaction with LTER site schoolyard programs. Ross & Quetin contributed to the JASON project. Fraser and Ducklow helped host Susan Cowles, an Adult Literacy Educator in the Teacher Experiencing Antarctica (TEA) Program. Fraser and Baker helped Tim Brock, an Eagle Scout visiting Antarctica under the auspices of the NSF.

Contributions Beyond Science and Engineering:

The Palmer LTER outreach and education, as coordinated by our information manager, is integral to our science program and provides an important contribution to the flow of information to the public in general. An increased understanding of ecosystem response to climate change (Smith, Synthesis volume discussed above) is an important issue for public education and policy.

Special Requirements

Special reporting requirements:

5. Special Requirements

5.A Objectives and Scope

Our overall objectives and scope of the project remain the same.

5.B Change in Objectives or Scope

(a) Once again a shortened summer cruise (imposed by the cruise schedule) limited sampling opportunities and required curtailment of some core grid sampling stations.

(b) For the Palmer field season Vernet & Smith combined zodiac operations in order to consolidate field activities.

Change in Objectives or Scope: None

Unobligated funds: less than 20 percent of current funds

Animal, Human Subjects, Biohazards: None

Categories for which nothing is reported: