

**Annual Report for Period:**10/2003 - 10/2004**Submitted on:** 07/07/2004**Principal Investigator:** Ducklow, Hugh W.**Award ID:** 0217282**Organization:** William & Mary Marine Inst**Title:**

LTER: PALMER, ANTARCTICA LTER: Climate Change, Ecosystem Migration and Teleconnections in an Ice-Dominated Environment

### Project Participants

#### Senior Personnel

**Name:** Ducklow, Hugh**Worked for more than 160 Hours:** Yes**Contribution to Project:****Name:** Burreson, Eugene**Worked for more than 160 Hours:** Yes**Contribution to Project:**

participated on research cruise aboard LM GOULD

**Name:** Martin, Daniel**Worked for more than 160 Hours:** Yes**Contribution to Project:**

Mr. Martin was a Staff Research Associate and the field team leader for the secondary production component at Palmer Station in the austral spring. He was in charge of the core sampling, including diving operations, acoustic transects from the zodiac once the ice cleared, and conducting growth experiments with larval krill sampled either with divers or with a net from the zodiac. Support was provided with cost-share funds from University of California at Santa Barbara.

**Name:** Patterson, Donna**Worked for more than 160 Hours:** Yes**Contribution to Project:****Name:** Curchitser, Enrique**Worked for more than 160 Hours:** Yes**Contribution to Project:**

#### Post-doc

**Name:** McCallister, Shannon**Worked for more than 160 Hours:** Yes**Contribution to Project:**

participated on research cruise aboard LM GOULD

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

#### Graduate Student

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

Ms. Oakes conducted experiments with larval krill at Palmer Station during the austral spring of 2002 as part of her Ph. D. thesis. She also assisted with the core program of sampling for the secondary production component during the Oct-Dec time frame. During the remainder of the year she continued the analysis of samples from previous winter cruises and drafting the chapters for

her thesis.

**Name:** Garibotti, Irene

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

**Name:** Stammerjohn, Sharon

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

**Name:** Daniels, Robert

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

**Name:** Jackson, Steve

**Worked for more than 160 Hours:** No

**Contribution to Project:**

### Undergraduate Student

**Name:** Fuller, Michelle

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Ms Fuller was a senior at University of California at Santa Cruz when she was part of the research team for the secondary production component on board the LM Gould in January 2003. She was a volunteer. She participated in all aspects of the core sampling and conduction of experiments during the cruise.

**Name:** Wright, Matthew

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Mr Wright was a sophomore at University of California at Santa Barbara when he was part of the research team for the secondary production component on board the LM Gould in January 2003. He was a volunteer. He participated in all aspects of the core sampling and conduction of experiments during the cruise.

**Name:** Valicenti, Lyndon

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Ms Valicenti was a junior at University of California at Santa Barbara when she was part of the research team for the secondary production component on board the LM Gould in January 2003. She was a volunteer. She participated in all aspects of the core sampling and conduction of experiments during the cruise.

**Name:** Holmes, Michael

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Mr. Holmes was a junior at California Polytechnical Institute in San Luis Obispo when he was a member of the secondary production research team on board the LM Gould in January 2003. He assisted in all aspects of sampling and conducting experiments during the cruise.

### Technician, Programmer

**Name:** Boch, Charles

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Mr. Boch was a field assistant during both the austral spring sampling from Palmer Station and on board the LM Gould during the annual cruise. He did both SCUBA diving and zodiac sampling at Palmer Station, and supervised the midnight to noon shift on

board the LM Gould. Partial support was provided with Palmer LTER funds.

**Name:** Johnson, Charleen

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

**Name:** Ireson, Kirk

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

**Name:** Kozlowski, Wendy

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

**Name:** Sines, Karie

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

**Name:** Denker, Christopher

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

**Name:** Anderson, Cynthia

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

**Name:** Geisz, Heidi

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

**Name:** Jerrett, Jennifer

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

**Name:** Pickering, Brett

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

**Name:** Chapman, Erik

**Worked for more than 160 Hours:** No

**Contribution to Project:**

**Name:** Iannuzzi, Richard

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

**Name:** Salerno, Jennifer

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Worked in lab and Participated on annual research cruise.

**Name:** Mills, Brendon

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

**Name:** Wanetick, Jerry

**Worked for more than 160 Hours:** No

**Contribution to Project:**

**Name:** Evans, Daniel

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

**Name:** Watson, Jordan

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

**Name:** Acheson, Leana

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

#### Other Participant

**Name:** Turnipseed, Mary

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

participated on research cruise aboard LM GOULD

**Name:** Ross, Robin

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Dr. Ross was a co-PI for the secondary production component of the Palmer LTER. The general tasks include (1) planning and preparing for the field season, both at Palmer Station and for the annual cruise, (2) participation in the field season, (3) data entry and analysis, and (4) manuscript preparation and submittal. She was Chief Scientist for the January 2003 cruise aboard the LM Gould. Partial support was provided.

**Name:** Quetin, Langdon

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Dr. Quetin was a co-PI for the secondary production component of the Palmer LTER. The general tasks include (1) planning and preparing for the field season, both at Palmer Station and for the annual cruise, (2) participation in the field season, (3) data entry and analysis, and (4) manuscript preparation and submittal. He conducts the dry suit training class for the divers participating in the austral spring field season for the Palmer LTER. Partial support was provided.

**Name:** Lindsey, Emily

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Ms Lindsey graduated from Brown University in May 2002, and joined the secondary production research team both at Palmer Station in December and on board the LM Gould in January 2003. She participated as an assistant in all aspects of the core sampling from zodiacs and from the ship, and in conducting experiments with Antarctic krill.

**Name:** Rawls, Dawn

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

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

**Name:** McCoy, Kim  
**Worked for more than 160 Hours:** Yes  
**Contribution to Project:**

**Name:** Smith, Raymond  
**Worked for more than 160 Hours:** Yes  
**Contribution to Project:**

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

**Name:** Ferrara, Michelle  
**Worked for more than 160 Hours:** Yes  
**Contribution to Project:**

**Name:** Tillbury, Graham  
**Worked for more than 160 Hours:** Yes  
**Contribution to Project:**

**Name:** Bechtel, Jefferey  
**Worked for more than 160 Hours:** Yes  
**Contribution to Project:**

**Name:** Bostrom, Erin  
**Worked for more than 160 Hours:** Yes  
**Contribution to Project:**

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

**Name:** Veloza, Adriana  
**Worked for more than 160 Hours:** Yes  
**Contribution to Project:**

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

**Name:** Martinson, Douglas  
**Worked for more than 160 Hours:** Yes  
**Contribution to Project:**

**Name:** Rapoport, Shana

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Participated on annual research cruise.

**Name:** White, Bryan

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Participated on annual research cruise and at Palmer Station.

**Name:** Pelletreau, Karen

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Participated on annual research cruise.

**Name:** Loomis, Eli

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Participated on annual research cruise and at Palmer Station.

**Name:** Cheng, Brian

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

**Name:** Green, Kristen

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

**Name:** Kaiser, Amy

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

**Name:** Watts, Jason

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

**Name:** Haupt, Alison

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

**Name:** Talley, Shannon

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

**Name:** Cadiz, Robin

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

**Name:** Lefens, Mark

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

**Research Experience for Undergraduates****Name:** Raulfs, Estella**Worked for more than 160 Hours:** Yes**Contribution to Project:**

participated on research cruise aboard LM GOULD

**Years of schooling completed:** Freshman**Home Institution:** Other than Research Site**Home Institution if Other:** College of William and Mary**Home Institution Highest Degree Granted(in fields supported by NSF):** Doctoral Degree**Fiscal year(s) REU Participant supported:** 2003**REU Funding:** REU supplement**Name:** Rogers, Lauren**Worked for more than 160 Hours:** Yes**Contribution to Project:**

participated in research at Palmer Station

**Years of schooling completed:** Other**Home Institution:** Other than Research Site**Home Institution if Other:** Stanford University**Home Institution Highest Degree Granted(in fields supported by NSF):** Doctoral Degree**Fiscal year(s) REU Participant supported:** 2003**REU Funding:** REU supplement**Name:** Tutrow, Jonathan**Worked for more than 160 Hours:** Yes**Contribution to Project:****Years of schooling completed:** Sophomore**Home Institution:** Other than Research Site**Home Institution if Other:** Loyola Marymount University**Home Institution Highest Degree Granted(in fields supported by NSF):** Master's Degree**Fiscal year(s) REU Participant supported:** 2002**REU Funding:** REU supplement**Name:** Middaugh, Nicole**Worked for more than 160 Hours:** Yes**Contribution to Project:**

Participated on annual research cruise with LTER-REU support.

**Years of schooling completed:** Junior**Home Institution:** Same as Research Site**Home Institution if Other:****Home Institution Highest Degree Granted(in fields supported by NSF):** Doctoral Degree**Fiscal year(s) REU Participant supported:** 2004**REU Funding:** REU supplement**Name:** Mills, Anne**Worked for more than 160 Hours:** Yes**Contribution to Project:**

Participated on annual research cruise with LTER-REU support.

**Years of schooling completed:** Junior**Home Institution:** Same as Research Site

**Home Institution if Other:****Home Institution Highest Degree Granted(in fields supported by NSF):** Doctoral Degree**Fiscal year(s) REU Participant supported:** 2004**REU Funding:** REU supplement**Name:** Tsui, Tracee**Worked for more than 160 Hours:** Yes**Contribution to Project:**

Analyzed data and developed outreach website.

**Years of schooling completed:** Junior**Home Institution:** Same as Research Site**Home Institution if Other:****Home Institution Highest Degree Granted(in fields supported by NSF):** Doctoral Degree**Fiscal year(s) REU Participant supported:** 2004**REU Funding:** REU supplement**Name:** Haber, Shaun**Worked for more than 160 Hours:** Yes**Contribution to Project:****Years of schooling completed:** Freshman**Home Institution:** Same as Research Site**Home Institution if Other:****Home Institution Highest Degree Granted(in fields supported by NSF):** Associate's Degree**Fiscal year(s) REU Participant supported:****REU Funding:** REU supplement**Name:** Kelly, Joann**Worked for more than 160 Hours:** Yes**Contribution to Project:**

Joann worked in Ducklow's lab at VIMS, processing and analyzing sediment trap samples, and helping out with other routine lab duties.

**Years of schooling completed:** Freshman**Home Institution:** Same as Research Site**Home Institution if Other:****Home Institution Highest Degree Granted(in fields supported by NSF):** Doctoral Degree**Fiscal year(s) REU Participant supported:** 2004**REU Funding:** REU supplement**Organizational Partners****Digital Library for Env and Sci Edu****NSF Artists and Writers Program****California Center for Ocean Sci Edu****Scripps Committee for Outreach Programs****San Diego Supercomputer Center**



**University of Wisconsin, Madison****Old Dominion University****University of La Plata****University of Nevada Desert Research Institute**

DRI Post-doc Joseph Grzyski participated on our annual cruise

**Instituto Argentino de Nivologia**

Dr. Irene Garibotti from the Instituto Argentino de Nivologia, Glaciologia y Ciencias Ambientales; Mendoza, Argentina collaborated with coPI Maria Vernet on several manuscripts reporting on LTER findings.

**UCSD Teacher Education Program****Teacher's Experiencing Antarctica****LTER Network Office****UCSD Preuss Middle/High School****Rawls Byrd Elementary School****University of Florida**

Dr. T K Frazer of University of Florida: worked at Juan Carlos I base (Spanish) on Livingston Island; with a group transported by the Spanish Navy visited Palmer Station and received live krill and phytoplankton cultures. Members of the visiting party consulted with various people on station to learn about different ways to conduct science at stations in the Antarctic.

**Spanish Antarctic Program, Juan Carlos B**

Dr. T K Frazer of University of Florida: worked at Juan Carlos I base (Spanish) on Livingston Island; with a group transported by the Spanish Navy visited Palmer Station and received live krill and phytoplankton cultures. Members of the visiting party consulted with various people on station to learn about different ways to conduct science at stations in the Antarctic.

**Other Collaborators or Contacts**

Helena Karasti, Oulu University, Finland  
 Geoffrey Bowker, UCSD Communication Department  
 Cheryl Peach, UCSD Birch Aquarium  
 Lucy Bledsoe, NSF Artists and Writers Program  
 Cindy Baker, College of William and Mary Public Relations  
 Pete Barnes, K12 teacher  
 Lara Kessler, K12 schools  
 Daniel Grossman, NSF Media Program  
 Martha Ferrario, University of La Plata  
 Rebecca Dickhut, VIMS  
 Elizabeth Canuel, VIMS  
 Michael Bender, Princeton  
 Matthew Reuer, Princeton  
 David Kirchman, U Delaware  
 Craig Carlson, UCSB  
 Mary Cerrullo, Children's book writer  
 Cyndy Chandler, Data Manager of the JGOFS Data Office, WHOI

Paula Levin, Graduate Coordinator Teacher Education Program  
 Indalecio Manzano, Science Chair UCSD Preuss Elementary/Middle School  
 Thomas K Frazer, University of Florida  
 Christine Ribic, Univ of Wisconsin  
 William Walker, M.S., Collaborator, NMFS., Seattle, WA.  
 Eileen Hofmann, Ph.D., Collaborator, Old Dominion U., Norfolk, VA.

### Activities and Findings

#### **Research and Education Activities: (See PDF version submitted by PI at the end of the report)**

Please see attached PDF file.

#### **Findings: (See PDF version submitted by PI at the end of the report)**

Please see attached PDF file.

#### **Training and Development:**

We provide a rich experience in field research -- both at Palmer Station and aboard LM GOULD for numerous undergrad and graduate students listed in our participants section.

#### **Outreach Activities:**

The Palmer LTER partnered with Scripps Committee for Outreach Programs in Education (SCOPE) taking science into the classroom through the efforts of SIO graduate student participants. PAL LTER partners with other San Diego based programs such as Partnerships Involving the Scientific Community in Elementary Schools (PISCES) as well as with the Birch Aquarium's efforts with the California Center for Ocean Science Education Excellence (COSEE) support and purchase of toolkit materials.

Twelve volunteers were taken into the field as part of the Palmer LTER field program for the 2002-2003 season. In addition, a Research Experience for Undergraduates student participated in the January cruise. NSF Artist and Writer participant Dan Grossman was hosted by Palmer LTER participants while in the field at Palmer Stations. Contributions to his online website for both teacher guides and for photo galleries. An Antarctic Storytelling Workshop in conjunction with NSF Writer and Artists Program participant Lucy Bledsoe took place in San Diego in March 2003 in coordination with the Palmer LTER Information Management component.

Communication with the public occurred through Antarctic Sun article ([http://pal.lternet.edu/lter/biblio/2002/mccoy\\_apv\\_pg6\\_ant\\_sun2002\\_29dec.pdf](http://pal.lternet.edu/lter/biblio/2002/mccoy_apv_pg6_ant_sun2002_29dec.pdf)) as well as an LTER Network News article on outreach with schools ([http://pal.lternet.edu/lter/biblio/2003/LTER\\_newsletters/Spring2003/pg05\\_spring03\\_vol16no1.pdf](http://pal.lternet.edu/lter/biblio/2003/LTER_newsletters/Spring2003/pg05_spring03_vol16no1.pdf)). In addition, William and Mary initiated a new website 'William and Mary in Antarctica' (<http://www.wm.edu/Antarctica/index.php>) and held a variety of outreach activities in collaboration with teachers who participated in a variety of ways with the field experience. In addition, a Picture-of-the-Day ship activity resulted in public outreach for the Palmer LTER January 2003 cruise. It was followed up by coordination of the photos into the Palmer LTER online photo gallery.

Discussions with the LTER Schoolyard cross-site efforts developed over plans for an All Scientists Meeting Workshop to be held jointly by the Information Managers and the LTER Education Representatives. Discussions with the Digital Library activities continued with participation at the Joint Conference for Digital Libraries in May 2003. A mini workshop was held with previous TEA participant Besse Dawson as well as with the NSDL group Science Education Resource Education (SERC) led by director Cathy Manduca.

Beth Simmons, a high school oceanography teacher with training in curriculum development, initiated design of a Palmer LTER framework for case-based module development. Training through the 'Understanding by Design' program continued with a PalLTER prototype module 'Penguin Bones' used as a presentation module.

### Journal Publications

- Hollibaugh, J. T., N. Bano and H. W. Ducklow., "Widespread Distribution in Polar Oceans of a 16S rRNA Gene Sequence with Affinity to Nitrosospira-like Ammonia- Oxidizing Bacteria.", *Applied and Environmental Microbiology*, p. 1478, vol. 68, (2002). Published
- Garibotti, I. A., M. Vernet, M. E. Ferrario, R. C. Smith, R. M. Ross and L. B. Quetin, "Phytoplankton spatial distribution in the Western Antarctic Peninsula (Southern Ocean)", *Marine Ecology Progress Series*, p. 21, vol. 261, (2003). Published
- Garibotti, I. A., M. Vernet, W. A. Kozlowski and M. E. Ferrario., "Composition and biomass of phytoplankton assemblages in coastal Antarctic waters: a comparison of chemotaxonomic and microscopic analyses", *Marine Ecology Progress Series*, p. 27, vol. 247, (2003). Published
- Thomas K. Frazer, Langdon B. Quetin, Robin M. Ross, "Abundance, sizes and developmental stages of larval krill, *Euphausia superba*, during winter in ice-covered seas west of the Antarctic Peninsula", *J. Plankton Res*, p. 1067, vol. 24, (2002). Published
- Karen L. Haberman, Robin M. Ross, Langdon B. Quetin, Maria Vernet, Gabriella A. Nevitt, Wendy Kozlowski, "Grazing by Antarctic krill *Euphausia superba* on *Phaeocystis antarctica*: an immunochemical approach", *Mar. Ecol. Prog. Ser.*, p. 139, vol. 241, (2002). Published
- Karen L. Haberman, L. B. Quetin and R. M. Ross, "Diet of the Antarctic krill (*Euphausia superba* Dana) I. Comparisons of grazing on *Phaeocystis antarctica* (Karsten) and *Thalassiosira antarctica* (Comber).", *J. Expt. Mar. Biol. Ecol.*, p. 79, vol. 283, (2003). Published
- Karen L. Haberman, Robin M. Ross, Langdon B. Quetin, "Diet of the Antarctic krill (*Euphausia superba* Dana) II. Selective grazing in mixed phytoplankton assemblages", *J. Expt. Mar. Biol. Ecol.*, p. 97, vol. 283, (2003). Published
- Langdon B. Quetin, Robin M. Ross, Thomas K. Grazer, Margaret O. Amsler, Carol Wyatt-Evens, Stephanie A. Oakes, "Growth of larval krill, *Euphausia superba*, in fall and winter west of the Antarctic Peninsula", *Mar. Biol.*, p. 833, vol. 143, (2003). Published
- Greenland, D., B. P. Hayden, J.J. Magnuson, S. V Ollinger, R.A. Pielke, Sr., and R. C. Smith  
R. C. Smith, "Long-term research on biosphere-atmosphere interactions", *BioScience*, p. 33, vol. 53, (2003). Published
- Hader, D.P., H.D. Kumar, R.C. Smith and R.C. Worrest, "Aquatic ecosystems: effects of solar ultraviolet radiation and interactions with other climatic change factors", *Photochemical and Photobiological Sciences*, p. 39, vol. 2, (2003). Published
- Stammerjohn, S.E., M. R. Drinkwater, R.C. Smith and X. Liu, "Ice-atmosphere interactions during sea-ice advance and retreat in the western Antarctic Peninsula region (accepted)", *Journal of Geophysical Research*, p. 3329, vol. 108C, (2003). Published
- Massom, R.A., S.E. Stammerjohn, R.C. Smith, M.J. Pook, R.A. Iannuzzi, N. Adams, D.G. Martinson, C. Folwer and Y. Massom, "Major impact of anomalous atmospheric circulation on sea ice in the Palmer LTER Region, Antarctica, late austral winter-early Spring 2001", *Journal of Climatology*, p. , vol. , (2003). Submitted
- EH Hofmann, DP Costa, KL Daly, JM Klinck, WR Fraser, JJ Torres, "U.S. Southern Ocean Ecosystems Dynamics Program", *Oceanography*, p. 64, vol. 15, (2002). Published
- Carrillo, C.J., R.C. Smith, and D.M. Karl, "Processes regulating oxygen and carbon dioxide in surface waters west of the Antarctic Peninsula (accepted)", *Marine Chemistry*, p. 161, vol. 84, (2004). Published
- Patterson, D. L., E. J. Woehler, J. P. Croxall, J. Cooper, S. Poncet and W. R. Fraser., "Breeding distribution and population status of the Northern Giant Petrel *Macronectes halli* and the Southern Giant Petrel *M. giganteus*.", *Marine Ornithology.*, p. , vol. , ( ). Accepted
- Karasti, H. and K. S. Baker., "Infrastructuring for the long-term: ecological informationmanagement.", *Proceedings of the Hawai'i International Conference on SystemSciences (HICSS) 2004*, 5-8 January, Big Island, Hawaii IEEE. New Brunswick, NJ., p. 1, vol. , (2002). Published
- Gales, J. N., W. R. Fraser, D. P. Costa and C. Southwell., "Do crabeater seals forage cooperatively?", *Deep Sea Research II.*, p. , vol. , (2004). Accepted

- Chiuchiolo, A. L., R. M. Dickhut, M. A. Cochran and H. W. Ducklow., "Persistent organic pollutants at the base of the Antarctic marine food web.", *Environmental Science and Technology*, p. , vol. , (2004). Accepted
- Chapman, E. W., C. A. Ribic and W. R. Fraser., "The distribution of seabirds and pinnipeds in Marguerite Bay and their relationship to physical features during austral winter 2001", *Deep Sea Research II*, p. , vol. , (2004). Accepted
- Bowker, G. C. and K. S. Baker., "Information ecology: open system environment for data, memories and knowing.", *Journal of Intelligent Information Systems (BDEI Special Series)*., p. , vol. , (2004). Accepted
- Baker, K. S., "Ecological design: an interdisciplinary, interactive participation process in an information environment.", *Proceedings of the workshop on Requirements Capture for Collaboration in e-Science*, 14-15 January, Edinburgh., p. 5, vol. , (2004). Published
- Smith, R. C., W. R. Fraser, S. E. Stammerjohn and M. Vernet., "Palmer Long-Term Ecological Research on the Antarctic Marine Ecosystem.", *Antarctic Peninsula Climate Variability: Historical and Paleoenvironmental Perspective*. E. Domack, A. Leventer, A. Burnett, R. Bindschadler, P. Convey and M. Kirby. eds. American Geophysical Union. Washington, DC, p. 131, vol. , (2003). Published
- Siegel, V., R. M. Ross and L. B. Quetin., "Krill (*Euphausia superba*) recruitment indices from the western Antarctic Peninsula: are they representative of larger regions?", *Polar Biology*, p. 672, vol. 26, (2003). Published
- Quetin, L. B. and R. M. Ross., "Episodic recruitment in Antarctic krill, *Euphausia superba*, in the Palmer LTER study region.", *Marine Ecology Progress Series*, p. 185, vol. 259, (2003). Published
- Liu, J., G. A. Schmidt, D. G. Martinson, D. Rind, G. Russell and X. Yuan., "Sensitivity to sea ice to physical parameterizations in the GISS global climate model.", *Journal of Geophysical Research*, p. 35-1, vol. 108, (2003). Published
- Fraser, W. R. and E. E. Hofmann., "A predator's perspective on causal links between climate change, physical forcing and ecosystem response.", *Marine Ecology Progress Series*, p. 1, vol. 265, (2003). Published
- Church, M. J., E. F. DeLong, H. W. Ducklow, M. B. Karner, C. M. Preston and D. M. Karl., "Abundance and distribution of planktonic Archaea and Bacteria in the waters west of the Antarctic Peninsula.", *Limnology and Oceanography*, p. 1893, vol. 48, (2003). Published
- Ainley, D. G., G. Ballard, S. D. Emslie, W. R. Fraser, P. R. Wilson and E. J. Woehler., "Adelie penguins and Environmental change.", *Science*, p. 429, vol. 300, (2003). Published
- Gauthier-Clerc, M., Gendner, J-P, Ribic, C.A., Fraser, W. R., Woehler, E.J., Descamps, S., Gilly, C., Le Bohec, C. & Le Maho, Y. 2004., "Long-term effects of flipper bands on penguins.", *Proceedings of the Royal Society, London B (suppl), Biology Letters*, published online., p. 1, vol. , (2004). Published
- Ross, R M and L B Quetin., "Working with living krill -- The people and the places.", Ross, R M and L B Quetin. 2003. Working with living krill ? The people and the places. *Marine and Freshwater Behaviour and Physiology* 36(4): 207-228., p. 207, vol. 36, (2003). Published

### **Books or Other One-time Publications**

- Ducklow, H. W., "Biogeochemical Provinces: Towards a JGOFS Synthesis.", (2003). Book, Published  
 Editor(s): M. J. R. Fasham  
 Bibliography: *Ocean Biogeochemistry: A New Paradigm*. New York. Springer-Verlag.
- Baker, K.S., G.Bowker and H.Karasti, "Designing an Infrastructure for Heterogeneity in Ecosystem Data, Collaborators, and Organizations", (2002). Book, Published  
 Editor(s): Digital Government Research Center  
 Collection: *Proceedings of the 2nd National Conference on Digital Government Research*  
 Bibliography: Los Angeles, CA: 141-144

- Baker, K.S., J.Brunt and D. Blankman, "Organizational Informatics: Ste Description Directories for Research Networks", (2002). Book, Published  
 Editor(s): N. Callaos, J.Porter and N.Rishe  
 Collection: Proceedings of the 6th World Multi-Conference on Systematics, Cybernetics and Informatics  
 Bibliography: IIS 7: 355-360
- Brunt, J.W., P.McCartney, K.S.Baker and S.Stafford, "The Future of Ecoinformatics in Long Term Ecological Research", (2002). Book, Published  
 Editor(s): N.Callaos, J.Porter and N.Rishe  
 Collection: Proceedings of the 6th World Multi-Conference on Systematics, Cybernetics and Informatics  
 Bibliography: IIS 7:367-372
- Gold, A.K., K.S.Baker, J-Y LeMeur and K.Balkdridge, "Building FLOW: Federating Libraries on the Web", (2002). Book, Published  
 Editor(s): International Conference on Digital Libraries  
 Collection: Proceedings of the 2nd ACM/IEEE-CS Joint Conference on Digital Libraries  
 Bibliography: New York, ACM Press: 287-288
- Melendez-Colom, E.C. and K.S. Baker, "Common Information Management Framework: In Practice", (2002). Book, Published  
 Editor(s): N.Callaos, J.Porter and N.Rishe  
 Collection: Proceedings of the 6th World Multi-Conference on Systematics, Cybernetics and Informatics  
 Bibliography: IIS 7:385-389
- Goodin, D. and R.C. Smith, "Century to Millennial Scale -synthesis", (2003). Book, Published  
 Editor(s): D. Greenland, D. Goodin and R. C. Smith  
 Collection: Climate variability and ecosystem response at Long-Term Ecological Research (LTER) sites  
 Bibliography: New York, Oxford Press
- Greenland, D. D. Goodin and R. C. Smith, "Climate Variability and Ecosystem Response at Long-Term Ecological Research (LTER) Sites (accepted)", (2003). Book, Published  
 Bibliography: New York, Oxford Press
- Greenland, D., D. Goodin and R. C. Smith, "An introduction to climate variability and ecosystem response", (2003). Book, Published  
 Editor(s): D. Greenland, D. Goodin and R.C. Smith  
 Collection: Climate Variability and Ecosystem Response at Long-Term Ecological Research (LTER) Sites  
 Bibliography: New York,Oxford Press
- Smith, R.C., W.R. Fraser and S. E. Stammerjohn, "Climate variability and ecological rsonpe of the marine ecosystem in the western Antarctic Peninsula (WAP) region", (2003). Book, Published  
 Editor(s): D. Greenland, D. Goodin and R. C. Smith  
 Collection: Climate Variability and Ecosystem Response at Long-Term Ecological Research (LTER) Sites  
 Bibliography: New York, Oxford Press
- Smith, R.C., X. Yuan, J. Liu, D.G. Martinson and S. E. Stammerjohn, "The quasi-quintennial time sacle -synthesis", (2003). Book, Published  
 Editor(s): D. Greenland, D. Goodin and R.C. Smith  
 Collection: Climate Variability and Ecosystem Response at Long-Term Ecological Research (LTER) Sites  
 Bibliography: New York, Oxford Press
- Smith, R.C., W.R. Fraser, S.E. Stammerjohn, and M. Vernet, "Palmer Long-Term Ecological Research on the Antarctic Marine Ecosystem", (2003). Book, Published  
 Editor(s): E. Domack, A. Burnett, A Leventer, P. Conley, M. Kirby and R. Bindschadler  
 Collection: Antarctic Peninsula Climate Variability: A Historical and Paleoenvironmental Perspective  
 Bibliography: Washington, DC, American Geophysical Union
- Vernet, M. and R. C. Smith, "Estimating NPP in marine pelagic ecosystems", (2003). Book, Submitted  
 Editor(s): Timothy J. Fahey and Alan Knapp

Collection: Principles and standards for measuring net primary production  
Bibliography: LTER synthesis series, Oxford Press

Wendy Kozlowski and Maria Vernet, "Response of pigments in sea ice algae to ultraviolet radiation exposure - time series studies", (2003).  
Abstract & Poster, Published

Collection: 10th Congress of the European Society for Photobiology (ESP), Vienna, Austria, 6-11 September 2003.

Bibliography: Sesson: Environmental Photobiology

DL Patterson, AL Easter-Pilcher, WR Fraser, "The effects of human activity and environmental variability on long-term changes in Adelie  
Penguin populations at Palmer Station, Antarctica", (2003). Book, Published

Editor(s): WWC Gieskes, J Rozema, RML Schorno, SM van der Vies and WJ Wolff

Collection: Antarctic Biology in a Global Context

Bibliography: Proceedings VIIIth SCAR International Biology Symposium, Backhuys Publishers, Leiden, p 301-307

Karasti, H., K. S. Baker and G. C. Bowker, "Proceedings of the Computer Supported Scientific Collaboration Workshop", (2003). Proceedings  
volume, Published

Editor(s): Karasti, H., K. S. Baker and G. C. Bowker

Bibliography: Eighth European Conference on Computer Supported Cooperative Work, Helsinki, Finland, 14 September 2003. Finland,  
University of Oulu.

Convey, P., D. Scott and W. R. Fraser., "Biophysical and habitat changes in response to climate alteration in the Arctic and Antarctic.", (2003).  
Book, Published

Editor(s): L. Hannah and T. Lovejoy.

Collection: Climate Change and Biodiversity: Synergistic Impacts, Series: Advances in Applied Biodiversity Science (AABS).

Bibliography: Conservation International, Center for Applied Biodiversity Science (CABS) Washington, DC pp. 77-82.

Baker, K. S., A. K. Gold and F. Sudholt., "FLOW: co-constructing low barrier repository infrastructure in support of heterogeneous knowledge  
collection(s).", (2003). Conference proceedings, Published

Collection: Proceeding of the 2003 Joint Conference on Digital Libraries(JCDL'03)

Bibliography: 27 May - 31 June, Houston, Texas IEEE Computer Society. New Brunswick, NJ. pp. 397

Ducklow, H. W., J. L. Oliver and W. O. Smith, Jr., "The role of iron as a limiting nutrient for marine plankton processes.", (2003). Book,  
Published

Editor(s): J. Melillio, C. Field and B. Moldan

Collection: Interactions of the Major Biogeochemical Cycles: Global Change and Human Impacts. SCOPE 61).

Bibliography: Washington: Island Press. Xxi + 357 p.

Ducklow, H. W., "Chapter 9. Seasonal production and bacterial utilization of DOC in the Ross Sea, Antarctica.", (2003). Book, Published

Editor(s): G. Di Tullio

Collection: Biogeochemical Cycles in The Ross Sea.

Bibliography: Washington, DC: American Geophysical Union. Antarctic Research Series Volume 78.

H. Karasti, K. S. Baker, G.C.Bowker., "ECSCW 2003 Computer Supported Scientific Collaboration (CSSC).", ( ). Book, Accepted

Collection: SIGGROUP Bulletin (in press).

Bibliography: University of Oulu, Finland

### Web/Internet Site

**URL(s):**

<http://pal.lternet.edu>

**Description:**

Palmer LTER Home Page

### Other Specific Products

**Product Type:** Teaching aids

**Product Description:**

Palmer LTER Education Outreach Trunks

**Sharing Information:**

Collection of books, videos, maps, posters, manuscripts and artifacts relevant to polar research. Shared with formal and informal educators and researchers in our laboratory, during workshops or classroom visits.

**Product Type:** Physical collection (samples, etc.)

**Product Description:**

Palmer LTER Photo Gallery

**Sharing Information:**

Collections of photos of Antarctic field work or environment shared via web.

**Product Type:** Physical collection (samples, etc.)

**Product Description:**

Continue archive of preserved samples of zooplankton (in formalin) and fish larvae (in ethanol) from every station occupied during the annual summer cruise.

Continue collection of frozen samples of young Antarctic krill in the spring for condition factor analysis, and of frozen samples of all sizes of Antarctic krill for wet weight analysis.

**Sharing Information:**

After the planned analysis of the preserved samples is completed, all samples are shipped to the Smithsonian Institution for long-term archival, and are available to any researcher making the request.

**Product Type:** Audio or video products

**Product Description:**

A video of Antarctic krill under the ice has been edited from underwater footage taken by SCUBA divers.

**Sharing Information:**

The video clip can be viewed through the Palmer LTER web site.

### Contributions

**Contributions within Discipline:**

Palmer LTER has maintained a regional-scale time series of key ecological and biogeochemical properties and processes over the past 13 years in one of the most remote and hostile regions on the planet. In doing so, we have also maintained a creative and vital program and made important fundamental observations on the response of the Antarctic marine ecosystem to climate change. We thus demonstrate how a long-term approach to science transcends monitoring and contributes to the disciplines of physical, biological and chemical oceanography, Antarctic and climate science.

**Contributions to Other Disciplines:**

Ongoing collaborative efforts (Baker/Bowker/Karasti) of PAL LTER serve as a unique bridge for information science, digital library science, and organizational informatics, taking into account sociotechnical issues while remaining grounded within a practicing environmental field research project. The NSF/CISE/BDEI grant 'Designing an Infrastructure for Heterogeneity of Ecosystem Data, Collaborators and Organizations' continues to investigate a conceptual framework sensitive to infrastructure development, as explored in the fields of CSCW, social informatics and scientific collaboratory assessment. A particular focus on collections of documents contributes to ongoing digital library work on federated repositories and information flow.

**Contributions to Human Resource Development:**

Palmer LTER continues to train graduate students in oceanography and climate science and affords them valuable experiences for fieldwork in the Antarctic. Through our ongoing REU program, we also take undergraduate volunteers on our annual cruise and we have hosted teachers at Palmer Station. Finally through our Outreach Programs we expose K-12 students to Antarctic Science and demonstrate the attractions and rewards of careers in science. Finally, there is an ongoing mentoring of environmental scientists with respect to information management which is an integral part of the LTER vision, contributing to the development of data sharing and archival practices.

**Contributions to Resources for Research and Education:**

(please see also human resources)

A major strength of our outreach focus is the coordinated activity that creates a bidirectional flow of information between field science, information management, education, and informal outreach through synergistic site education activities such as coordination of the Palmer LTER education workshops, participation in the LTER Network Education Committee and interaction with other LTER site schoolyard programs.

**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 and to the community over time. An increased understanding of ecosystem response to disturbance on decadal scales (ie, climate change; see Synthesis volume discussed elsewhere) is an important issue for both public education and for national policy.

**Special Requirements**

**Special reporting requirements:** None

**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:**



## RESEARCH ACTIVITIES

### Overview.

In April, 2004 we completed the second field season of the current award, and the 13th in the Palmer LTER program that commenced in 1991-92. The annual summer cruise (LMG 04-01) and summer season at Palmer Station were both successful with few major problems. We lost 5 days off the cruise due to logistical demands imposed by other cruises. This resulted in our canceling one of 3 24-h process studies but the entire LTER grid was completed. The BioSonics Acoustic Sensor system was lost when a Leopard Seal attacked and sunk a Zodiac tied up at the dock overnight at Palmer Station. The Autonomous Profiling Vehicle from ??? failed to perform reliably during the past season and has been retired. The Fast Repetition Rate Fluorometer failed during the cruise, depriving us of some important data. Otherwise most individual systems worked well and we collected much valuable data.

We held a large annual meeting in Montana in August, 2003. Many students and technicians were invited to meet with the PIs. Several guests (David Ainley, Colm Sweeney and Andrew Clarke) also attended our meeting. We reviewed the past season, presented and discussed results and planned for the year ahead. One major topic was how to replace retiring PI Ray Smith (see below). Ducklow and X. Yuan (Martinson colleague) attended the Southern Ocean meeting at The Royal Society in London in July.

Ray Smith is retiring in September 2004. We are considering alternatives for filling his place in PAL. In the interim we've decided to hire a postdoctoral fellow and started a formal search in January, 2004. We are currently negotiating with a candidate.

Specific project activities are presented below.

### Seabirds (Fraser BP-013).

The seabird research group worked in the Palmer Station region from mid-October 2003 to mid-April 2004, sampling daily as weather permitted, and focusing its activities on the demography, foraging ecology and breeding biology of AdÈlie penguins. As in past seasons, we obtained basic ecological data on other seabirds and marine mammals in the Palmer area to ensure the continuity of species-specific databases that originated in the early 1970s. In January, two group members participated in the annual LTER cruise (LMG 04-01), continuing surveys of seabirds and marine mammals to investigate their abundance and distribution relative to annual variability in the regional oceanography. This cruise included a 4-day field camp on Avian Island, Marguerite Bay, and a 1-day sampling effort on Armstrong Reef, Renaud Island, north of Marguerite Bay. AdÈlie penguins were sampled at both locations to compare aspects of their ecology with similar data from Palmer populations. Other research activities included further deployments of ARGOS-linked instruments on AdÈlie penguins to obtain at-sea foraging locations and dive-depth profiles, and the construction of a snow fence on Dream Island north of Palmer Station. The latter marks the beginning of experiments that for the next two years will examine the effects of snow deposition on AdÈlie penguin demography.

*Major education activities, training, development and findings.* Our field program has traditionally attracted both graduate and undergraduate students interested in gaining more experience in a variety of areas, including project planning and logistics, implementing and developing field methods and data management and analysis. Most of these students remain with our program for 2-3 years, and eventually seek positions with state and federal

governments, or pursue other degrees. This season Cynthia Anderson obtained a position with the Canadian Wildlife Service following her training with our program, Jordan Watson accepted a teaching position (Chemistry and Ecology) with a non-profit organization in Cambodia and Daniel Evans is supervising an endangered species research program of the USFWS. Heidi Geisz was accepted as a Master's student at the Virginia Institute of Marine Science, College of William and Mary.

*Outreach Activities.* The field team hosted Fen Montaigne, NSF Writers and Artists Program, during his extended stay at Palmer Station. Mr. Montaigne was a freelance writer specializing in environmental topics on assignment for National Geographic to produce a story on climate change. Personnel including Fraser, Patterson, Geisz and Pickering, were also involved in many off-site outreach activities, including talks to fraternal organizations and presentations at colleges, universities and at K -12 schools.

### **Phytoplankton (Vernet BP-016).**

The phytoplankton (BP-016) and bio-optics (BP-032) groups carried out semi-weekly sampling via Zodiac Mark V within the 2-mile boating limit (Stations B & E) from October 2003 to the first of April 2004, and participated in the January 2004 cruise on the continental shelf. Throughout the field season, the phytoplankton group (BP-016) sampled core variables, including daily primary production, particulate carbon and nitrogen, nutrients, and photosynthetic pigments. Core parameters for BP-032 included discrete chlorophyll and in situ conductivity, temperature, salinity and fluorescence measurements. For the collection of in-water optical data, a Biospherical Instruments Profiling Reflectance Radiometer was deployed throughout the season at all stations sampled. Also, an Ocean Sensors Autonomous Profiling Vehicle (APV) was moored in Arthur Harbor to collect time series CTD and fluorescence data. While working out mechanical difficulties between October and February, the APV was deployed a total of 72 days, with data being collected every four to six hours. On February 25<sup>th</sup>, the instrument was recovered and found to have irreparable piston damage and was returned to OS for repairs.

In collaboration with Joseph Grzyski, DRI, time series data (October through December) on Arthur Harbor sub-surface water was collected with a Fast Track Rate Repetition Fluorometer for phytoplankton physiological studies of environmental forcing (i.e. photo-inhibition, nutrient limitation). Additionally, weekly experiments were carried out on the effect of ultraviolet radiation on daily primary production and phytoplankton composition, on the influence of microzooplankton grazing on primary production, and the on the rates of DOC production as compared to primary production.

Data analyses during this period included: (1) An investigation of phytoplankton dynamics during periods of ice formation and ablation. (2) A study of carbon cycling through the coastal Antarctic food chain. (3) A study of the major drivers to inter-annual variability in primary production and its relationship to climate variability. (4) A study of pigment changes in winter sea ice algae after exposure to ultra-violet radiation. During this period we also completed a project looking at the relationship of temporal and spatial variability in primary production to environmental parameters. 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.

### **Zooplankton and micronekton (Ross/Quetin BP-028).**

The zooplankton and micronekton (BP-028) group participated in the seasonal sampling from Palmer Station from mid-October 2003 until late January 2004, and participated in the January 2004 annual cruise. Seasonal sampling included collection of Antarctic krill for: 1) condition factor of ~ one year old krill in austral spring at the end of their first winter, and 2) length and stage or mature female frequency and in situ growth rate experiments from October through January. Twice-weekly bioacoustic runs of two transects (B to E and F to J) within the 3.7 km boating limits of Palmer Station were conducted with a BioSonics Model 102 echosounder from mid-November when ice left the area until mid-January when a leopard seal punctured the pontoons on the zodiac holding the echosounder equipment and the system was irreparably damaged by saltwater. Collection of krill was done by SCUBA divers in the early spring when waters were ice-covered, and with a net from a Mark V zodiac once the waters were ice-free. On the cruise, two net tows conducted simultaneously with an acoustic transect (BioSonics DT-X echosounder) were done at each station. At each station, the catch was analyzed for zooplankton community composition, including fish larvae. If Antarctic krill or salps were in the catch, length frequency and either occurrence of mature females (krill) or phase (solitary/aggregate for salps) determinations were done on all or a subsample of the total. In situ growth and egg production experiments on Antarctic krill at selected stations allow estimations of secondary production of this dominant member of the zooplankton/micronekton community. At process stations, the grazing activity (whole body fluorescence for krill and salps and fecal pellet production experiments for krill only) of the two dominant macrozooplankton grazers was evaluated. In February/March 2004 we conducted a series of experiments in a collaborative effort with Dr. T K Frazer at the Spanish base. We investigated the relationship between ingestion rate measured by chlorophyll a disappearance, and estimated by the field ingestion method with plant pigment (whole body fluorescence) in the krill immediately at the end of the experiment and clearance times estimated by the disappearance of pigment in the krill.

*Education activities-* S A Oakes, a Ph. D. student partially supported by the Palmer LTER, continued her study of the energetic consequences of larval krill feeding on surfaces or in 3-dimensional space. Two SCUBA divers (Green, Cheng) new to the program were trained for dry suit use in polar waters. Undergraduates and recent undergraduates from UCSB experienced the operation of a multi- and interdisciplinary research program, and valuable hands-on experience in zooplankton ecology during the research cruise.

### **Bio-optics (Smith/Vernet BP-032)**

The bio-optics (BP-032) and phytoplankton (BP-016) groups carried out coordinated semi-weekly sampling via Zodiac Mark V within the 2-mile boating limit (Stations B & E) from October to the first of April 2004, and participated in the January 2004 cruise on the continental shelf. In collaboration with other LTER PIs the BP-032 group focused on Profiling Reflecting Radiometer (PRR) and SeaCAT CTD data and analysis.

Analysis of satellite data included: SeaWiFS ocean color data, to provide an estimate of pigment biomass; passive microwave satellite data, to provide daily estimates of sea ice extent and/or sea ice coverage; scatterometer data, to provide estimates of monthly winds. A space/time analysis of SeaWiFS data, along with observations by Vernet (BP-016), is being used to study the relationship of pigment biomass to other environmental parameters. Microwave and scatterometer analysis were carried out in collaboration with Martinson and Stammerjohn (B-

021-L). These satellite data are being used to investigate the larger regional domain surrounding the Palmer LTER ship sampling grid as well as the space/time climatology and seasonal variability of the western Antarctic Peninsula region. These data are also being used in the collaboration with the PAL PI synthesis effort (see Vernet findings).

### **Microbes and Biogeochemistry (Ducklow BP-045) 2003-2004**

2003-2004 was our second full season since joining PAL LTER. We conducted semi-weekly sampling in Arthur Harbor (LTER Stations B,E) via Zodiac continuously from mid-October, 2003 until 01 April, 2004. The work is coordinated closely with Maria Vernetis (BP-016) sampling. Our objective is to gain a new understanding of the variability in bacterial dynamics and carbon cycling in the immediate nearshore ecosystem, as well as attaining insights into the controlling factors and linkages to processes occurring offshore as sampled on the annual summer cruise. We collected data on bacterial abundance and production rates, dissolved organic carbon concentrations and lipid biomarkers.

We also participated on LMG 04-01. Ducklow served as Chief Scientist. The specific objectives of our project are to understanding the role of bacteria in the Antarctic marine foodweb and document spatial and interannual variability in selected carbon system properties (DOC and DIC). The deep ocean sediment trap array was recovered and redeployed successfully.

In addition to fieldwork we completed sample analyses for some but not all samples collected in 2002-2003. Analysis of DOC samples was delayed because the Palmer Station DOC analyzer proved unreliable for the second straight year. DIC samples were subcontracted to Lamont Doherty for analysis. Sediment trap samples for 2003 and 2004 are being analyzed now. All bacterial samples for 2002-03 and 2003-04 have been analyzed. Data are being processed now. We are analyzing data on DOC release experiments performed by the 016 group. Finally, we completed an inverse model analysis of the marine foodweb (including penguins) in the LTER study area (Robert Danielsí MSc thesis at VIMS). This work continues with a comparison between the LTER and Ross Sea foodwebs. Ducklow is invited to give a keynote address at the SCAR-EASIZ Final Symposium in September, and will synthesize findings from LTER and other Antarctic programs (AESOPS, ROAVERRS, BAS etc).

*Education activities*- Two REU students (one William & Mary, one Oberlin College) participated on our January cruise, experiencing the Antarctic environment, learning about oceanographic research and participation in our investigations in microbiology and biogeochemistry. A third RU student (W&M) created a website featuring the W&M educational initiative in the Antarctic and its interactions with the Williamsburg K-12 schools. A 4th REU student (UVA) worked in the lab at VIMS processing sediment trap samples. Lauren Rogers, a recent Stanford graduate supervised my field program for the entire season, learning about every facet of our research from logistic setup to field and labwork to data management.

### **Information Management (Baker)**

Site data management activities included support for annual updates to the Palmer LTER database. In addition, transition of the Palmer LTER computational infrastructure was planned and largely carried out this year after a decade of hardware use. In preparing for redesign of the Palmer LTER data system, an earlier workshop on Data Management Exchange provided input for the installation of the Joint Global Ocean Flux Studies (JGOFS) Data Management System. Installation occurred this year. The system is one the oceanographic community's standards

(<http://usjgofs.who.edu/jg/dir/jgofs/>) and Palmer PIs are familiar with the user interface. This application makes use of hierarchical file structure by study (cruise or season) so is compatible with the existing Palmer LTER system; conversion scripts are required to migrate to the expected JGOFS formats. Transfer of the data has been initiated with the goal of porting a full set of files from one cruise and one particular file from all the cruises in order to identify all data migration issues that need to be addressed and put needed computational infrastructure into place. In addition, the JGOFS data requirements are being juxtaposed with the LTER Ecological Metadata Language requirements as data is quality controlled and normalized. Transition work includes a site variable dictionary and establishment of a unit dictionary in XML and compatible with JGOFS and EML. A mapping of the site metadata form tags to those of EML has been initiated; full requirements are a subject of ongoing development throughout the community. Additional analysis packages such as LAS/FERRET and Ocean Data View and community exchange protocol packages such as NVOBS and OPENDaP are being investigated as part of transition efforts.

A focus on science and technology studies continues with collaborators G. Bowker, chair of the Dept of Communication at UCSD and H Karasti at the University of Oulu. This work has been presented to the LTER community via talks and written communications including articles in the LTER Newsletters. A paper was presented at the Hawaii International Conference on System Science and a poster presented at the LTER All Scientists Meeting. Follow-up on the Computer Supported Scientific Collaboration Workshop at the European Computer Supported Cooperative Work Conference in September 2003 included a published proceedings and a paper as well as the opportunity to consider, together with the international community, how collaboration in the field of science is being addressed.

LTER Network activity included participation in the LTER Information Manger Committee, attendance at the LTER IM Committee Meeting, a web services workshop, and an LTER IM Executive Committee Meeting in San Diego. Support was provided for the Spring 2004 LTER IM Databits issue. A new Palmer LTER website is under design that includes integration of a subset of collaborative tools and synergies with ongoing efforts at the LTER Network Office, at other LTER sites, and with an Antarctic NEON.

### **Outreach and Education (Baker)**

Palmer LTER education activities are summarized on the site education web page (<http://www.ices.ucs.edu/lter/education>). Coordination with the LTER Network Schoolyard activities continues with Palmer LTER participants attending and presenting at the education meetings held at the LTER All Scientists Meeting in Seattle (KS Baker, BE Simmons, and DRowls, 2003. Palmer LTER Outreach: Education-by-Design; R Bohanan, P McCartney, K Baker, A Berkowitz, and S Ortega. Integrating Long-Term Ecological Research and Data into Education Seattle, Washington, 18-21 September 2003).

Contacts with primary and secondary schools continued through partnerships with classrooms and university education office efforts. Coordination is ongoing with partners Scripps Committee for Outreach Programs in Education (SCOPE), an oceanography program taking science into the classroom, and the California Center for Ocean Science Education Excellence (COSEE), an NSF regional ocean science center consortium, a program fostering community awareness of long-term Antarctic science through outreach. Attendance at a national education workshop (B. Simmons, 2003. Looking at Data: Sea Ice. Science Education Resource Center) provided

feedback for the site's ongoing work this year in developing a Palmer LTER education framework. Prototype modules and lessons are under development in addition to a summary of the underlying pedagogy. Work with a subset of researchers helped to identify initial topics and data sets of interest for teaching at various levels of K-12 curricula.

LTER and Palmer LTER were highlighted at the UCSD/SIO annual open house (B Simmons, and K Baker, 2003. Palmer Station Antarctic Marine Biome and the Long-Term Ecological Network) with over a thousand attendees and 100 participants stopping to take a survey about Antarctica and to hear about Palmer LTER work. The survey provided valuable feed-back for next year's outreach efforts and about public perceptions of Antarctic Scientific research. Partnerships continue to develop with UCSD Preuss Middle/High School in La Jolla, California and with Rawls Byrd Elementary School in Williamsburg, Virginia. Other ongoing informal education efforts include contributions to the UCSB Marine Science Education Center-tours of touch tanks for pre-schoolers and VIMS publications (H Ducklow, VIMS leads long-term ecological research program in Antarctica. *The Crest*. 5: 6, 2003). The William & Mary outreach site (<http://www.wm.edu/antarctica>) presents a variety of Palmer activities, lessons, and continues field journaling representing a range of participant views over the years including teachers, volunteers, PhD's, students and technicians (LTER Network News, Baker, 2001).

Collaboration with authors whose work reaches K-12 student classrooms introduces the concepts of long-term and marine ecosystem science through both non-fiction and fiction books. Palmer LTER is cited in Mary Cerullo's recent book 'Under-the-Antarctic-ice'. As author of *Phytoplankton Soup* and *Zooplankton Soup*, collaboration on another school book is under discussion. Coordination continues with author Lucy Bledsoe, a participant in the NSF/OPP program for Artists and Writers for the 2003-2004 season. Palmer LTER contributed to the LTER Newsletter an article on Bledsoe's Antarctic book series (D Rawls, Palmer LTER Site: Publication of New Children's Book, *The Network Newsletter* Fall2003). Having sponsored an Antarctic Storytelling workshop introducing LTER concepts prior to Bledsoe's deployment, a post-deployment workshop is planned.

## RESEARCH FINDINGS

### Specific findings:

#### Seabirds (Fraser BP-013).

With the conclusion of the 2003-2004 season, we ended the acquisition of two complementary, overlapping databases on AdÉlie penguin foraging ecology that span the combined efforts of the GLOBEC and LTER programs since autumn 2001, and include continuous seasonal data on diets, foraging locations and dive profiles. Following the development of a statistical filter to validate and merge some database components, analyses are progressing with the objective of presenting results at the upcoming July 2004 SCAR meetings in Germany. Preliminary findings indicate there are significant differences in all aspects of AdÉlie penguin foraging ecology between the Palmer and Marguerite Bay populations. Moreover, and especially significant, is that we have observed gender-specific differences in the winter foraging ecology of this species that may account for some previously unexplained trends in the demography of AdÉlie penguins.

#### Phytoplankton (Vernet BP-016 and Vernet/Smith BP-032).

This component of the Palmer LTER is studying the spatial and temporal variability of primary production in the Western Antarctic Peninsula, physiochemical 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 edge dynamics during the spring and summer and, to a lesser extent, with the ice during the previous winter. (2) This year production was slightly higher than last season. (3) Dilution experiments to estimate the fate of the phytoplankton carbon revealed that microzooplankton grazing in coastal waters near Palmer Station (St. B) was negligible throughout the season (average = - 0.0009 d<sup>-1</sup>, stdev = 0.009 d<sup>-1</sup>, n = 17). These results continue to be consistent with the 2002-2003 season at Palmer as well as Ross Sea estimates. (5) Experiments of bacterial uptake of phytoplankton carbon excretion show low values (1-2% of primary production ñ see Ducklow results). (6) Experiments suggest that macrozooplankton grazing and cell sedimentation are the main sources of loss of phytoplankton from the upper mixed layer, with advection being an unknown factor. (7) Size fractionation of chlorophyll a through the season show that Palmer Station has a classical bloom development with a high proportion of small cells early in the season (October through December), including through the spring bloom (December), while large cells dominate/become more dominant during the January bloom and then during the fall (March).

The rate of primary production at Palmer Station in this season was average, with an estimated annual production of 220.8 g C m<sup>-2</sup> year<sup>-1</sup> (integrated over 6 months) from a maximum of 354 g C m<sup>-2</sup> year<sup>-1</sup> measured in 1995-1996 and a minimum of 54 g C m<sup>-2</sup> year<sup>-1</sup> in 1998-1999. Regional daily production on the shelf, sampled in January of 2004, was slightly below average, with 428 mg C m<sup>-2</sup> d<sup>-1</sup>, compared to the 10-year mean of 609 mg C m<sup>-2</sup> d<sup>-1</sup>. Chlorophyll levels mirrored the main production pulses (late November, late December and early February) throughout the season, with an additional increase in the measured chlorophyll a without a corresponding increase in production in the late fall (late March).

### **Zooplankton and micronekton (Ross/Quetin BP-028).**

During the 0304 season, salps were primarily restricted to the northern transects and the outer shelf stations of the study region. Recruitment success of the 2003 year class of Antarctic krill was low, and reproduction the summer of 2004 delayed, but abundance was at approximately average levels. With grazing experiments performed on station, we found a strong correlation between measured ingestion rate and the pigment content (whole body fluorescence) of Antarctic krill. This information will allow us to better interpret grazing activity data (whole body fluorescence) taken at process stations during the annual cruise. Analysis of samples taken in austral spring 2002 for diet analysis with a molecular fingerprint technique (PCR-DGGE) was completed. The diet of krill feeding under the ice in spring showed evidence of feeding both on the sea ice biota and in the water column.

### **Bio-optics (Smith/Vernet BP-032)**

Using satellite data we have developed a monthly climatology for a larger (~ 10 times) regional domain surrounding our normal 200 km x 1000 km Palmer LTER ship sampling grid along the western Antarctic Peninsula (WAP). This climatology covers the seven seasons from 1997/98 through 2003/04 and permits our regular January cruises to be placed into a larger spatial and a seasonal temporal context. These data are permitting a testing of several of our original, as well as a few new, hypotheses relating sea ice and pigment biomass. We find, in agreement with our initial hypothesis, that pigment biomass in the WAP region usually require relatively shallow mixed layer depths including, especially, those produced by stratification in the marginal sea ice zone. However, we may also be seeing an important influence of glacial melt water and investigating this influence is a current research focus. In addition, the climatology for the larger regional domain often shows increased biomass beginning in early spring beyond the shelf break before moving on shore in late spring, early summer. There is also evidence that a strong (weak) spring bloom follows a strong (weak) fall bloom, in agreement with the Ackley/Sullivan phytoplankton entrainment in sea ice hypothesis. This larger climatology should also permit an evaluation of the influence of the Antarctic Circumpolar Current (and associated Circumpolar Deep Water) as compared to local forcing within the Palmer LTER grid.

### **Microbes and Biogeochemistry (Ducklow BP-045) 2003-2004**

We have now observed bacterial production rates for parts of all of 3 field seasons at Palmer Station (Jan-Mar 2002; Nov, 2002 ñ March, 2003 and Oct, 2003 ñ April 2004). There is substantial short-term (~10 day), seasonal and interannual variability in the BP signal. In general rates are low (~5% of NPP) but not inconsistent with observations elsewhere in the Antarctic. BP appears to be limited by the supply of dissolved organic matter from phytoplankton, which appears to average less than 10% of the NPP. Bacterial numbers as well as cell size and physiological state (DNA content) begin to increase in December, about a month after the phytoplankton. This initial rise is followed by a series of miniblooms lasting into March. The bacterial signal appears to be reflected in the temporal sequence of semilabile DOC concentrations. Semilabile DOC averages about 10-20 µMol above the deepwater background value, without a clear seasonal pattern.

We completed construction of a detailed, quantitative description of foodwebs for the LTER region in 1996 and 1999 (high and low production years respectively). Our approach was to use as much of the LTER data as possible and then use an inverse method top reconstruct the missing (not observed) flows. The models show that krill dominate the carbon fluxes in both



years, removing substantial portions of the primary production. The microbial loop and DOC fluxes are a relatively small part of the total carbon throughput but still significant. Only a small fraction of CO<sub>2</sub> (< 1%) is released by upper trophic level predators, in contrast to earlier speculations.