Preview of Award 1344502 - Annual Project Report

Cover

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Submission Date:	N/A
Signature of Submitting Official (signature shall be submitted in accordance with agency specific instructions)	N/A

Accomplishments

*** What are the major goals of the project?**

The major goal of our project is to obtain a comprehensive understanding of the Antarctic coastal marine ecosystem of the western Antarctic Peninsula, a region strongly impacted by regional warming, through long-term observations, experiments and process studies and numerical mdeling.

*** What was accomplished under these goals (you must provide information for at least one of the 4 categories below)?**

Major Activities: Sea Ice & Climate. We focused on understanding how regional and seasonal air-sea-ice interactions led to record-breaking high sea ice extents across Antarctica in 2013. We investigated the physical mechanisms underlying ice-ocean-ecosystem interactions to better predict their space-time variability. We are finalizing analyses of modeled ice-ocean-ecosystem interactions using assimilated mooring data to investigate the role of deep ocean heat on sea ice dynamics and different iron sources from different seasonal ice-ocean interactions and the impact on biological productivity. We also investigated the ice-climate system on space/time scales relevant to polar marine ecology, including short term (episodic) to long-term (climate change) variability.

Physical Oceanography. New this year was an assessment of the northern grid

physical oceanographic variables covariance matrix, via an optimal interpolation allowing filling of stations no longer sampled in the original northern grid. We also did a thorough analysis to determine which few northern grid stations might allow the best optimal interpolation of those not sampled. Grad student Darren McKee took the lead in determining the best location for our moorings and glider tracks allowing us to determine if the dominant UCDW enters the shelf via the other canyons that intersect the continental shelf break like the Marguerite Trough.

Modeling. We are using an inverse foodweb model constrained with data from the annual cruises. We generated two model solutions for north and south regions with Adélie penguin colonies presenting different population trends over 1995−2006. We are working with a global ocean model, the Community Earth System Model to investigate biogeochemical processes and climate-biogeochemical interactions in the Southern Ocean to provide broader context for PAL. Specific foci include the marine iron, carbon and oxygen cycles. We are utilizing 1 km satellite and *in situ* data to characterize the spatial and temporal variations of phytoplankton in relation to physical circulation, sea-ice, and bathymetry. At local scales, canyons bisect the shelf and act as conduits for warm UCDW, reduce seasonal ice concentrations, and provide a reservoir of macro and micronutrients. Shoreward of many canyon heads are Adélie penguin breeding colonies. We address the hypothesis that these locations reflect predictable access to higher biological productivity overlying the canyons.

Microbes. PhD student Cat Luria is working on her thesis on microbial community composition for the past 2 years at Palmer Station and aboard our cruise. We continued to conduct Thorium-234 disequilibrium measurements and NO3 uptake assays on the cruise, to provide new data on particle export and new production in the WAP system, and with a view to making this an ongoing component of our core measurements in the next award period. A new PhD student (Ms. Hyewon Kim) has started time series analyses of macronutrient stocks (N, P, Si) in our study region.

Phytoplankton. The phytoplankton group focused on phytoplankton community composition and biogeochemistry, temperature regulation of physiological flexibility in natural phytoplankton communities, correlation scales between high phytoplankton productivity and zones of penguin foraging, role of modified circumpolar deep water in driving phytoplankton blooms, transport of heat via subsurface eddies steered by seafloor topography, trace signatures of methyl mercury in phytoplankton communities, and collection of core time series measurements at Palmer station and the LMG. These objectives were studied using traditional techniques, flow through sampling from the ship, deployment of underwater gliders, and manipulative experiments. New results are published in Nature Communications (Saba et al 2014).

Zooplankton. We emphasized the role that zooplankton play in carbon and nutrient cycling, long-term changes in zooplankton community structure, and characterizing the zooplankton prey field in penguin foraging regions. In addition to core net hauls, we performed fecal pellet production experiments to determine their role in export of organic carbon. Using an acoustic towfish we surveyed deep-canyon penguin feeding grounds to investigate penguin prey fields. Sample analysis of copepod community structure was completed by M. Gleiber, who defends her MS in August. We also completed analysis of the macrozooplankton data for long-term abundance trends and effects of environmental parameters on these trends.

Seabirds. We operated from November 2013 to April 2014, sampling daily as weather and sea ice allowed, focusing on the demography, foraging ecology and breeding biology of Adélie, gentoo and chinstrap penguins. On the LMG, we surveyed seabirds and marine mammals within the LTER grid, and conducted a 5-day field camp on Avian Island, Marguerite Bay, but were not able to reach Charcot Island, our most southerly Adélie penguin research site. Remaining cruise time was as a result focused on the northern half of the grid, which allowed us to conduct censuses and obtain diet samples at important, but rarely visited seabird colonies near Prospect Point, Renaud Island and the Cape Monaco-Rosenthal Islands region.

Cetaceans. We are incorporating a cetacean component to the LTER program both intellectually and operationally. Core activities included underway visual surveys from the LMG and photo-ID and biopsy sampling from small boats across the LTER grid. We covered a substantial portion of the study area in coastal and offshore, and open and ice-covered waters. We were able to take advantage of several opportunities to collect skin and blubber biopsy samples that are critical to understanding population structure and demographics in the cetacean community. As well, we collected over 50 unique photo-ID images of humpback whales that contribute to our long-term catalog of known individuals and that will enhance our ability to determine connectivity between feeding and breeding grounds.

Information Management. PAL and CCE collaborated on improving data access and availability, resulting in major improvements to the fundamental structure supporting data management processes and workflows. Additional databases were added to the system. A comprehensive pre-published database was built to support an integrated environment for producing research-critical data products and supporting new or improved elements of quality control and quality assurance. The incorporation of this new database has improved both the quality of published data products as well as IM's ability to provide synthetic products to facilitate research objectives. A re-designed on-disk file structure, standardized data processing scripts and an activity and process tracking database were also developed to provide a well documented and traceable workflow for data submission, documentation, processing and publishing.

Education & Outreach. Use of technology for PAL E/O requires coordination between station, vessel and local resources. Webcams will transport students an Adélie penguin breeding site. From iPads students will predict survey areas, design functions of AUVs and use Google Earth to track penguins. Technology specialists, curriculum coordinators and teachers have tested communications between school and station. Students will use data to study penguin foraging tracks and hydrography, including 3D chlorophyll and temperature maps. Google Earth will help students predict optimal foraging areas. A partnership with the PoLAR Project aids us in developing *Ecochains,* an Antarctic card game focusing on species reliance on sea ice. *Polar Voices* ture will have PAL scientists explaining research against a backdrop of soundscapes with voice actors stringing together events to create a contemporary story asking audiences to rethink, understand and respond to climate change in Antarctica.

Specific Objectives:

Significant Results:

Sea Ice and Climate. 2013 was a record-breaking year for daily maximum Antarctic sea ice extent. There were 116 days when the daily maximum circumpolar sea ice extent reached an all-time record high for that particular day (**Fig 1;** Reid et al., accepted). The new record high for maximum winter sea ice extent was reached on 1 Oct 2013 at 19.6 x 106 km2 and was 2 standard deviations above the 1979-2012 mean. On the

2013 record day, sea ice extent was higher in nearly all Southern Ocean regions. Analysis of ice, ocean and atmosphere anomalies reveals a sequence of regional wind and ocean patterns contributing to the record maximum, and across the Antarctic continent, there were above normal temperatures and pressures from Aug-Oct, with many of these anomalies exceeding 3 standard deviations (Fogt et al, submitted). For the PAL study region, the anomalously long ice season was unusual and opposite in sign to the (decreasing) long term trend (**Fig 2**). The long ice season was primarily due to a late spring sea ice retreat, a new record for the PAL time series (1990-present). New model results indicate that advective-driven thermocline variability can contribute to a shortening of the ice season by entraining more ocean heat from below, decreasing ice production, total ice thickness and consequently, the ice season (**Fig 3**) (Saenz et al., in prep).

Physical Oceanography. We have processed all of the CTD data and mooring data through 2013, submitted them to the relevant national data repositories and loaded them onto our local webpage. Our results of the grid sampling analysis unfortunately showed that we are unable to fill the northern grid with the limited number of stations we have time to sample. We have devised a mooring array with glider tracks that should allow us to answer the question of cross-shelf transport for what appears to be the second most important canyon-hotspot in our system. We found that the incredibly good correlation between global deep water and local UCDW warming was artificially enhanced by standardizing the data so that they could be presented at a similar scale. We are currently re-evaluating the best manner with which to make this comparison. We expect to have this issue resolved and the paper published shortly.

Numerical Ecosystem Modeling. Sailley et al (2013) found that the northern WAP is dominated by the microbial food web, with an increasing trend (**Fig 4**). Sensitivity analyses indicated that the northern colony of Adélie penguins appears to have sufficient krill during summer to sustain its basic metabolic needs and rear chicks, suggesting the importance of other processes in regulating the Adélie population decline. Jonsson et al. (*submitted*) found that 2 climate models represent well some aspects of the seasonal structures of Southern Ocean phytoplankton biomass and net community production. Below 60S, the models fail to predict the observed extent of biological O2 undersaturation likely due to problems with the simulated ecosystem dynamics or vertical transport of oxygen (**Fig 5**). Kavanaugh et al. (*submitted*) found that canyons exhibited higher sea surface temperature and reduced ice coverage relative to adjacent shelf areas (**Fig 6**). In situ and satellite-derived pigment patterns indicate increased dominance by diatoms over canyons and seasonal ice-dependent shifts in phytoplankton biomass. Canyons appear to support a phytoplankton community conducive to both grazing by krill and enhanced vertical export.

Microbial Biogeochemistry. In Ducklow et al (2013), we conceptualize the Antarctic coastal zone as an integrated system including the terrestrial coastal domain along with the water column and nearshore benthos. Observations at Palmer and Rothera (BAS) Stations provide comparison of similar nearshore systems experiencing a range of annual sea ice cover. **Fig 7** illustrates the annual spring-summer phytoplankton blooms in the two areas, following the annual sea ice retreat.

Phytoplankton Ecology. We documented how climate variability ripples through the food web using two decades of data (Saba et al 2014). Positive anomalies in chlorophyll-*a* and bacterial productivity, occurring on average every 4-6 years (**Fig 9**), were

constrained by physical processes in the preceding winter/spring and a negative phase of the Southern Annular Mode (SAM). Favorable conditions for phytoplankton, specifically diatoms, were increased winter ice extent and duration, reduced spring/summer winds, and increased water column stability via enhanced salinity-driven density gradients. Years of positive chl-*a* anomalies were associated with a robust krill cohort the following summer, which was evident in Adélie penguin diets, thus demonstrating a tight coupling within the food web. The projected increase in positive SAM events, winds, temperature, and sea-ice decline will have significant, negative impacts on phytoplankton biomass, krill recruitment, and upper trophic levels.

Zooplankton Ecology. We examined long-term changes and subdecadal cycles in abundance of major taxa of macrozooplankton (1993-2013) and their relationship with sea ice, atmospheric climate indices, phytoplankton biomass and productivity, and sea surface temperature (**Figs 10-11**). Trends for krill species included a 5-year cycle in abundance peaks (positive anomalies) for *Euphausia superba* but no long-term trend, and an increase in *Thysanoessa macrura* in the North; with variability in both species strongly influenced by primary production 2-years prior. *E. crystallorophias* abundance was more closely tied to ice duration. The salp *Salpa thompsonii* and pteropod *Limacina helicina* cycled between negative and positive anomalies in the North, but with increasing positive anomalies in the South over time. Variation in salp and pteropod abundance were best explained by the Antarctic Oscillation index and Multivariate El Niño Southern Oscillation index, respectively; higher abundance of both species occurred in more ice-free conditions. There was also an increase in carnivorous gelatinous zooplankton (chaetognaths *Pseudosagitta* sp, and polychaete worm *Tomopteris* sp).

Seabird Ecology. Although Adélie penguin demography is thought to be influenced primarily by variability in the marine environment, an analysis of long-term population trends in our region provides the first evidence that populations are also affected by non-marine forcing factors (Fraser et al 2013). Trends over two decades show that demography has a “habitat-specific” component forced by interactions between the geomorphology of terrestrial breeding sites and prevailing wind direction, and which affect patterns of snow deposition that determine both the extent and quality of nesting habitat across the landscape. Penguin populations on different islands show different rates of decrease between islands (**Fig 12**). As the areal extent of suboptimal breeding habitat increases, so does the rate of population decrease.

Cetacean Ecology. We have generated movement tracks for humpback whales outfitted with satellite-linked tags and show their movement in and around the LTER study region in summer months (**Fig 13, Table 1**). Having demonstrated that the distribution of humpback whales is primarily affected by that of Antarctic krill, our main hypothesis is that the movement pattern of humpback whales throughout the summer months into the autumn will reflect the distribution and abundance of krill and therefore the home range areas of whales will become more coastal and concentrate over time. We find this to be the case (**Fig 14**) for a number of different spatial use metrics, confirming our belief. This knowledge about how whales move and respond to environmental change will be the focal point of our future research, and linking how the behavior of whales affects or is linked with those of other krill predators in the region will be tested in the future.

Key outcomes or Other

achievements:

*** What opportunities for training and professional development has the project provided?**

The IM for PAL LTER (James Conners) was elected to the LTER Information Management Executive Committee during the 2013 Annual IMC Meeting at UAF in Fairbanks, Alaska. He attended the Annual IM Executive meeting in February 2014, hosted by CAP LTER at Arizona State University in Tempe Arizona. J. Conners also attended the EarthCube End-User Ocean Ecosystem Dynamics Workshop in October 2013 at Woods Hole, MA, the goal of which was to discuss cyberinfrastructure needs of the ocean ecosystem dynamics community.

Second-year PhD student Darren McKee (Columbia) participated in his first annual LTER cruise, where he took charge of the moorings and CTD program and learned extensively from the other PIs by helping with their research during his downtime. Darren gave his first *major* oral conference presentation at the Ocean Sciences Honolulu meeting.

*** How have the results been disseminated to communities of interest?**

Results have been presented at conferences and meetings, public lectures and educational outreach outlets such as kiosks at the Smithsonian Natural History Museum and Boston Aquarium.

*** What do you plan to do during the next reporting period to accomplish the goals?**

In our final reporting period we will continue to analyze our data and synthesize results. A joint special issue of BioScience is planned with MCM-LTER to examine common and contrasting biotic responses to climate forcing.

Supporting Files

Filename	Description	Uploaded By	Uploaded On
Figures for PAL Report.pdf	PDF of supporting Figures for Significant Results.	Hugh Ducklow	06/12/2014

Products

Books

Book Chapters

Doney, S.C. (2013). Marine ecosystems, biogeochemistry, and climate. *Ocean Circulation and Climate, 2nd Ed. A 21st century perspective 2.* G. Siedler, S.M. Griffies, J. Gould, and J.A. Church. Academic Press. London. . Status = PUBLISHED; Acknowledgement of Federal Support = Yes ; Peer Reviewed = Yes ; ISBN: 978-0-12-391851-2.

Schofield, O., Kohut, J., Saba, G., Xu, Y., Wilkin, J., Glenn, S. M. (2014). Ocean observing and prediction. *Encyclopedia of Natural Resources.* Wang, Y. Q.. Taylor & Francis. New York, NY. . Status = PUBLISHED; Acknowledgement of Federal Support = No ; Peer Reviewed = Yes ; DOI: 10.1018/E-ENRW-120048087.

Conference Papers and Presentations

D.C. McKee, D.G. Martinson, O. Schofield (2014). *A Spatio-Temporal Study Of The Transport Of Upper Circumpolar Deep Water Onto The Western Antarctic Peninsula Continental Shelf*. TOS/AGU/ASLO Ocean Sciences Meeting. Honolulu, HI. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Saba, G. K., Fraser, W. R., Saba, V. S., Ducklow, H. W., Schofield, O. (2014). *Austral winter and spring controls on the food web at Palmer station, West Antarctic Peninsula.*. TOS/AGU/ASLO Ocean Sciences Meeting. Honolulu, HI,. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Schofield, O., Saba, G., Finkel, Z., Irwin, A., Ducklow, H. (2014). *Biogeochemical and ecological consequences of phytoplankton community composition along a melting West Antarctic Peninsula.*. TOS/AGU/ASLO Ocean Sciences Meeting. Honolulu, HI,. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Schofield, O., Meredith, M., Newman, L. (2014). *Building a Southern ocean observing system.*. TOS/AGU/ASLO Ocean Sciences Meeting. Honolulu, HI,. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Gleiber, M. R., Steinberg, D. K. (2014). *Copepod community structure and climate warming along the Western Antarctic Peninsula*. TOS/AGU/ASLO Ocean Sciences Meeting. Honolulu, HI. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Schofield, O. (2013). *Dawn in the new age of robotic oceanography*. XXV Meeting of the Council of Managers of National Antarctic Programs. Seoul, S KOREA. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Schofield, O (2013). *Invited Plenary Talk: Dawn in the age of robotic phycology*. International Phycological Congress.. Orlando, FL. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Glenn, S., Schofield, O., Kohut, J. (2014). *Leveraging ocean observatories and web-based educational tools for sustained undergraduate research in ocean science*.. TOS/AGU/ASLO Ocean Sciences Meeting. . Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Steinberg, D. K., H. W. Duckow, and C.M. Luria. (2014). *Production of dissolved organic matter by Antarctic zooplankton and its effect on bacteria production.*. TOS/AGU/ASLO Ocean Sciences Meeting. Honolulu, HI,. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Kavanaugh, M. T., Doney, S. C., Ducklow, H. W., Schofield, O., Stammerjohn, S. E. (2014). *Role of submarine canyons on phytoplankton dynamics along the Westerm Antarctic peninsula*. TOS/AGU/ASLO Ocean Sciences Meeting. Honolulu, HI,. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Brum, J. R., Hurwitz, B. L., Schofield, O., Ducklow, H. W., Sullivan, M. B. (2014). *Seasonal time bombs: Temperate viruses dominate the Southern Ocean and substantially affect microbial dynamics.*. TOS/AGU/ASLO Ocean Sciences Meeting. Honolulu, Hawaii. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Curtice, C., A. Friedlaender, D. Johnston, P. Haplin, N. Gales, and H. Ducklow. (2014). *Spatially and temporally dynamic humpback whale feeding areas in Antarctica.*. Symposium on Animal Movement and Environment. Raleigh, NC. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Schofield, O. (2013). *The Center of Southern Ocean Biogeochemical and Ocean Modeling.*. Southern Ocean Observing System Science Steering Committee Meeting and Southern Ocean Asian Science Workshop.. Shanghai, CHINA. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Carvalho, A. F., Schofield, O., Saba, G., Kohut, J., Ducklow, H. (2014). *The role of light availability and nutrient delivery in controlling phytoplankton bloom in Palmer Canyon in West Antarctic Peninsula*. TOS/AGU/ASLO Ocean Sciences Meeting. Honolulu, HI. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Inventions

Journals

Bernard, Kim S and Steinberg, Deborah K (2013). Krill biomass and aggregation structure in relation to tidal cycle in a penguin foraging region off the Western Antarctic Peninsula. *ICES Journal of Marine Science: Journal du Conseil*. 70 (4), 834--849. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Constable, Andrew J and Melbourne-Thomas, Jessica and Corney, Stuart P and Arrigo, Kevin R and Barbraud, Christophe

and Barnes, David KA and Bindoff, Nathaniel L and Boyd, Philip W and Brandt, Angelika and Costa, Daniel P and others (2014). Climate change and Southern Ocean ecosystems I: How changes in physical habitats directly affect marine biota. *Global change biology*. . Status = ACCEPTED; Acknowledgment of Federal Support = No ; Peer Reviewed = Yes

Convey, Peter and Chown, Steven L and Clarke, Andrew and Barnes, David KA and Bokhorst, Stef and Cummings, Vonda and Ducklow, Hugh W and Frati, Francesco and Green, TG Allan and Gordon, Shulamit and others (2014). The spatial structure of Antarctic biodiversity. *Ecological Monographs*. 84 (2), 203--244. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Ducklow, H.W., Fraser, W.R., Meredith, M.P., Stammerjohn, S.E., Doney, S. C., Martinson, D.G., Sailley, S.F., Schofield, O.M., Steinberg, D.K., Venables, H. J., and Amsler, C.D. (2013). West Antarctic Peninsula: An ice-dependent coastal marine ecosystem in transition. *Oceanography*. 26 (3), 190. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Fogt RL, Scambos TA, Barreira S, Braathen GO, Bromwich DH, Campbell GG, Clem KR, Colwell S, Haran T, Johnson B, Keller LM, Kramarova N, Lazzara MA, Lieser J, Liu H, Long CS, Massom RA, Nash ER, Newman PA, Pitts MC, Pope A, Reid P, Santee ML, Setzer A, Shu S, Stammerjohn S, Wang L, Wang S-H, Wang S, Weber M. (2014). State of the Climate 2013, Antarctica.. *Bulletin of the American Meteorological Society, Special supplement*. . Status = OTHER; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Fraser, William R and Patterson-Fraser, Donna L and Ribic, Christine A and Schofield, Oscar and Ducklow, Hugh (2013). A nonmarine source of variability in Ad{\'e}lie penguin demography. *Oceanography*. 26 (3), 207--209. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Garzio, L.M., Steinberg, D.K., Erickson, M., and Ducklow, H.W. (2013). Microzooplankton grazing along the Western Antarctic Peninsula. *Aquatic Microbial Ecology*. 70 215. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Jonsson, B.F., S. Doney, J. Dunne, and M.L. Bender. (2014). Evaluating Southern Ocean biological production in two ocean biogeochemical models on daily to seasonal time-Scales using satellite chlorophyll and O2/Ar observations.. *Biogeosciences*. . Status = SUBMITTED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Kavanaugh, M.T., F.N. Abdala, H. Ducklow, D. Glover, W. Fraser, D. Martinson, S. Stammerjohn, O. Schofield, and S.C. Doney. (2014). The effect of continental shelf canyons on phytoplankton biomass and community composition along the western Antarctic Peninsula.. *Marine Ecology Progress Series*. . Status = SUBMITTED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Massom, R. A., Reid, P., Stammerjohn, S., Barreira, S., Leiser, J., and Scambos, T. A. (2013). Antarctica: Sea ice extent and concentration [in "State of the Climate in 2012"]. *Bull. Amer. Meteor. Soc.*. 94 (8 (Supp)), S141. Status = PUBLISHED; Acknowledgment of Federal Support = No ; Peer Reviewed = Yes

Meredith, M. P., Schofield, O., Newman, L., Urban, E., Sparrow, M. (2014). Development and long-term vision for the Southern Ocean Observing System.. *Current Opinion in Environmental Sustainability*. . Status = PUBLISHED; Acknowledgment of Federal Support = No ; Peer Reviewed = Yes ; DOI: doi.org/j.cosust.2013.02.002

Misumi, K., Lindsay, K., Moore, J.K., Doney, S. C., Bryan, F.O., Tsumune, D., and Yoshida, Y. (2013). The iron budget in ocean surface waters in the 20th and 21st centuries: projections by the Community Earth System Model version 1.. *Biogeosciences Discussions*. 10 8505. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Muller-Karger, F., Roffer, M., Walker, N., Oliver, M., Schofield, O., Abbott, M., Graber, H., Leben, R., Goni, G (2014). Satellite remote sensing in support of an integrated ocean observing system.. *Geoscience and Remote Sensing Magazine. IEEE*. 1 (4), 8. Status = PUBLISHED; Acknowledgment of Federal Support = No ; Peer Reviewed = Yes

Pedulli, M., JJ. Bisagni, HW. Ducklow, R. Beardsley and C. Pilskaln (2014). Estimates of potential new production (PNP) for the waters off the western Antarctic Peninsula (WAP) region. *Continental Shelf Research*. 84 . Status = AWAITING_PUBLICATION; Acknowledgment of Federal Support = No ; Peer Reviewed = Yes

Reid P, Stammerjohn S, Massom R, Scambos T, Leiser J. (2014). The record 2013 Southern Hemisphere sea ice extent maximum.. *Annals of Glaciology*. . Status = ACCEPTED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Saba, GK, Fraser, WR, Saba, VS, Iannuzzi, RA, Coleman, KE, Doney, SC, Ducklow, HW, Martinson, DG, Miles, TN, Patterson-Fraser, DL, Stammerjohn, SE, Steinberg,DK and Schofield, OM. (2014). Winter and Spring Controls on the Summer Food Web of the coastal West Antarctic Peninsula. *Nature Communications*. . Status = AWAITING_PUBLICATION; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Saenz B, Stammerjohn S, Doney S, Fritsen C, Ross R, Quetin L, Vernet M. (2014). Marine physical-biological coupling in the west Antarctic Peninsula. *Journal of Geophyscial Research Oceans.*. . Status = OTHER; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Saenz B, Stammerjohn S, Doney S. (2014). Ice-atmosphere-ocean coupling in the west Antarctic Peninsula.. *Journal of Geophyscial Research Oceans.*. . Status = OTHER; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Sailley, S.F., Ducklow, H., Moeller, H.V., Fraser, W. R., Schofield, O., Steinberg, D.K., Garzio, L.M., and Doney, S. (2013). Carbon fluxes and pelagic ecosystem dynamics near two western Antarctic Peninsula Adélie penguin colonies: an inverse model approach.. *Marine Ecology Progress Series*. 492 253. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Schofield, O., Glenn, S., and Moline, M. (2013). The Robot Ocean Network. *American Scientist*. 101 434. Status = PUBLISHED; Acknowledgment of Federal Support = No ; Peer Reviewed = Yes

Schofield, O.M., Ducklow, H., Bernard, K.S., Doney, S. C., Patterson-Fraser, D., Gorman, K., Martinson, D., Meredith, M.P., Saba, G.K., Stammerjohn, S., Steinberg, D.K., and Fraser, W. (2013). Schofield, O.M., Ducklow, H., Bernard, K.S., Doney, S. C.. *Oceanography*. 26 (3), 204. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Sul, Woo Jun and Oliver, Thomas A and Ducklow, Hugh W and Amaral-Zettler, Linda A and Sogin, Mitchell L (2013). Marine bacteria exhibit a bipolar distribution. *Proceedings of the National Academy of Sciences*. 110 (6), 2342--2347. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Licenses

Other Products

Other Publications

Simmons, Beth (2014). *Never a Dull Moment: Palmer LTER Scientists Still Encounter Surprises After 22 Years Of Observations*. Article in Antarctic newspaper. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Patents

Technologies or Techniques

Thesis/Dissertations

McKee, D.C.. *A spatio-temporal study of the transport of Upper Circumpolar Deep Water onto the western Antarctic Peninsula continental shelf (MSc Thesis)*. (2013). Columbia University. Acknowledgement of Federal Support = Yes

Nikrad, M.. *Abundance and Growth Activity of Bacterioplankton Clades in Coastal Waters of the Arctic Ocean and West Antarctic Peninsula*. (2013). University of Delaware. Acknowledgement of Federal Support = Yes

Owens, S.. *Advances in measurements of particle cycling and fluxes in the ocean*. (2013). Massachusetts Institute of Technology and WHOI. Acknowledgement of Federal Support = Yes

Mankoff, K.. *MULTI-SCALE INVESTIGATIONS OF SUBGLACIAL AND SUB-ICE SHELF CONDUIT HYDROLOGY*. (2013). University of California-Santa Cruz. Acknowledgement of Federal Support = Yes

Pedulli, M.. *SEASONAL NITRATE DRAWDOWN, POTENTIAL NEW PRODUCTION AND EXPORT PRODUCTION FOR WATERS OFF THE WESTERN ANTARCTIC PENINSULA (WAP) REGION*. (2014). University of Massachusetts-Dartmouth. Acknowledgement of Federal Support = Yes

Huang, K.. *Studies of the Oxygen and Carbon Cycles in the Surface Ocean*. (2013). Princeton University. Acknowledgement of Federal Support = Yes

Websites
Palmer Station Antarctica LTER
http://pal.lternet.edu/

The project website for PAL LTER (http://pal.lternet.edu/) was recently re-developed and deployed using the Drupal CMS, supported by an information management supplement. This redevelopment allowed for many improvements over the previous version of the website. One of these improvements was a better structured layout of site content and materials. In addition, the website's overall appearance and dynamic display capabilities were much improved by the nature of Drupal's modern and well supported community of developers and modules. Using Drupal as the project's website platform also provides for the ability to collaborate with the increasing number of LTER sites choosing to use Drupal for either website or data system development. Components developed within this common framework can be shared across these sites, preventing reinvention, promoting standardization and optimizing personnel resources.

Participants/Organizations

Research Experience for Undergraduates (REU) funding

Form of REU funding support:	REU supplement
How many REU applications were received during this reporting period?	0
How many REU applicants were selected and agreed to participate during this reporting period?	0
REU Comments:	

What individuals have worked on the project?

Name	Most Senior Project Role	Nearest Person Month Worked
Ducklow, Hugh	PD/PI	2
Conners, James	Co-Investigator	5
Doney, Scott	Co-Investigator	2
Fraser, Bill	Co-Investigator	12

Martinson, Douglas	Co-Investigator	2
Meredith, Mike	Co-Investigator	1
Schofield, Oscar	Co-Investigator	3
Simmons, Beth	Co-Investigator	4
Stammerjohn, Sharon	Co-Investigator	4
Steinberg, Debbie	Co-Investigator	5
Friedlaender, Ari	Faculty	3
Reinfelder, John	Faculty	2
Saba, Grace	Faculty	3
Davis, Arly	K-12 Teacher	4
Fulda, Renee	K-12 Teacher	4
Hermann, Nell	K-12 Teacher	5
Saenz, Ben	Postdoctoral (scholar, fellow or other postdoctoral position)	6
Stukel, Mike	Postdoctoral (scholar, fellow or other postdoctoral position)	1
Farry, Shawn	Other Professional	5
Gordon, Jesse	Other Professional	5
Hallwachs, Grace	Other Professional	5
McAtee, Carrie	Other Professional	4
McConnell, Madison	Other Professional	3
Meraz, Andrew	Other Professional	5
Patterson-Fraser, Donna	Other Professional	12

Pickering, Brett	Other Professional	2
Seidel, Dena	Other Professional	3
Cope, Joseph	Technician	6
Foley, Heather	Technician	2
Iannuzzi, Richard	Technician	6
Jevon, Fiona	Technician	3
Lima, Ivan	Technician	1
Paxton, Domi	Technician	4
Ruck, Kate	Technician	3
Shelton, Naomi	Technician	9
Vivancos, Sebastian	Technician	6
Bowman, Jeff	Graduate Student (research assistant)	1
Carvalho, Filipa	Graduate Student (research assistant)	12
Collins, Jamie	Graduate Student (research assistant)	3
Couto, Nicole	Graduate Student (research assistant)	12
Gleiber, Miram	Graduate Student (research assistant)	12
Ivory, Jamie	Graduate Student (research assistant)	2
Kavanaugh, Maria	Graduate Student (research assistant)	6
McKee, Darren	Graduate Student (research assistant)	12
Rohr, Tyler	Graduate Student (research assistant)	6
Ruck, Kate	Graduate Student (research assistant)	2
Schultz, Cristina	Graduate Student (research assistant)	6

Abdala, Felipe	Undergraduate Student	3
Henris, Shannon	Undergraduate Student	9
Ho, Oliver	Undergraduate Student	4
Melillo, Austin	Undergraduate Student	4
Pfirrmann, Bruce	Undergraduate Student	2
Trivett, Paige	Undergraduate Student	6
Cook, Ben	Other	5

Full details of individuals who have worked on the project:

Hugh W Ducklow
Email: hducklow@ldeo.columbia.edu
Most Senior Project Role: PD/PI
Nearest Person Month Worked: 2

Contribution to the Project: Lead PI and leader, Microbial Biogeochemistry component

Funding Support: Columbia University

International Collaboration: No
International Travel: Yes, Chile - 0 years, 0 months, 5 days

James Conners
Email: jconners@ucsd.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 5

Contribution to the Project: Responsible for Information Management component of project

Funding Support: This award

International Collaboration: No
International Travel: No

Scott Doney
Email: sdoney@whoi.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 2

Contribution to the Project: Leader numerical modeling component and LTER coPI; joined microbial biogeochemistry component in past FY

Funding Support: WHOI

International Collaboration: No
International Travel: Yes, Chile - 0 years, 0 months, 5 days

Bill Fraser
Email: Fraserbfraser@3rivers.net
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 12

Contribution to the Project: CoI and leader, seabird component of project

Funding Support: This award

International Collaboration: No
International Travel: Yes, Chile - 0 years, 0 months, 5 days

Douglas Martinson
Email: dgm@ldeo.columbia.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 2

Contribution to the Project: Responsible for physical oceanography component of project

Funding Support: LTER Award

International Collaboration: No
International Travel: No

Mike Meredith
Email: mmm@bas.ac.uk
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Lead PI for British Antarctic Survey project Rothera Time Series, a partner project to PAL

Funding Support: British Antarctic Survey

International Collaboration: Yes, United Kingdom
International Travel: No

Oscar Schofield
Email: oscar@marine.rutgers.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 3

Contribution to the Project: CoI and leader, phytoplankton component of project

Funding Support: Institutional support

International Collaboration: No
International Travel: Yes, Chile - 0 years, 0 months, 5 days

Beth Simmons
Email: besimmons@oceaningenuity.org
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 4

Contribution to the Project: CoI and Education and Outreach coordinator

Funding Support: Annual supplements to LTER Award

International Collaboration: No
International Travel: No

Sharon Stammerjohn
Email: Sharon.Stammerjohn@Colorado.EDU
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 4

Contribution to the Project: Responsible for Climate/Sea Ice component of project

Funding Support: LTER Award Subcontract Separate ONR & NSF Awards

International Collaboration: No
International Travel: No

Debbie Steinberg
Email: debbies@vims.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 5

Contribution to the Project: Co-I and leader of project zooplankton component

Funding Support: Institutional support

International Collaboration: No
International Travel: No

Ari Friedlaender
Email: Ari.Friedlaender@oregonstate.edu
Most Senior Project Role: Faculty
Nearest Person Month Worked: 3

Contribution to the Project: collaborator to LTER project studying cetaceans in local ecosystem

Funding Support: Pacific Life Ocean Foundation

International Collaboration: No
International Travel: Yes, Chile - 0 years, 0 months, 5 days

John Reinfelder
Email: reinfelder@envsci.rutgers.edu
Most Senior Project Role: Faculty
Nearest Person Month Worked: 2

Contribution to the Project: member of phytoplankton research team on cruise

Funding Support: Rutgers Univ

International Collaboration: No
International Travel: Yes, Chile - 0 years, 0 months, 5 days

Grace Saba
Email: saba@marine.rutgers.edu
Most Senior Project Role: Faculty
Nearest Person Month Worked: 3

Contribution to the Project: Research Scientist, Schofield Lab

Funding Support: Another NSF award (G Saba, PI) and Rutgers Univ

International Collaboration: No
International Travel: No

Arly Davis
Email: adavis@sandwich.k12.ma.us
Most Senior Project Role: K-12 Teacher
Nearest Person Month Worked: 4

Contribution to the Project: 7th grade science teacher in Education/Outreach

Funding Support: RET Supplement to LTER award

International Collaboration: No
International Travel: No

Renee Fulda
Email: rfudala@sandwich.k12.ma.us
Most Senior Project Role: K-12 Teacher
Nearest Person Month Worked: 4

Contribution to the Project: 7th grade science teacher in Education/Outreach

Funding Support: RET Supplement to LTER Award

International Collaboration: No
International Travel: No

Nell Hermann
Email: nhp11@scasd.org
Most Senior Project Role: K-12 Teacher
Nearest Person Month Worked: 5

Contribution to the Project: Collaborated with Beth Simmons, project E&O coordinator, developing K-12 lesson plans and participating in cruise outreach program

Funding Support: LTER Award RET Supplement

International Collaboration: No
International Travel: No

Ben Saenz
Email: blsaenz@gmail.com
Most Senior Project Role: Postdoctoral (scholar, fellow or other postdoctoral position)
Nearest Person Month Worked: 6

Contribution to the Project: postdoctoral fellow with S Stammerjohn working on sea ice/ecosystem model

Funding Support: no support

International Collaboration: No
International Travel: No

Mike Stukel
Email: mstukel@umces.edu
Most Senior Project Role: Postdoctoral (scholar, fellow or other postdoctoral position)
Nearest Person Month Worked: 1

Contribution to the Project: Postdoc working on export processes at Palmer Station and on cruise (Ducklow supervision)

Funding Support: separate award to Ducklow (ANT-1340886)

International Collaboration: No
International Travel: No

Shawn Farry
Email: farrysc@hotmail.com
Most Senior Project Role: Other Professional
Nearest Person Month Worked: 5

Contribution to the Project: Field team leader for Fraser component at Palmer Station

Funding Support: LTER Award subcontract and institutional support (PORG)

International Collaboration: No
International Travel: Yes, Chile - 0 years, 0 months, 5 days

Jesse Gordon
Email: j4gordon@ucsd.edu
Most Senior Project Role: Other Professional
Nearest Person Month Worked: 5

Contribution to the Project: Information Management staff

Funding Support: LTER subcontract to SIO

International Collaboration: No
International Travel: No

Grace Hallwachs
Email: ghallwachs@ucsd.edu
Most Senior Project Role: Other Professional
Nearest Person Month Worked: 5

Contribution to the Project: Information management staff

Funding Support: LTER subcontract to SIO

International Collaboration: No
International Travel: No

Carrie McAtee
Email: mcateecarrie@gmail.com
Most Senior Project Role: Other Professional
Nearest Person Month Worked: 4

Contribution to the Project: Field team member for seabird group

Funding Support: This award and institutional support

International Collaboration: No
International Travel: Yes, Chile - 0 years, 0 months, 5 days

Madison McConnell
Email: mhm98@cornell.edu
Most Senior Project Role: Other Professional
Nearest Person Month Worked: 3

Contribution to the Project: Field team member in seabird group

Funding Support: This award and institutional support

International Collaboration: No
International Travel: Yes, Chile - 0 years, 0 months, 5 days

Andrew Meraz
Email: ameraz@ucsd.edu
Most Senior Project Role: Other Professional
Nearest Person Month Worked: 5

Contribution to the Project: Information Management staff

Funding Support: LTER Subcontract to SIO

International Collaboration: No
International Travel: No

Donna Patterson-Fraser
Email: patterdo@3rivers.net
Most Senior Project Role: Other Professional
Nearest Person Month Worked: 12

Contribution to the Project: Field team member, data analyst, and Fraser project administrative coordinator

Funding Support: LTER Award subcontract and institutional support (PORG)

International Collaboration: No
International Travel: No

Brett Pickering
Email: pickerbr@hotmail.com
Most Senior Project Role: Other Professional
Nearest Person Month Worked: 2

Contribution to the Project: Field team leader seabird project on cruise

Funding Support: This award and institutional support

International Collaboration: No
International Travel: Yes, Chile - 0 years, 0 months, 5 days

Dena Seidel
Email: denaseidel@masongross.rutgers.edu
Most Senior Project Role: Other Professional
Nearest Person Month Worked: 3

Contribution to the Project: Directed educational video about our cruise

Funding Support: Institutional support

International Collaboration: No
International Travel: No

Joseph Cope
Email: joecope@vims.edu
Most Senior Project Role: Technician
Nearest Person Month Worked: 6

Contribution to the Project: Lead technician in Steinberg lab

Funding Support: LTER Award

International Collaboration: No
International Travel: Yes, Chile - 0 years, 0 months, 5 days

Heather Foley
Email: heather.foley@duke.edu
Most Senior Project Role: Technician
Nearest Person Month Worked: 2

Contribution to the Project: field team member of cetacean component

Funding Support: Duke Univ

International Collaboration: No
International Travel: Yes, Chile - 0 years, 0 months, 5 days

Richard Iannuzzi
Email: iannuzzi@ldeo.columbia.edu
Most Senior Project Role: Technician
Nearest Person Month Worked: 6

Contribution to the Project: Research technician under Martinson supervision (physical oceanography)

Funding Support: LTER Award

International Collaboration: No
International Travel: No

Fiona Jevon
Email: fionajevon@gmail.com
Most Senior Project Role: Technician
Nearest Person Month Worked: 3

Contribution to the Project: Field team member in microbial biogeochemistry component at Palmer Station

Funding Support: This award

International Collaboration: No
International Travel: Yes, Chile - 0 years, 0 months, 5 days

Ivan Lima
Email: ivan@whoi.edu
Most Senior Project Role: Technician
Nearest Person Month Worked: 1

Contribution to the Project: technician/programmer in modeling component

Funding Support: This award

International Collaboration: No
International Travel: No

Domi Paxton
Email: domipaxton@gmail.com
Most Senior Project Role: Technician
Nearest Person Month Worked: 4

Contribution to the Project: Technician in Steinberg lab, participated in LTER Cruise

Funding Support: This award and another NSF award

International Collaboration: No
International Travel: Yes, Chile - 0 years, 0 months, 5 days

Kate Ruck
Email: ruck.kate@gmail.com
Most Senior Project Role: Technician
Nearest Person Month Worked: 3

Contribution to the Project: Tecnician in Steinberg lab and on cruise

Funding Support: This award

International Collaboration: No
International Travel: Yes, Chile - 0 years, 0 months, 5 days

Naomi Shelton
Email: nshelton@ldeo.columbia.edu
Most Senior Project Role: Technician
Nearest Person Month Worked: 9

Contribution to the Project: Lab technician and field team leader for microbial biogeochemistry component

Funding Support: this award, Columbia University

International Collaboration: No

International Travel: Yes, Chile - 0 years, 0 months, 5 days

Sebastian Vivancos
Email: vivancos@ldeo.columbia.edu
Most Senior Project Role: Technician
Nearest Person Month Worked: 6

Contribution to the Project: Field team member of microbial biogeochemistry component at Palmer Station

Funding Support: This award

International Collaboration: No
International Travel: Yes, Chile - 0 years, 0 months, 5 days

Jeff Bowman
Email: bowmanjs@uw.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 1

Contribution to the Project: member of microbial biogeochemistry team on cruise

Funding Support: University of Washington

International Collaboration: No
International Travel: Yes, Chile - 0 years, 0 months, 5 days

Filipa Carvalho
Email: filipa@marine.rutgers.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 12

Contribution to the Project: PhD student in Schofield lab phytoplankton-optics component

Funding Support: Fellowship from Portugal

International Collaboration: No
International Travel: Yes, Chile - 0 years, 0 months, 5 days

Jamie Collins
Email: jrcollins@whoi.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 3

Contribution to the Project: member of microbial biogeochemistry component at Palmer Station and on cruise

Funding Support: Woods Hole Oceanographic Inst

International Collaboration: No
International Travel: Yes, Chile - 0 years, 0 months, 5 days

Nicole Couto
Email: ncouto@marine.rutgers.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 12

Contribution to the Project: Grad student in Schofield lab (phytoplankton-optics-glider component.

Funding Support: Institutional support & Teledyne Webb

International Collaboration: No
International Travel: Yes, Chile - 0 years, 0 months, 5 days

Miram Gleiber
Email: mrglei@vims.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 12

Contribution to the Project: Grad student in Steinberg Lab

Funding Support: LTER Award

International Collaboration: No
International Travel: Yes, Chile - 0 years, 0 months, 5 days

Jamie Ivory
Email: jaivory@vims.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 2

Contribution to the Project: member of zooplankton field team on cruise

Funding Support: NSF GK-12 Fellowship

International Collaboration: No
International Travel: Yes, Chile - 0 years, 0 months, 5 days

Maria Kavanaugh
Email: mkavanaugh@whoi.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 6

Contribution to the Project: conducting PhD thesis research in modeling group

Funding Support: WHOI

International Collaboration: No
International Travel: No

Darren McKee
Email: dmckee@ldeo.columbia.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 12

Contribution to the Project: PhD student in Martinson's lab

Funding Support: LTER Award and institutional resources

International Collaboration: No
International Travel: Yes, Chile - 0 years, 0 months, 5 days

Tyler Rohr
Email: trohr@whoi.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 6

Contribution to the Project: conducting PhD thesis research in modeling component

Funding Support: This award, WHOI

International Collaboration: No
International Travel: No

Kate Ruck
Email: rukke@vims.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 2

Contribution to the Project: grad student in Steinberg Lab

Funding Support: LTER Award

International Collaboration: No
International Travel: Yes, Chile - 0 years, 0 months, 5 days

Cristina Schultz
Email: cschultz@whoi.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 6

Contribution to the Project: conducting PhD thesis research in modeling component

Funding Support: This award, WHOI

International Collaboration: No
International Travel: No

Felipe Abdala
Email: abdalafn@live.com
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 3

Contribution to the Project: Summer intern in Doney Lab

Funding Support: Brazilian government

International Collaboration: Yes, Brazil
International Travel: No

Shannon Henris
Email: srhenris@email.wm.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 9

Contribution to the Project: worked in zooplankton lab at VIMS

Funding Support: no support (student volunteer)

International Collaboration: No
International Travel: No

Oliver Ho
Email: ho.oliver9@gmail.com
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 4

Contribution to the Project: member of phytoplankton component field team at Palmer Station and aboard cruise

Funding Support: Rutgers Univ

International Collaboration: No
International Travel: Yes, Chile - 0 years, 0 months, 5 days

Austin Melillo
Email: paustmel@msn.com
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 4

Contribution to the Project: field team member, phytoplankton group at Palmer Station and on cruise

Funding Support: Rutgers univ

International Collaboration: No
International Travel: Yes, Chile - 0 years, 0 months, 5 days

Bruce Pfirrmann
Email: bwpfirrmann@gmail.com
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 2

Contribution to the Project: member of zooplankton field team on cruise

Funding Support: Institutional support

International Collaboration: No
International Travel: Yes, Chile - 0 years, 0 months, 5 days

Paige Trivett
Email: paige.trivett74@gmail.com
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 6

Contribution to the Project: worked in zooplankton lab at VIMS

Funding Support: no support (student volunteer)

International Collaboration: No
International Travel: No

Ben Cook
Email: bpcfx7@gmail.com
Most Senior Project Role: Other
Nearest Person Month Worked: 5

Contribution to the Project: Field team member

Funding Support: LTER Award subcontract and institutional support (PORG)

International Collaboration: No
International Travel: Yes, Chile - 0 years, 0 months, 5 days

What other organizations have been involved as partners?

Name	Type of Partner Organization	Location
Detroit Zoological Society	Other Nonprofits	Detroit, MI
PoLAR Hub Project	Academic Institution	Barnard College, New York City
Sandwich STEM Academy	School or School Systems	Sandwich, MA

Full details of organizations that have been involved as partners:

Detroit Zoological Society

Organization Type: Other Nonprofits
Organization Location: Detroit, MI

Partner's Contribution to the Project:
Financial support
In-Kind Support
Facilities

More Detail on Partner and Contribution: New outreach effort and project support for Fraser component of project (see appended outreach document

PoLAR Hub Project

Organization Type: Academic Institution
Organization Location: Barnard College, New York City

Partner's Contribution to the Project:
Collaborative Research

More Detail on Partner and Contribution: PoLARHub working with LTER education/Outreach http://the polar hub.org

Sandwich STEM Academy

Organization Type: School or School Systems
Organization Location: Sandwich, MA

Partner's Contribution to the Project:
Collaborative Research

More Detail on Partner and Contribution: Sandwich STEM Academy is a venue for application of teaching materials developed by project Education Coordinator, who works in concert with instructors at the STEM Academy

Have other collaborators or contacts been involved? Yes

Impacts

What is the impact on the development of the principal discipline(s) of the project?
Nothing to report.

What is the impact on other disciplines?
Nothing to report.

What is the impact on the development of human resources?

Six PhD students who conducted their research in conjunction with PAL researchers completed their research and successfully defended their theses in 2012-14. One PAL postdoc (Grace Saba, Rutgers Univ) was promoted into a Research Scientists position at Rutgers, received her first NSF grant and has a paper in press in Nature Communications.

What is the impact on physical resources that form infrastructure?
Nothing to report.

What is the impact on institutional resources that form infrastructure?
Nothing to report.

What is the impact on information resources that form infrastructure?

The PAL LTER data management infrastructure has been much improved over this past year, resulting in a more stable environment for supporting long-term data collection and publishing. The benefits to the project include improved data access and availability, more efficient data workflow and better system documentation and maintainability. These results also ensure continued project support during personnel turnover.

What is the impact on technology transfer?
Nothing to report.

What is the impact on society beyond science and technology?
Nothing to report.

Changes/Problems

Changes in approach and reason for change
Nothing to report.

Actual or Anticipated problems or delays and actions or plans to resolve them
Nothing to report.

Changes that have a significant impact on expenditures
Nothing to report.

Significant changes in use or care of human subjects
Nothing to report.

Significant changes in use or care of vertebrate animals
Nothing to report.

Significant changes in use or care of biohazards
Nothing to report.