

# Breaking Ice, Building Knowledge

## *The Benefits of Ship-Based Teacher Research Experiences*

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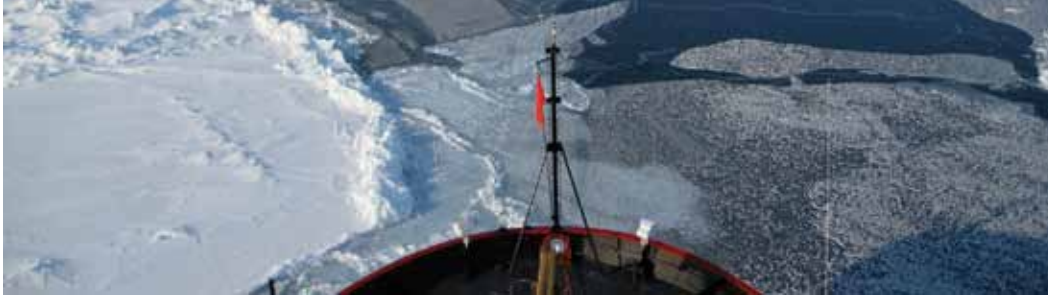


Photo by Simone Welch (PolarTREC 2009) Courtesy of ARCUS.

*The ship rocks while hurricane force winds and tall seas batter anything not tied down. Katabatic winds bite bitterly as ambient temperatures hover near single digits. Gear is swaying back and forth as the waves rush over the ship's deck. Not to be deterred, people are still working out on the deck and in the onboard labs. They are thousands of miles away from civilization with little contact to the 'outside' world. As the ship presses through the extreme conditions into one of the most remote regions of the world, cutting edge science is taking place and teachers are working alongside scientists to investigate our changing oceans.*

As part of the International Polar Year (IPY) (2007-2009), teachers from across the United States left the warmth and comfort of their homes and schools behind for weeks at a time to join scientists on ship-based expeditions to polar regions. It is here among the winds, waves, and breaking ice that they've push themselves to new areas of discovery and taken on the role of student to experience oceanographic science first-hand through a Teacher Research Experience (TRE). TRE's are powerful professional development opportunities, taking teachers out of the classroom and putting them into field experiences and collaborative relationships with scientists towards the shared goal of increasing the understanding of our polar oceans. Participating teachers' often return from their expeditions empowered with new purpose and conviction for their teaching, oodles of classroom material, and a newfound network of scientific content experts. Sharing their discoveries, the teachers' experiences have engaged students in active and meaningful learning and inspired the next generation of scientists and citizens.

Over the past three years, seventeen teachers have participated in ship-based TRE's in the Bering and

Figure 1. Researchers, Will Ostrom, Jim Dunn, and PolarTREC teacher, Gerty Ward start to drill the hole for the ice tethered profiler.

Photo: Rick Krishfield. Courtesy of ARCUS





**Figure 2.** The USCGC Healy busts through early spring sea ice on the Bering Sea. This ice isn't dirty; it is colonized by ice algae that are the primary producers of the Bering Sea ecosystem.

Photo by Maggie Prevenas (PolarTREC 2007).  
Courtesy of ARCUS

Beaufort Seas and Arctic and Southern Oceans on expeditions like the *Bering Sea Ecosystem Studies*, *Beaufort Gyre Observing System*, and the *Central Scotia Seafloor and the Drake Passage Deep Ocean Current Gateway*. The Arctic Research Consortium of the U.S. (ARCUS) supports TRE's through a program called PolarTREC (Teachers and Researchers Exploring and Collaborating), which is funded by the National Science Foundation, with some additional support from the NOAA Teacher at Sea program and the North Pacific Research Board. PolarTREC has matched teachers and researchers for hands-on polar research experiences on land, ice, and sea across the planet's polar regions. Using current technology and online tools such as journals, short videos, images, and real-time live events teachers shared their adventures before, during, and after the field experience

with classrooms, families, and the public. Diverse audiences utilized these tools, learning about places and things that stimulate curiosity and bring about new dimensions of discovery and understanding. Additionally, seeing their own teachers take risks out of their comfort zones has inspired students' ambitions and learning. TRE's are not new and additional programs such as ARMADA and the Teachers Experiencing the Arctic and Antarctica program have supported the immersion of teachers in polar and oceanic field research for over 15 years.

While onboard, teachers were more than mere observers of the science; they described themselves as active participants who felt like members of the research teams. PolarTREC teacher Jeff Peneston (New York) spent three weeks on the Swedish Icebreaker Oden as it travelled to McMurdo Station, Antarctica in the austral summer of 2008-2009. He describes the research activities he conducted while onboard, "I learned to drill and measure ice cores up to two meters thick...I spent time with the physical oceanographers and was able to use my underwater video camera to document how the CTD collects data from the water column. I also spent time with the atmospheric and oceanographic chemists. Perhaps my most memorable experiences came from helping the seal research team capture Crabeater and Weddell seals on the sea ice." Peneston added that, "these experiences will be woven into the stories I tell my students for the rest of my career."

Unique to ship-based expeditions, teachers were often able to rotate among research projects learning about multiple scientific disciplines.

The researchers who work closely with the teachers and mentor them in the field described them as working very hard and performing many of the same tasks as graduate students or technicians. Teachers participated in science meetings onboard, asked numerous questions, and even made contributions to the scientific missions. In the spring of 2007, Maggie Prevenas (Hawaii) spent three weeks on the U.S. Coast Guard Cutter *Healy* participating in the Bering Ecosystem Study as a PolarTREC and NOAA Teacher at Sea. She describes her place in the research expedition,

It was after my training of ice observations that my place on the mission was made clear to me... I remember looking down at the ice in the front of the ship, and seeing, rusty almost red like streaks in the water and on the broken ice. After breakfast, I scurried to the back of the ship and noticed the color of the ice was not as rusty, more of a brown color, and not as vivid as from the front... I gallop up to the bridge, look at the breaking ice. Yes, definitely red. Is it the reflection of the ship on the ice? Carlton, was the walrus expert on board and veteran ice watcher... I swallowed nervously and said, 'Hey Carlton, the color of the ice at the back of the ship is different than the ice at the front.' 'Hmm,' he said. Later I learned he had



**Figure 3.** Working with Swedish and American researchers, PolarTREC teacher Jeff Peneston displays an ice core sample that was drilled from this ice floe in the Southern Ocean. This part of the core is white because it did not contain the algae rich layer that the team was working to collect.

Photo: Jeff Peneston (PolarTREC 2008). Courtesy of ARCUS

spoke with Dr. Ray Sambrotto, and my observations added to other observations of the ship's effect on the photosynthesis of the ice algae. This was to be the start of a beautiful relationship we had—the ice and me... I think back to the day when my observations of the ice made a difference in an important research mission on global climate change effects in the Bering Sea Ecosystem.

Lollie Garay (Texas) spent seven weeks as a PolarTREC teacher on the Icebreaker Oden in 2007. Like others, she spent her time onboard engaged in numerous science activities.

As the sole teacher onboard that cruise, I was initially overwhelmed with the magnitude of the expedition and my own expectations of how I was going to translate this experience back into the classroom. However, within a few days at sea and with the encouragement and support from the science team, I began to feel like a contributing member of the expedition. Over the course of the next seven weeks in the Antarctic Seas, I was actually DOING science: observing sea ice conditions, ice coring, assisting in CTD casts, plankton tows, and processing samples...By the end of the cruise I had learned more than I could have ever imagined about the physical ocean, marine sciences, and the incredible Antarctic seas environment. I realized immediately that this was not the end of an experience, but only the beginning of a longer life study.

Once described affectionately as ‘summer camp for teachers,’ PolarTREC teachers have described the program as providing profound personal, professional, lasting, and life-changing impacts. Being engrossed in the field experience, and all that it embodies—unique logistics, harsh conditions, beautiful scenery, cutting edge science and technology—has led to a greater overall understanding of science as a process. This understanding has been transferred in numerous ways to the teachers’ classrooms, enriching student learning in earth system science and developing connections between the polar regions and their local environment.

Garay explains, “This experience impacted me deeply. It not only changed me but also my students in how we think and what we think about science. Being there made a profound impact on my ability to generate interest and develop inquiry in my science programs...that expedition was the catalyst for change in my classrooms.”

Subsequent to his expedition, Peneston planned a weekend field camp experience for his own 9<sup>th</sup> grade students. The students will simulate their own research project, drilling cores and exploring life through the frozen surface of a local lake in upstate New York. They will use some of the same lines of inquiry that were used during his expedition in the Amundsen Sea. Students choosing to study polar topics as part of their honors level symposium projects are using peer-reviewed journal articles written by expedition scientists as part of the literature review to support their projects. Peneston’s continued partnership with the researchers he met onboard provides not only expertise, but offers realistic examples of how scientists work and allows students to see them as “real people”—important for removing misconceptions about what scientists do.

Although the actual field research experience is central to the PolarTREC model and often the trip of a lifetime, many participants cite the ongoing collaboration and the relationship they



Figure 4. The nasal swab is quickly sealed into a sterile tube with a preservative. Once the team gets back to Sweden, the bacteria and viruses can be identified. Within minutes the procedures were complete and the seal was released.

Photo: Jeff Peneston (PolarTREC 2008). Courtesy of ARCUS



Figure 5. During a beautiful day in the high arctic, PolarTREC teacher Gerty Ward takes a reading of the solar radiation intensity with a Microtops photometer. Sunlight in the Arctic has an important contribution to the Earth's energy budget, and NASA will use the data collected by the photometer to verify satellite data.

Photo by Gerty Ward (PolarTREC 2008). Courtesy of ARCUS

Figure 6. The view of broken Antarctic sea ice as seen from the deck of the Icebreaker Oden.

Photo: Lollie Garay. (PolarTREC 2007). Courtesy of ARCUS

built with their teacher/researcher as one of the best outcomes of the program. Relationships with researchers not only gave teachers a network of professionals to contact for content advice, provided students access to meaningful discussions with scientists to answer questions and discuss careers opportunities. Teachers have used online “Polar Profiles”, interviews from the field, live events, pen pals, virtual and in person visits, and other methods to connect students and scientists. Ute Kaden (Texas) participated in a mission on the Icebreaker Oden in 2006. Her students in Brownsville, Texas had the opportunity to interview Emily Miller, a 23-year old graduate students with degrees in physics and applied mathematics. Onboard, she worked as a data technician where she oversaw real time data collection of plankton and monitored environmental conditions in seawater.

The interview, *Diving, Physics, Math & Engineering—A Girl's Way*, not

only highlighted an interesting science career but also demonstrated that girls can be successful in science and engineering.

As educational liaisons between the scientists and the public, it is the teacher's job to turn what they have learned onboard into meaningful opportunities to explain the science to students and the general public, and scientists have reported that the outreach activities related to the PolarTREC teacher have positively impacted their projects. Topics such as climate change often take new meaning when seen from the perspective of the teacher's first-hand experiences. Researcher satisfaction was also reflected in the interest to repeat the experience, and many researchers have applied to host additional PolarTREC teachers and/or continue to work closely with the teachers who join them in the field long after the expedition is complete.

Garay describes her ongoing relationship with researcher Dr. Patricia (Tish) Yager of the University of Georgia at Athens. When faced jointly with the challenge that natural oceanic cycles and their relationship to the carbon cycle are not well studied and therefore not well covered in the middle school science curriculum, Yager and Garay tackled this problem and together. They wrote a middle school level activity based on the role of the biological pump in moving carbon. They introduced the activity at a national conference, and as a result of that successful work, they have continued a dialogue for merging Dr. Yager's research with the teacher's interest in developing a cohesive



unit of study on marine ecosystems and climate sensitive carbon sequestration. The educational outreach conducted jointly by teachers and researchers provides forums for disseminating valuable information for developing ocean and polar literacy and bringing attention to current research and important global issues.

In the International Council for Science/World

Meteorological Organization Joint Committee report, *The State of Polar Research*, they stated that the, “IPY took place during a time when our planet was changing faster than ever in recorded human history, especially in the polar regions” (ICSU/WMO Joint Committee for IPY, 2009). The impacts of climatic change on the world’s oceans, and their impacts on us, will be one of the greatest challenges of the next generation. An understanding of the changes in sea ice, circulation, sea level, and the marine carbon cycle—complex and interrelated subjects—will be essential as tomorrow’s scientists, engineers, technicians, leaders, and citizens face the challenges associated with climate change.

PolarTREC teacher, Gerty Ward (North Carolina) participated in a 2008 oceanographic mission in Beaufort Sea, and explains, “I want to bring the excitement of the whole experience—from drilling holes in the ice, to the

crunch of the icebreaker, to the quiet of a land of ice, to my tiny room on the ship—into the classroom, the living room, wherever. I want my students to understand the important role that science will take in their lives as we begin to adapt to our changing planet. I want students to appreciate the environment as something we are a part of every day, not just something ‘to save.’ I want my students to understand the relationship between cause and effect: ocean temperatures, daily climate change, and school-day wardrobe choice. Students learn in an exceptionally meaningful and permanent way when they can develop a personal connection to the material.”



Figure 7. Lollie raises the plankton net.

Photo: Lollie Garay. Courtesy of ARCUS

Through ship-based expeditions, PolarTREC has developed an effective model for collaboration among educators and researchers interested in discussing, creating, sharing, and contributing their valuable knowledge, experience, and skills to learners of all ages across the globe. Engaging teachers in TRE’s, sparks knowledge, inquiry, and often a renewed interest in learning at a time when education is faced with the challenge of recruiting and preparing students to meet the science, technology, engineering and math demands of our future workforce. A recent article about TRE’s in the magazine *Science* agrees, “...that experience in the practice of science improves the quality and authenticity of science teaching and thereby increases student interest and achievement in science.” Moreover, it “enhances teachers’ skills in communicating science to students” and has “encouraged them to continue teaching” (Silverstein, *et al*, 2009).

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Figure 8. PolarTREC teacher, Lollie Garay stands on the ice with the massive Icebreaker Oden in the background.

Photo: Lollie Garay (PolarTREC 2007). Courtesy of ARCUS

## Links

PolarTREC – <http://www.polartrec.com>

NOAA Teacher at Sea Program – <http://teacheratsea.noaa.gov>

ARMADA Project – <http://www.armadaproject.org>

## References

International Council for Science (ICSU)/World Meteorological Organization (WMO) Joint Committee for the International Polar Year (IPY). 2009. *The State of Polar Research*.

[http://www.ipy.org/index.php?/ipy/detail/state\\_of\\_polar\\_research/](http://www.ipy.org/index.php?/ipy/detail/state_of_polar_research/).

Silverstein, Samuel C. *et al.* 2009. Teachers' Participation in Research Programs Improves Their Students' Achievement in Science. *Science* 326, 440 (2009).

# Additional Resources



### *Twentieth-century Marine Science: Decade by Decade* and *Earth Science: Decade by Decade*

These two recent publications from Christina Reed are available on Amazon. [http://www.amazon.com/Christina-Reed/e/B001JS6CJK/ref=ntt\\_dp\\_epwbk\\_0](http://www.amazon.com/Christina-Reed/e/B001JS6CJK/ref=ntt_dp_epwbk_0)

The December 2009 issue of *Oceanography*, a publication of The Oceanography Society is dedicated to the future of ocean biogeochemistry in a high CO<sub>2</sub> world and features on its cover changes seen in foraminifera, organisms mentioned in the School of Rock article in this issue. (See TOS.org)

