



TEACHERS AND RESEARCHERS EXPLORING AND COLLABORATING

PolarTREC STEM Experience Report

Denise Hardoy

Antarctic Fish Development Under Future Ocean Conditions



PolarTREC Expedition Page

<https://www.polartrec.com/expeditions/antarctic-fish-development-under-future-ocean-conditions>



This program is supported by the National Science Foundation under award 1918637. Any opinions, findings, and conclusions or recommendations expressed by this program are those of the PIs and coordinating team and do not necessarily reflect the views of the National Science Foundation.

Janet Warburton and Judy Fahnestock
Education Project Managers
Arctic Research Consortium of the US (ARCUS)
3535 College Rd. Suite 101
Fairbanks, AK 99709
(907) 474-1600
info@polartrec.com
www.polartrec.com

The PolarTREC Field Experience

I believe it is important to show my students what real science is... and that is how I found myself in Antarctica studying Antarctic Fish Development Under Future Ocean Conditions.

The PolarTREC program pairs teachers with research scientists for a symbiotic expedition. Scientists get a voice and a larger audience through the educator, and the educator gains valuable firsthand experience doing real science.

The Importance of Educator/Researcher Collaboration

I was fortunate to be paired with Dr. Anne Todgham's B-207 team investigating the effects of high carbon dioxide levels and temperature increases on juvenile Antarctic fish- namely *Trematomus pennellii*. Dr. Todgham is from U.C Davis in California. I met with the entire team at UC Davis in May before the expedition.



The B-207 Team

She gave me a tour of her lab and extensive facility at the university. It was great to see what she does outside of the scope of this one expedition. Then Dr. Todgham skyped with all of my middle school students. This collaboration helped to make the science real for my students. They were able to feel like part of the team. Now they are really looking forward to meeting this rock star team in person.

The Science Explained

The environment in the Southern Ocean has not changed substantially for millions of years. Unlike other oceans, it a remarkably stable ecosystem. Antarctic marine organisms have not needed to adapt to change. Evidence suggests that change has begun and will continue to escalate. Specifically, Dr. Todgham has identified the rise in carbon dioxide levels, and thus the rise in ocean temperature as important stressors predicted to change in this environment.



Trematomus pennellii

Dr. Todgham wants to know if these species will be able to cope with changes. In particular, she looks at energy budgets. She analyzes how various species allocate their limited energy resources. Preliminary research has shown that many species are capable of handling one stressor, such as temperature change, but do not do well when there are two stressors.

Teamwork makes Dreamwork

The team set up many types of experiments to attempt to answer this question. Dr. Todgham oversaw all projects. Milica Mandic, PhD examined mitochondrial changes in heart tissue. Grad student Amanda Frazier monitored changes in oxygen consumption of the whole fish by measuring oxygen levels going into and out of a swim chamber.



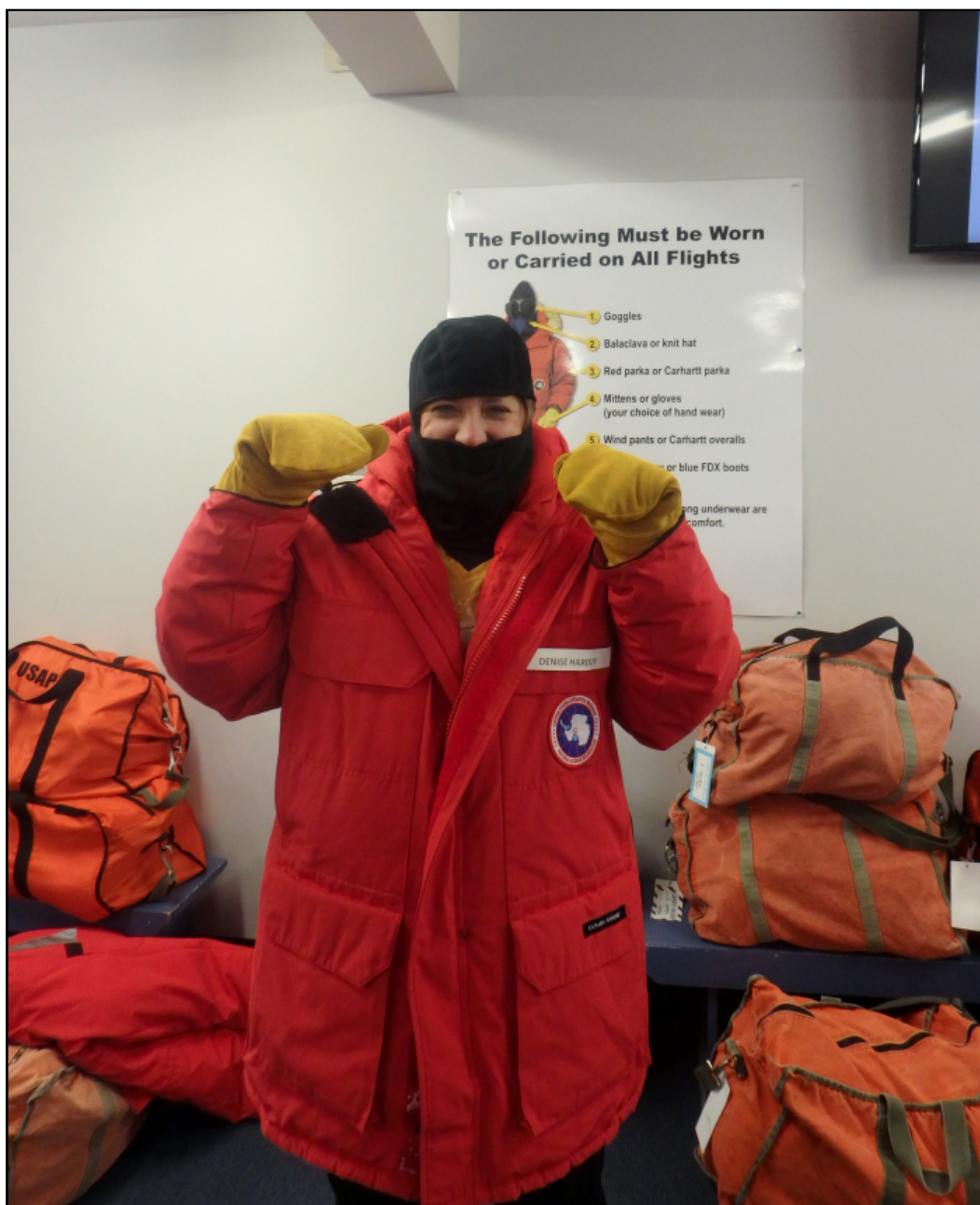
Andrew Naslund and Amanda Frazier checking water chemistry

Andrew Naslund, grad student and lab , focused on behavioral changes. I was able to help him in several of his trials. What struck me the most while participating in this investigation was the importance of teamwork, collaboration, and adapting the work to changing conditions. You can plan a perfectly designed experiment, but things don't always work out like you planned. Our protocol called for one type of fish, but they were not to be found. After a team meeting, changes were made in the protocol and new experiments were designed. This is an important concept that my middle school students can learn from.

Linking PolarTREC to my Classroom and School

My students got to see firsthand my role in collaborating with team members. Our aquarium system had to be checked daily. I often helped record tank temperatures and got to help run the spectrophotometer to determine the pH for every tank. We needed to keep accurate records of the system temperature and carbon dioxide levels to verify the integrity of the experimental data.

Throughout the entire process, from being selected to packing and prepping, to journaling and Skyping, my students remained exceptionally engaged. They were motivated to learn more about Antarctica and the role climate change is playing in that ecosystem.



Denise Hardoy trying on ECW gear

Even as I returned to the classroom, it provided a common experience I could reference. It was like they were there with me. Even the littles at my school are always wanting to talk about Antarctica with me. Parents and visitors are asking questions as well.

Moving forward, I will be integrating Antarctic lessons for my middle school students. I will collaborate on a series of lessons with Dr. Todgham. Once published on the PolarTREC website, other teachers will have access to these plans. We are working on developing lessons that highlight ongoing changes in the Earth's climate using data analysis from some of Dr. Todgham's work, and replication of behavior experiments that we conducted in Antarctica. These lessons will be NGSS aligned and will focus on student-driven inquiry.

Connecting to my Community

This experience provided an interesting opportunity for discussions about climate change with my community. Coming from a rural ag community, many people tend to dismiss, "climate change" as a political ploy. However, those same people are now willing to listen and are genuinely interested

in “the facts” and my first-hand experience. My small community has been overwhelmingly supportive of my involvement and can’t wait to hear more about it.



Denise with Jiffy drill

Expectations and Outcomes

This experience exceeded my expectations. I knew that my students would be engaged. I knew they would see real science in action. I knew it was the adventure of a lifetime for me. What I didn't expect was all of the extra benefits that I have seen. I was able to see many other types of projects going on in Antarctica that my students are now following. For example, they are learning about the deterioration of the Thwaites Glacier from the Icefin project. I also didn't expect my community to now see me as an expert in polar science. They want to know what I saw firsthand and are actually listening to the data that I can show them. My husband jokes that I am “famous” now. I think that's funny, but it has put me in contact with people I didn't know, talking about Antarctic science. These are conversations that never would have happened without PolarTREC.

So, I've been to the bottom of the Earth...Now what?

I have to say that it has been a little crazy getting into the swing of things back home in Lockwood, California. It took a few days to evaluate where my kiddos were in their lessons and then plan forward for the rest of the year. I came home to storms and lots of rain, which ended up with leaks in my classroom roof, and black mold growing in our ceiling. We had to abandon our awesome science room and take refuge temporarily in a tiny primary classroom. There was no room to bring any of my science supplies. Unfortunately, I had to go back to textbooks for a while. That has been awful, but unavoidable. We are all looking forward to moving back into a clean classroom soon. The point is...life goes on. I have to deal with the day to day stuff, and then learn how to fit in all that I learned on this expedition.



Behavioral Tests with GoPro begins

I was able to jump right into sharing my experience with classrooms and my community. For two days in December, I presented to ten classrooms and one Rotary Club meeting. It was a fun whirlwind. There is just nothing like hugs from an entire class of third graders that are over the moon excited to see pictures, hear stories, and of course try on Big Red. An added bonus has been showing everyone the preserved fish that Dr. Todgham gave me as well as the volcanic rock samples that NSF granted permission for me to bring back. The look on a sixth grader's face when they realize they are actually holding a piece of Antarctica is worth all the paperwork and customs lines to bring it home! I then went on to address our school board at their January meeting. Everyone was excited to hear about the adventure and science.

I have more outreach in the works. I am scheduled to return to more local classrooms to show them pictures and return the paper penguins that they made and I took to Antarctica for them. Then I am doing an author's event for multiple school districts. Their theme is Adventure, so they invited me to speak. I will be one of their rotations for this event. I should see 400-500 students that day. I am also planning a community event. So many people have asked to see pictures and hear about my experience that I am scheduling a community presentation. It will probably be an open house for our school's new multipurpose building!

In the long term, I will continue to visit classrooms, present at the Monterey Bay Aquarium teacher institutes, and apply to present at our state Science Teachers Conference in November. I am contacting local media to follow up on the stories they did about me before I left. I am speaking at county-wide science teacher events. This experience will also remain a topic of casual conversation for years to come.

PolarTREC has changed my students, my teaching, and my life. My students know that if they persevere, they can accomplish anything. They know what real science is, and consider themselves part of the team. I have never considered myself an adventurer or an environmental advocate. Yet, now I have been to a place that few get the opportunity to visit. I have taken my students to the bottom of the Earth, and this shared experience permeates my teaching. I am confident and comfortable talking to anyone about climate change. I have seen firsthand the struggle to get the data that we need to inform public policy. I don't yet know where this experience may lead, but I am ready for the challenge.

On the other hand....It's kind of funny. No one ever complains to me about how cold they are anymore!

Stay Cool



Denise Hardoy at McMurdo Station, Antarctica. Photo courtesy of Amy Osborne