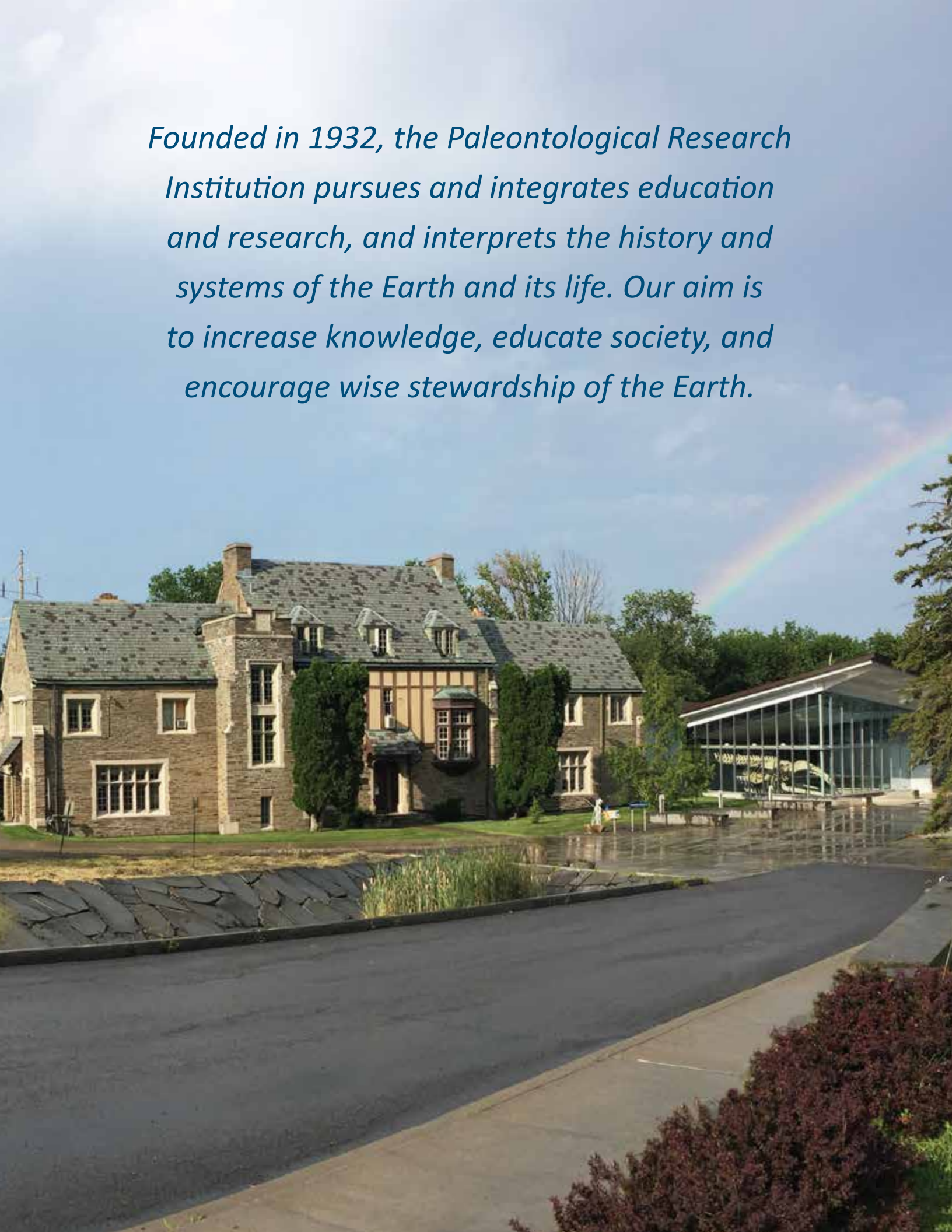
PALEONTOLOGICAL RESEARCH INSTITUTION ANNUAL REPORT FY17

Founded in 1932, the Paleontological Research Institution pursues and integrates education and research, and interprets the history and systems of the Earth and its life. Our aim is to increase knowledge, educate society, and encourage wise stewardship of the Earth.



PALEONTOLOGICAL
RESEARCH INSTITUTION

ANNUAL REPORT
FISCAL YEAR 2017

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Cornell University Affiliations

Since signing an agreement of affiliation in 2004 and renewing that relationship in 2010 and 2017, the Paleontological Research Institution (PRI) continues to strengthen its numerous formal and informal relationships with Cornell University.

Teaching and Research

PRI is a significant teaching resource for several Cornell programs and departments at both the undergraduate and graduate levels. Many courses require students to participate in exercises and training at the Museum of the Earth. Our collections and facilities are regularly used by Cornell faculty, staff, and, especially, undergraduate and graduate students for both research and teaching.

PRI's Director, Warren D. Allmon, is the Hunter R. Rawlings III Professor of Paleontology in the Department of Earth and Atmospheric Sciences, a position he has held since 2008.

Outreach

PRI continues to contribute to Cornell's historic land-grant mission by facilitating public outreach in collaboration with various faculty and departments of the University, including the Department of Earth and Atmospheric Sciences (EAS). We collaborate on the online Climate Change Science Clearinghouse, and are a subcontractor for projects applying for NSF Broader Impacts outreach.

PRI is also the lead organizer for Ithaca Darwin Days, hosted annually in collaboration with Cornell University since 2006. It features multiple events and programs celebrating the life and ideas of Charles Darwin.

Director's and President's Message

PRI's Director, Warren Allmon, and Board President, Brian Bauer, in Smith Woods.

DIRECTOR'S AND PRESIDENT'S MESSAGE

"What does PRI do?" The answer is both simple and complicated. The simple version is that we add to and share knowledge about the history and diversity of life on Earth. The complicated answer is that we do that in a multitude of ways, for a multitude of audiences, and we've been doing it for a long time.

Like the Earth's hot core, which is the engine of its volcanoes and moving continents, at PRI's core is paleontology—the study of fossils—and this is the engine of our diverse avenues of science and outreach. For 85 years, PRI scientists have been exploring the history of life as revealed in the fossil record, adding to basic scientific knowledge about organisms from protists to proboscideans. PRI cares for one of the nation's largest collections of fossils—more than three million specimens—that serves as a vital resource for this exploration, and which is used by scientists from around the world.

But PRI's activity goes far beyond fossils. The entire natural world is our subject, from trees to trilobites, from diatoms to dinosaurs, from mastodons to zebra mussels. We explore, research, publish, exhibit, educate, explain, and inspire.

We not only create new knowledge about the history and diversity of life; we share it, in every way we can:

- With all people, young and old. Since the Museum of the Earth opened in 2003, more than half a million people have visited it to learn about evolution, climate change, geology, fossils, biodiversity, and the relationship between art and science. Since taking over the Cayuga Nature Center and Smith Woods in 2011, PRI has expanded its mission toward being a major resource for environmental and natural history education for central New York.
- With teachers, in central New York and across the country. For more than 20 years, PRI has produced materials and products to help educators use their local environments to expand the abilities of students to learn about how the natural world came to be as it is, and how it may change in the future.
- With college students. Through its long historic connection and more recent formal affiliation with Cornell University, PRI has trained undergraduate and graduate students who have gone on to successful careers in science and education. We have inspired many more to learn more about the natural world.
- With other scientists, through our publications, including *Bulletins of American Paleontology*, founded in 1895 and one of the world's oldest and most respected paleontological journals, and also through our specimen collections.

PRI matters and changes lives. Our research points the way to how oyster beds can be restored more effectively, to improved understanding of the history of the diversity of life in the oceans, to how climate change affects ecology and evolution. Our educators inspire students, from pre-K to post-graduate, and teachers, from primary to PhD, to learn about the natural world, including the Earth's changing climate, at a time when this is more important than ever. Our educational venues—the Museum of the Earth and Cayuga Nature Center—serve as sources of insight and information for tens of thousands of residents of central New York and visitors from around the world. Our publications—on ecology, evolution, Earth science, science education, and (of course) fossils—reach far beyond Ithaca to readers of many backgrounds in many countries.

What PRI does… it's simple, complicated, and absolutely vital.

Collections

Today, natural history collections like PRI's are not only used to address questions just for the sake of knowledge, important as this is. They also play a vital role in our understanding of biodiversity, evolution, and the environmental impacts of climate change—information that profoundly affects our lives.

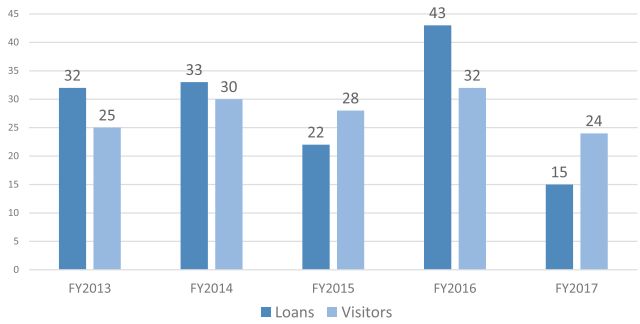
Collections Growth

PRI's collections rank among the 10 largest invertebrate paleontological collections in the United States and are the intellectual core of the Institution. Over 3,000,000 specimens and nearly 13,000 stratigraphic "bulk" samples provide a unique resource for scientific research, teaching, and exhibitions across the country and around the world.

PRI's collection continued to grow throughout fiscal year 2017 (FY 2017). Thirty-three donations, containing approximately 39,500 specimens, were accessioned into the research collection. These specimens ranged in geologic age from the Devonian (about 419 to 358 million years ago) to today, and locations from central New York to the Caribbean.

Collections Usage

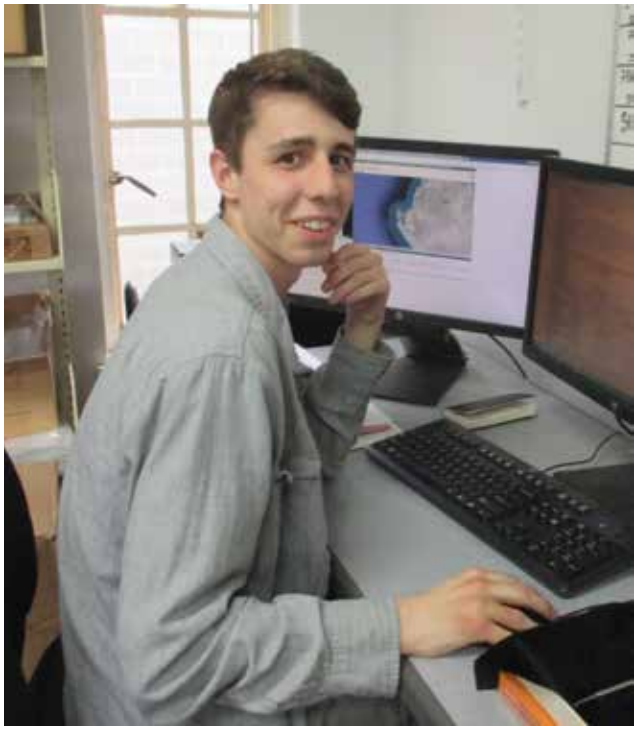
The number of specimen loans, visitors to the collection, and number of peer-reviewed scientific publications citing PRI specimens are the currency of a collection because they are used by granting agencies to gauge the value of PRI's collection for scientific research. In FY 2017, scientific loans of specimens in PRI's collection were made to researchers from around the U.S. and the world. 24 professional and student researchers also travelled to visit PRI's collections in FY 2017. PRI specimens are also often loaned for exhibition and public outreach purposes. For instance, in FY 2017 PRI specimens were used as part of the PRI Traveling Exhibit "Did Dinosaurs Poop?" at the EcoTarium in Massachusetts. PRI's collections were also cited in five professional and student publications in the 2017 fiscal year—a level comparable to reported use at much larger peer institutions.



Research Loans and Visitors FY 2013 - FY 2017

Specimen Digitization

Digitization—the process of creating or converting collections information into a digital form — is essential to make PRI's collections more available and therefore more relevant and valuable to today's scientific and



Cornell undergraduate Michael Zelko georeferencing South American localities as part of the EPICC project.

educational communities. Making our specimens and associated records (e.g., field notes and photos) available digitally will greatly increase public access, speed research, help preserve our collections for future generations, and open new outreach and education opportunities.

The 2017 fiscal year saw significant progress in specimen digitization. Our digitization efforts focused on an ongoing NSF-funded project dubbed the "Eastern Pacific Invertebrate Communities of the Cenozoic" (EPICC). This Thematic Collections Network (TCN) project has nine partner institutions, led by University of California Berkeley, cataloging, georeferencing (putting map coordinates on written locality descriptions) and photographing the Cenozoic invertebrate specimens from the west coast of the Americas, from Alaska to Chile.

The goal of the EPICC project is to make 1.6 million specimen records available to the public through data aggregators such as iDigBio (www.idigbio.org). PRI has committed to providing data on approximately

A Puzzling Collection from the University of Washington

While collections staff were surveying PRI's collection in preparation for the EPICC grant project, they came across a small but significant collection. This material was simply marked as "KVWP West Coast". It contained approximately 1,800 Eocene fossil specimens from Washington and Oregon. "KVWP" was an easy clue for collections staff. They were instantly recognizable as the initials of Katherine Van Winkle Palmer (1895-1982), PRI's second director. They wondered, however, how this material got into PRI's collection in the first place, especially since it was associated with University of Washington specimen labels.

Katherine Van Winkle Palmer

Katherine Van Winkle studied geology and earned her BS degree from the University of Washington in 1918. Her advisor was the well-known invertebrate paleontologist, Charles A. Weaver. Weaver wanted Van Winkle to get her PhD at Cornell and return to take his place at the University of Washington, so she headed east and began to study for her Ph.D. in Paleontology under PRI's founder, Gilbert D. Harris.

Van Winkle returned to Washington in 1922 as a visiting assistant professor and coauthored a paper with Weaver, *Fauna from the Eocene of Washington*. When she came back to Cornell to finish her degree, she and Weaver divided up their original study material into duplicate collections. One stayed with Weaver in Washington, one came with Van Winkle to Cornell.

Katherine got her PhD, married Ephraim L. Palmer, a Cornell professor, continued to work and teach and publish, but never took Weaver's place at the University of Washington. She eventually took the helm of PRI when Harris died in 1952. This small collection as well as the rest of Cornell's non-botanical paleontological collections was transferred to PRI in 1995-1996. However, much of the story of this small collection was lost, or vaguely referred to in publications. Nearly a century later, no one at PRI knew of the collections existence. If they had not been surveying material for the EPICC grant project, this collection may have remained hidden for many more years. Today, this small but significant collection has once again seen the light of day and the specimens' data will be digitized and made available to the public.

High-latitude settings promote extreme longevity in fossil marine bivalves

Today there is a pattern of increasing lifespan and decreasing growth rate with latitude in marine bivalves, but it is unknown whether this is due to cold temperatures or seasonal availability of food. In a paper published in the journal *Paleobiology*, David K. Moss and his colleagues, including PRI board member Linda C. Ivany, used specimens from the Zinsmeister Collection at PRI to test the hypothesis that seasonal availability of food is more important than cool temperatures in promoting extreme longevity.

Moss, who is now a postdoctoral researcher at the University of North Carolina Chapel Hill, said, "The Zinsmeister Collection is world famous and is one of the best collections of mollusks from the Cretaceous and Eocene of Seymour Island, Antarctica. During this time, temperatures on Seymour Island resembled those of modern day North Carolina. Despite being much warmer, all of the bivalves we examined were slow growing and long-lived, which suggests that food, not cool temperature might be the driving factor promoting extreme longevity of high-latitude bivalves."

Moss also commented that "Our study truly would not have been possible without the collections housed at PRI. Furthermore, given that revealing growth bands requires cross-sectioning specimens, we are very appreciative for the loan of material."

A fossil of Retrotapes newtoni *(Wilckens, 1911), from Seymour Island, Antarctica.*

David K. Moss on a fossil collecting trip.

"Our study truly would not have been possible without the collections housed at PRI."

A section of the Skaneateles Public Library collection on display at the library before accessioning to PRI.

42,000 specimens, 12,600 photographs and 1,400 localities. In FY 2017, we cataloged about 25,000 specimens and took about 2,000 photographs.

Volunteers and interns as well as undergraduate and graduate students have played a vital role in the success of the EPICC project. They have helped us check taxonomy, research and georeference localities, and take photographs of specimens. Michael Zelko, a junior at Cornell majoring in Biology, had this to say about his opportunity to work on the project: "I get to learn a lot about collections management and the behind the scenes work which goes on in museums. I have the added bonus of working with such amazing, friendly people since my freshman year. It is so exciting to be a part of such a large project, and I feel honored to be able to grow as a student while the grant progresses."

A Eurypterid fossil from the Skaneateles Public Library natural history collection.

Skaneateles Library Donation

The Public Library in Skaneateles, New York, long had a small natural history collection. The specimens were gifted to them in the late 1800s by Ezra B. Knapp (1830-1908), a local educator and bookseller. When the library decided to divest itself of the collection, PRI trustee John Allen facilitated the library's offer of the specimens to PRI in 2016. Associate Director for Outreach Rob Ross and Collections Manager Leslie Skibinski visited the library to pick up the collection. It had many research-quality specimens with data, including three large and well preserved eurypterids (sea scorpions). It also contained some excellent exhibit-quality specimens including a large slab of rugose coral, probably from Staghorn Point (a very famous fossil site) on Skaneateles Lake in the Finger Lakes region of central New York.

As it turns out, the library's collection was already connected to PRI. The Holotype specimen (the specimen used to describe a new species in the scientific literature) of a fossil clam *Mytilarca (Plethomytilus) knappi* Hall 1884 was gifted to PRI after it was found in the library's collection in 1948.

Research

Since PRI's founding in 1932, research has been a fundamental aspect of our history and identity. Research at PRI continues to contribute to various disciplines regionally and internationally, and strengthens our public programs, exhibitions, and service as an educational resource.

Research Facilities

PRI provides four research labs to our own and visiting scientists and students, each providing unique research capabilities. They include the **BioLab**, which is a "clean lab" for microscope work. This lab is used for dissection, microfossil processing, scanning electron microscopy, and histology. This lab is also home to PRI's new amino acid racemization (AAR) dating equipment.

An aquatic room for maintaining living aquatic animals and plants, the **WetLab** allows researchers to care for live specimens. The **PaleoLab** is a "dirty lab" used for processing field collections. This lab is used for rough specimen cleaning and preparation.

A combination research space and public exhibit in the Museum of the Earth, the **PrepLab** is used by staff, graduate students, and volunteers to conduct fine specimen preparation. Viewing windows allow Museum visitors to observe and interact with specimen preparers.

Research Awards

Since 1993, PRI has presented several annual awards, designed to recognize and encourage excellence in paleontology, particularly systematic paleontology (the branch of the discipline concerned with the description and analysis of the diversity of ancient life).

Allison Carsrud operating the scanning electron microscope in the BioLab.

The Gilbert Harris Award is presented annually to an individual who has achieved lifetime excellence in the field of systematic paleontology. Nominations are solicited through the Paleonet Listserver, and the Board's Science Committee recommends an awardee. The award is presented at the Friends of PRI Reception at the annual meeting of the Geological Society of America. In November 2016, the award was presented to Dr. Neil Landman of the American Museum of Natural History.

The Katherine Palmer Award is given to a non-professional in recognition of significant contributions to the science of paleontology. It is usually presented at the MAPS (Mid-America Paleontology Society) Fossil Expo in Iowa City, Iowa. The 2017 award was presented to Val Gunther of Brigham City, Utah.

The J. Thomas Dutro Jr. Student Award in Systematic Paleontology is given annually to a full-time graduate student for work in any area of systematic paleontology. The 2017 award was given to Brooke Long from the South Dakota School of Mines and Technology.

Since 2008, PRI has invited applications from advanced undergraduate and graduate students and post-doctoral researchers for the **John W. Wells Grants-in-Aid of Research Program**, named for John W. Wells, a former president of the PRI Board of Trustees (1961-1963), professor of geology at Cornell, and leading expert on fossil and living corals. The program awards grants of up to $500 to visit PRI's collections for research in any field of paleontology. The 2016 awardee, Lyndsey Farrar, an undergraduate student from the State University of New York at Oneonta, visited PRI's collection in FY 2017. During her visit, she sorted through over 1,000 boxes of Ordovician fossils collected and published on by Cornell professor and former PRI trustee, John L. Cisne, for a project to assess changes in body size and abundance of trilobites along an environmental gradient. The FY 2017 Wells awardee was Damián Pérez from the División Paleoinvertebrados, Museo Argentino de Ciencias Naturales "Bernardino Rivadavia".

Summer Symposium

The Tenth Annual PRI Summer Symposium was held in the Museum in July of 2016, with more than 40 people in attendance. First held in 2007 as part of PRI's 75th birthday celebration, this event has become popular for a variety of people, including faculty, students, amateurs, and artists, to present their work in an informal atmosphere. This year's keynote speakers were former PRI trustee emerita Nancy Budd and Tricia Kelley and former trustee, and chair of Cornell's Department of Plant Biology, Bill Crepet.

"Through PRI I have been able to engage not just with the scientific community but also with local Ithacans in a way many of my fellow students have not."

Ming Khan, Cornell University senior

"PRI has played a very large role in my time at Cornell University. I have volunteered and worked here since my freshman year, during which time I not only conducted my own research but also learned about the educational initiatives which a science or natural history museum conducts in order to engage the community. PRI's world class collections—especially the Zinsmeister collection of Eocene fossils from Antarctica—and guidance from Dr. Warren Allmon, have inspired me and definitely enriched my Cornell experience. Through PRI I have been able to engage not just with the scientific community but also with local Ithacans in a way many of my fellow students have not."

Research Reports

Peer-reviewed publications by staff and affiliated students

Allmon, W.D., 2016, Species, lineages, splitting, and divergence: Why we still need "anagenesis" and "cladogenesis". Biological Journal of the Linnean Society, published online: 1 Sept., 2016. Published in print, 1 February 2017, 120(2): 474–479.

Allmon, W.D., 2016, Studying species in the fossil record: A review and recommendations for a more unified approach. In Species and speciation in the fossil record. **W.D. Allmon** and M.M. Yacobucci, eds., University of Chicago Press, Chicago, pp. 59-120.

Allmon, W.D., and S.D. Sampson, 2016, The stages of speciation: A stepwise approach to analysis of speciation in the fossil record. In Species and speciation in the fossil record. **W.D. Allmon** and M.M. Yacobucci, eds., University of Chicago Press, Chicago, pp. 121-167.

Allmon, W.D., 2016, Coming to terms with "tempo and mode": Speciation, anagenesis, and assessing relative frequencies in macroevolution. In Evolutionary theory: A hierarchical perspective. N. Eldredge, T. Pievani, E. Serrelli, and I. Temkin, eds., University of Chicago Press, Chicago, pp. 260-281.

Allmon, W.D., 2016, Darwin and palaeontology: a re-evaluation of his interpretation of the fossil record. Historical Biology, 28(5): 680-706.

Allmon, W.D., 2017, Life-restorations of ammonites and the challenges of taxonomic uniformitarianism. Earth Science History, 36(1): 1-29.

Anderson, B.A.†, A. Hendy, E.H. Johnson†, and **W.D. Allmon**, 2017, Paleoecology and paleoenvironmental implications of turritelline gastropod-dominated assemblages from the Gatun Formation (Upper Miocene) of Panama. Palaeogeography, Palaeoecology, Palaeoclimatology, 2017: 132-146.

Barnosky, A.D., E.A. Hadley, P. Gonzalez, J. Head, P.D. Polly, A.M. Lawing, J.T. Eronen, D.D. Ackerly, K. Alex, E. Biber, J. Blois, J. Brashares, G. Ceballos, E. Davis, **G.P. Dietl**, R. Dirzo, H. Doremus, M. Fortelius, H.W. Greene, J. Hellmann, T. Hickler, S.T. Jackson, M. Kemp, P. L. Koch, C. Kremen, E. L. Lindsey, C. Looy, C.R. Marshall, C. Mendenhall, A. Mulch, A.M. Mychajliw, K. Nowak, U. Ramkrishnan, J. Schnitzler, K.D. Shrestha, K. Solari, L. Stegner, M.A. Stegner, N.C. Stenseth, M.H. Wake, and Z. Zhang. 2017. Merging paleobiology with conservation biology to guide the future of terrestrial ecosystems. Science, 355:eaah4787

Casey, M., L. Fall, and **G.P. Dietl**, 2016, You are what you eat: Stable isotopic evidence indicates that the naticid gastropod *Neverita duplicata* is an omnivore. Frontiers in Ecology and Evolution, 4(125): 1-13.

Dietl, G.P., and S.R. Durham†, 2016, Geohistorical records indicate no impact of the Deepwater Horizon oil spill on oyster body size. Royal Society Open Science, 3: 160763. http://dx.doi.org/10.1098/rsos.160763

Dietl, G.P., and J.A. Smith†, 2016, Live-dead analysis reveals long-term response of the estuarine bivalve community to water diversions of the Colorado River. Ecological Engineering 106 (Part B): 749-756.

Dietl, G.P., S.R. Durham†, J.A. Smith†, and A. Tweitmann†, 2016, Mollusk assemblages as records of past and present ecological status. Frontiers in Marine Science, 169. doi:10.3389/fmars.2016.00169.

Duggan-Haas, D., 2016, Critical zone science, interdisciplinarity and the NGSS. The Earth Scientist, 32(3): 15–18.

Johnson, E.H.†, B.M. Anderson†, and **W.D. Allmon**, 2017, Can we learn anything from all those pieces? Obtaining data on drilling predation from fragmented high-spired gastropod shells. Palaios, 32(5): 271-277.

Kosloski, M.†, **G.P. Dietl**, and J. Handley, 2017, Anatomy of a cline: Dissecting anti-predatory adaptations in a marine gastropod along the U.S. Atlantic coast. Ecography 40: 1285–1299.

Pietsch, C., H.C. Harrison, and **W.D. Allmon**, 2016, Whence the Gosport Sand (upper Middle Eocene, Alabama)? The origin of glauconitic shell beds in the Paleogene of the U.S. Gulf and Atlantic Coastal Plains. Journal of Sedimentary Research, 86(11): 1249-1268.

Sagarin, R., D.T. Blumstein, and **G.P. Dietl**, 2016, Security, evolution and. In Kliman, R.M., ed., Encyclopedia of Evolutionary Biology, vol. 4, pp. 10–15. Oxford: Academic Press.

Smith, J.A.†, and **G.P. Dietl**, 2016, Live-dead analysis reveals long-term response of the estuarine bivalve community to water diversions along the Colorado River. Ecological Engineering, http://dx.doi.org/10.1016/j.ecoleng.2016.09.013

(PRI staff indicated in bold; "†" indicates past or current Cornell student)

Smith, J.A.†, D.A. Auerbach, K.W. Flessa, A.S. Flecker, and **G.P. Dietl**, 2016, Fossil clam shells reveal unintended carbon cycling consequences of Colorado River management. Royal Society Open Science, 3: 160170.

Waite, R., and **W.D. Allmon**, 2016, Observations on the biology and sclerochronology of *Turritella duplicata* (Linnæus, 1758) (Cerithioida, Turritellidae) from southern Thailand. Malacologia, 59(2): 247-269.

White, T., and **D. Duggan-Haas**, 2016, Critical zone science and observatories and related education and outreach activities and resources. The Earth Scientist, 32(3): 7–10.

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Allmon, W.D., 2016, Museum collections and the philosophy of paleontology. Geological Society of America Annual National Meeting, Abstract No. 11-3.

Anderson, B.M.†, and **W.D. Allmon**, 2016, When domes are spandrels: On septation in turritellids and other gastropods. Geological Society of America Annual National Meeting, Abstract No. 46-11.

Allmon, W.D., T.M. Khan†, J.H. Escobar, A.J.W. Hendy, E. Stiles, and B.M. Anderson†, 2016, Biostratigraphic and evolutionary significance of turritellid gastropods from the Miocene of northern Colombia. Geological Society of America Annual National Meeting, Abstract No. 75-5.

Allmon, W.D., D.H. Geary, D.S. Friend†, P.J. Harries, J. Pustilnik†, and R. Ostrander, 2016, Ranges of variability in marine mollusks from "greenhouse" and "icehouse" climatic regimes: Plio-Pleistocene of Florida vs. Late Cretaceous of the U.S. Western Interior Seaway and Gulf Coastal Plain. Geological Society of America Annual National Meeting, Abstract No. 209-12.

Casey, M., L.M. Fall, and **G.P. Dietl**, 2016, Stable isotopic analysis reveals omnivory in the naticid gastropod *Neverita duplicata*: Part 2, Modern food web analysis. Geological Society of America Abstracts with Programs 48(7): doi: 10.1130/abs/2016AM-281792

Dietl, G. P., S.R. Durham†, J.A. Smith†, and A. Tweitmann†, 2016, AMBI and Bentix can be applied to molluscan death assemblages to guide environmental management decisions. Geological Society of America Abstracts with Program 48(7): doi: 10.1130/abs/2016AM-284937

Dietl, G.P., D.A. Burney, M. Casey, B. Crowley, S. Durham†, E. Reed†, and J.A. Smith†, 2016, Conservation paleobiology: using the past to manage for the future. International Union for Conservation of Nature World Conservation Congress, 1-10 September 2016, Honolulu, Hawaii, USA.

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Duggan-Haas, D., **R.M. Ross**, and T. White, 2017, The critical zone (CZ): Where rock meets life and the NGSS meets your class! National Science Teachers Association annual meeting, Los Angeles, CA: http://www.nsta.org/conferences/schedule2.aspx?id=2017los

(PRI staff indicated in bold; "†" indicates past or current Cornell student)

Duggan-Haas, D., and **R.M. Ross**, 2016, Key ideas for making and using virtual fieldwork experiences. American Geophysical Union Fall Meeting, ED41C-07. 2016.

Escobar, J.H., A.J.W. Hendy, C. Jaramillo, J.H. Curtis, F. Moreno, and **W.D. Allmon**, 2016, Isotope sclerochronology of Miocene molluscs from the Guajira Peninsula, Colombia. Geological Society of America Annual National Meeting, Abstract No. 240-18.

Fall, L.M., M. Casey, and **G.P. Dietl**, 2016. Stable isotopic analysis reveals omnivory in the naticid gastropod *Neverita duplicata*: Part 1, Laboratory feeding experiments. Geological Society of America Abstracts with Programs 48(7): doi: 10.1130/abs/2016AM-281799

Gigliotti, M.†, **C. Pietsch**, and **W.D. Allmon**, 2016, Turritellids take over: Latitudinal range expansion and body size increase in turritellid gastropods since the late Cretaceous. Geological Society of America Annual National Meeting, Abstract No. 163-31.

Hendricks, J.R., 2016, Ultraviolet (UV) light reveals the shell coloration patterns and phylogenetic diversity of Miocene cone snails (Conidae) from the Gatun Formation of Panama. Geological Society of America Annual National Meeting, Abstract No. 312-9.

Kellner, C.†, D.S. Friend†, and **W.D. Allmon**, 2016, Residual color patterns in Eocene *Athleta* (Gastropoda: Volutidae) from the U.S. Gulf and Atlantic Coastal Plain. Geological Society of America Annual National Meeting, Abstract No. 77-14.

Pietsch, C., L.C. Ivany, J.A. Sessa, **W.D. Allmon**, J.C. Handley, and R. Lockwood, 2016, Multi-scale biotic analysis of the Paleocene-Eocene thermal maximum shows little impact on shallow marine mollusks. Geological Society of America Annual National Meeting, Abstract No. 311-10.

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(PRI staff indicated in bold; "†" indicates past or current Cornell student)

Brendan Anderson, Cornell PhD student

Cornell PhD student Brendan Anderson works on the evolution of marine snails under the supervision of PRI Director Warren Allmon. Brendan's research involves using gene sequences of living snails of the family Turritellidae to reconstruct their evolutionary relationships, and then comparing these patterns to those derived from analysis of their fossil and modern shells. His aim is to understand the evolutionary history of this important group of mollusks, which has been abundant and diverse around the world for the past 130 million years. Brendan states, "The collections at PRI have provided me with the majority of specimens I have used in my research. I have conducted isotopic analyses on recent and fossil PRI specimens to study how the animals grew. I have also examined specimens using sections, CT scans and PRI's electron microscope to study how shell features such as different thicknesses and ornamentation evolved. Access to a wide variety of fossil and recent species has been a vitally important part of my research."

Publications

PRI has been a publisher of high-quality scientific research since its beginning. In fact, our *Bulletins of American Paleontology* (BAP) has been published since 1895 and predates the Institution itself. This technical journal remains one of the few remaining print outlets for monographic (book)-length papers in systematic paleontology, the nuts-and-bolts descriptive work that underlies all other aspects of paleobiological research. Until recently, BAP was what the PRI was best known for among professionals. One of our most recently published issues is titled "A silicified Late Triassic (Norian) bivalve molluscan fauna from the Alexander Terrane, southeastern Alaska" and was written by SUNY-Cortland professor Dr. Christopher McRoberts.

McRoberts notes, "It is an unfortunate trend that fewer and fewer conventional paleontology journals are providing access to systematic research, and fewer still that might be willing to publish larger monographic treatments (say of a particular fossil fauna or taxonomic group). Although the number of potential venues who might publish large monographic paleontological works are in decline, *Bulletins of American Paleontology* has a long history of publishing high-quality long-format systematically-focused paleontological research. The journal is well respected within the science and produced at a very high quality."

More recently, PRI's catalog of publications have greatly expanded in both subject matter and intended audience. This is well exemplified by two books that we published this year: *The Teacher-Friendly Guide to Climate Change* (edited by Ingrid Zabel, Don Duggan-Haas, and Robert Ross) and *Smith Woods: The Environmental History of an Old Growth Forest Remnant in Central New York State* (by Warren Allmon, Marvin Pritts, Peter Marks, Blake Epstein, David Bullis, and Kurt Jordan).

Published This Year by PRI:

Systematics of the gastropods of the Lower-Middle Miocene Cantaure Formation, Paraguana Peninsula, Venezuela

Landau, B. M., C. M. da Silva, A. Heitz, with cooperation of A. W. Janssen. 2016. Bulletins of American Paleontology No. 389-390: 1-582.

The Teacher-Friendly Guide to the Earth Science of the Southwestern US

Lucas, M. D., R. M. Ross, and A. N. Swaby (eds.). 2016. Paleontological Research Institution Special Publication No. 51. Ithaca, New York, 458 pp.

A silicified Late Triassic (Norian) bivalve molluscan fauna from the Alexander Terrane, southeastern Alaska

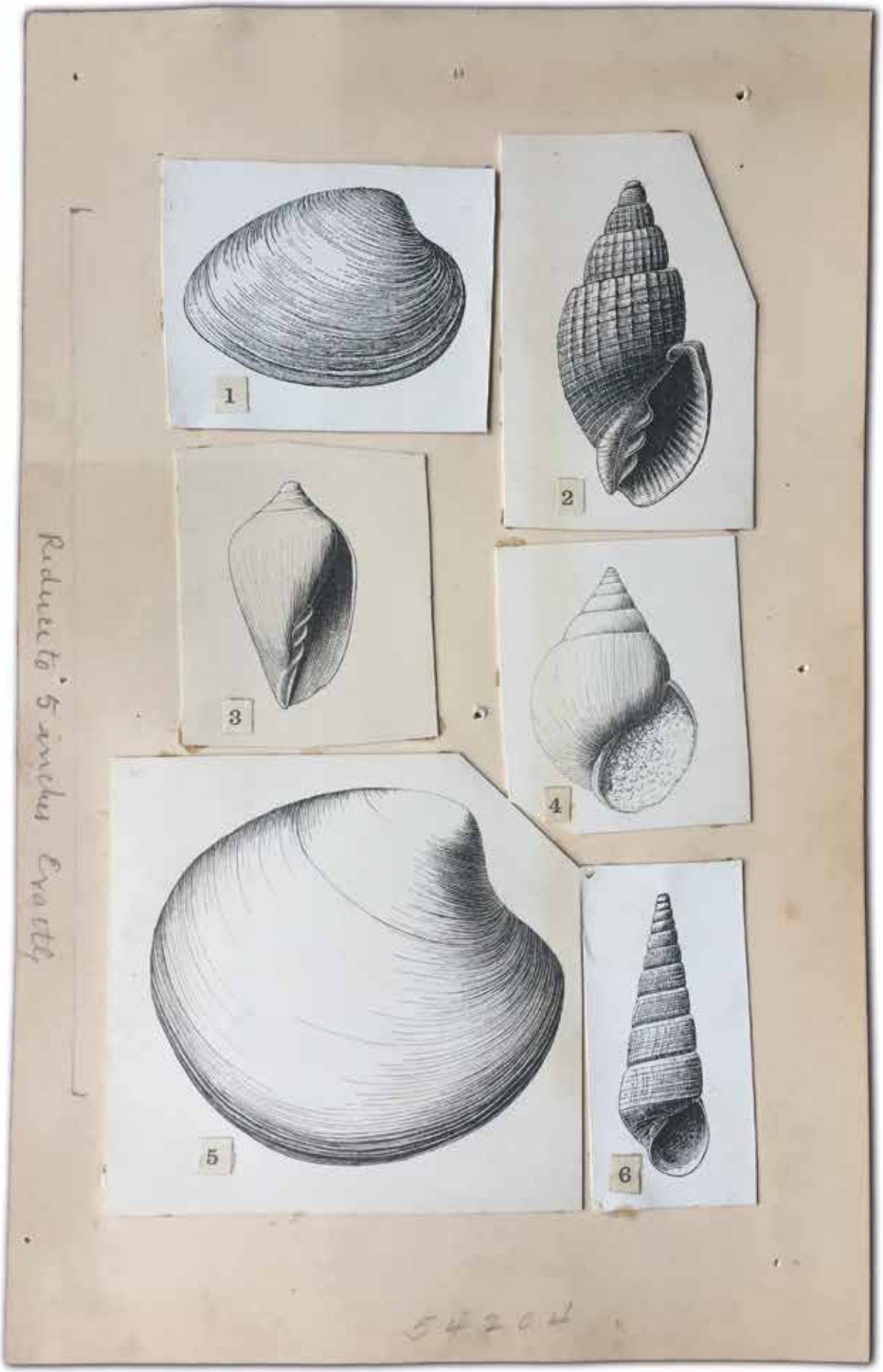
McRoberts, C. A. 2017. Bulletins of American Paleontology No. 391: 1-110.

The Teacher-Friendly Guide to Climate Change

Zabel, I. H. H., D. Duggan-Haas, and R. M. Ross. 2017. Paleontological Research Institution Special Publication No. 53. Ithaca, New York, 284 pp.

Smith Woods: The Environmental History of an Old Growth Forest Remnant in Central New York State

Allmon, W. D., M. P. Pritts, P. L. Marks, B. P. Epstein, D. A. Bullis, K. A. Jordan. 2017. Paleontological Research Institution Special Publication No. 52. Ithaca, New York, 207 pp.



Original of Plate 1 of Bulletins of American Paleontology Vol. 1, No. 1, published by PRI founder Cornell professor Gilbert Harris. Harris began publishing the Bulletins of American Paleontology in 1895. The journal is now in its 122nd year of publication.

Outreach

PRI provides local, regional, and national educational outreach by offering programming, publications, and resources to schools, teachers, and science educators, and to larger partnerships and institutions.

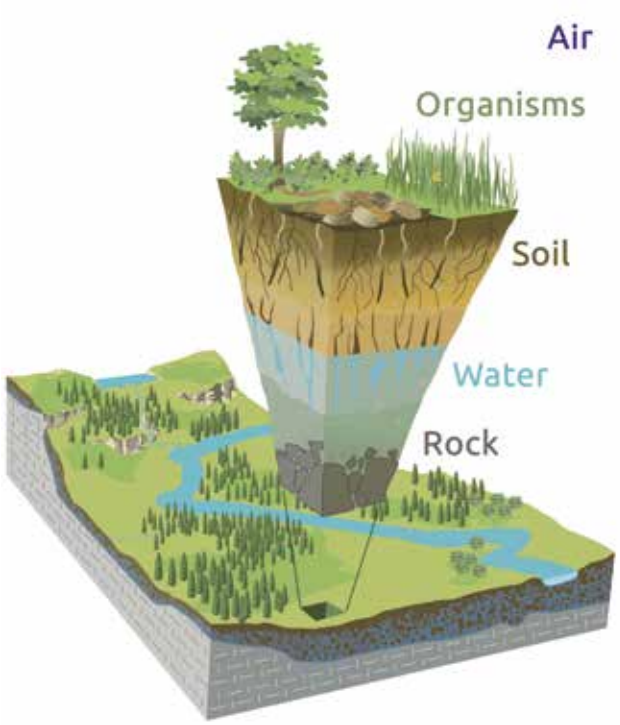
Leadership and Partnerships

- **Next Generation Science Standards (NGSS)**
  PRI education staff were involved in discussions of national development and implementation of the new Next Generation Science Standards (NGSS). Director of Teacher Programs Don Duggan-Haas worked with the Science Teachers Association of New York State as they evaluated the standards and gave feedback to the State Education Department. In June, he was appointed to the Science Content Advisory Panel/ Science Education Steering Committee for New York State Education Department as the state begins implementation of the New York State P-12 Science Learning Standards, the new science standards based heavily upon the NGSS.

- **ReaL Earth Inquiry Project**
  PRI completed its national series of Teacher-Friendly Guides to regional Earth science in fall 2016, the final

  piece of PRI's multi-year, $1.8 million NSF-funded project ReaL Earth Inquiry. PRI involved dozens of geoscientists and geoscience educators in creating the Guides. PRI promoted the books and associated professional development tools and workshops throughout FY 2017. PRI is also a national leader in the design, development, and dissemination of Virtual Fieldwork Experiences (VFEs) as part of the ReaL Earth Inquiry project (www.virtualfieldwork.org).

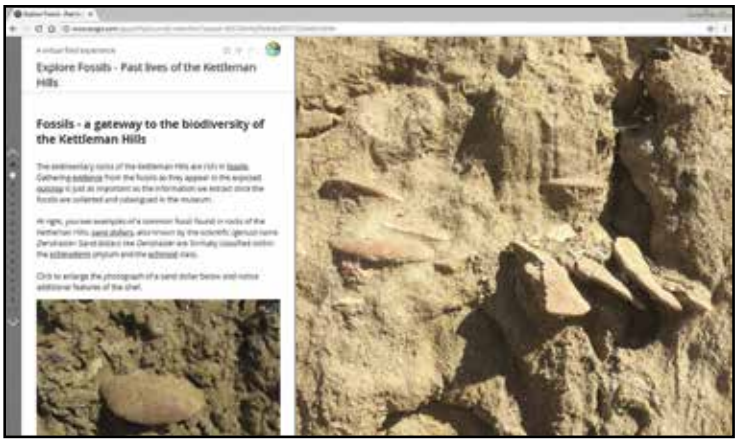
- **Critical Zone Observatory Network**
  PRI is the educational outreach partner for the Critical Zone Observatory (CZO) Network, whose National Office was established at Cornell University in 2014. The Critical Zone is the outer skin of the



Critical Zone layers. (Modified from Chorover, J., R. Kretzschmar, F. Garcia-Pichel, and D. L. Sparks. 2007. Soil biogeochemical processes in the critical zone. Elements 3, 321-326. (artwork by R. Kindlimann)

Earth, extending from the top of the tree canopy to the base of the groundwater lens. There are nine CZOs that monitor biological, chemical, and geological parameters across a range of ecosystem types. PRI staff members Don Duggan-Haas and Alexandra Moore are in the process of creating virtual fieldwork experiences for the nine CZO sites, with three drafts completed thus far (Shale Hills in Pennsylvania, Southern Sierra in California, and Luquillo in Puerto Rico).

A partnership with Binghamton's PBS/NPR affiliate WSKG has led to the production of a video series on CZ science called "Where Rock Meets Life." The first video, "Explore the Critical Zone," was released in March 2017. Don Duggan-Haas, Alexandra Moore, and Rob Ross have created a reviewed collection of educational resources drawn from the nine CZOs. These resources are available through a new E&O portal on the CZO National Office web site. The fall 2016 issue of the National Earth Science Teachers Association journal, *The Earth Scientist*, was a theme issue focused upon CZ science, and this fall's issue of the National Association of Geoscience Teachers' *In the Trenches* will focus on CZ science. Both issues were edited by Don Duggan-Haas.



Sample page from the EPICC Virtual Fieldwork website.

- **EPICC Virtual Fieldwork Experiences**
  PRI is partnering with educators at the University of California Museum of Paleontology to produce virtual fieldwork experiences to virtually visit classic paleontological field sites along the Pacific coast and to explore images and data from specimens that have been collected there. The partnership is the primary outreach vehicle for the project "Eastern Pacific Invertebrate Communities of the Cenozoic," a set of nine natural history museums (one of which is PRI) working together to put data online from museum specimens of fossil ocean life found along the Pacific coasts of the Americas. The VFEs at the EPICC outreach website can be used by anyone with an interest in fossils, especially Cenozoic marine fossils of the west coast of the U.S. *(see page 4)*

- **Climate Literacy and Energy Awareness Network (CLEAN)**
  Ingrid Zabel, PRI's Climate Change Education Manager, and Don Duggan-Haas are active members of the Climate Literacy and Energy Awareness Network (CLEAN). This group is responsible for the national Climate Literacy Principles that have been cited in several federal educational initiatives and requests for proposals in an array of grant programs. Don now serves on the CLEAN Advisory Board.

- **National Association of Geoscience Teachers (NAGT)**
  At the Geological Society of America's annual meeting in October 2016, Don Duggan-Haas, PRI's Director of Teacher Programs, assumed the role of First Vice President of the National Association of Geoscience Teachers (NAGT). He will serve on NAGT's Executive Board for four years and will serve as President from 2017-2018.

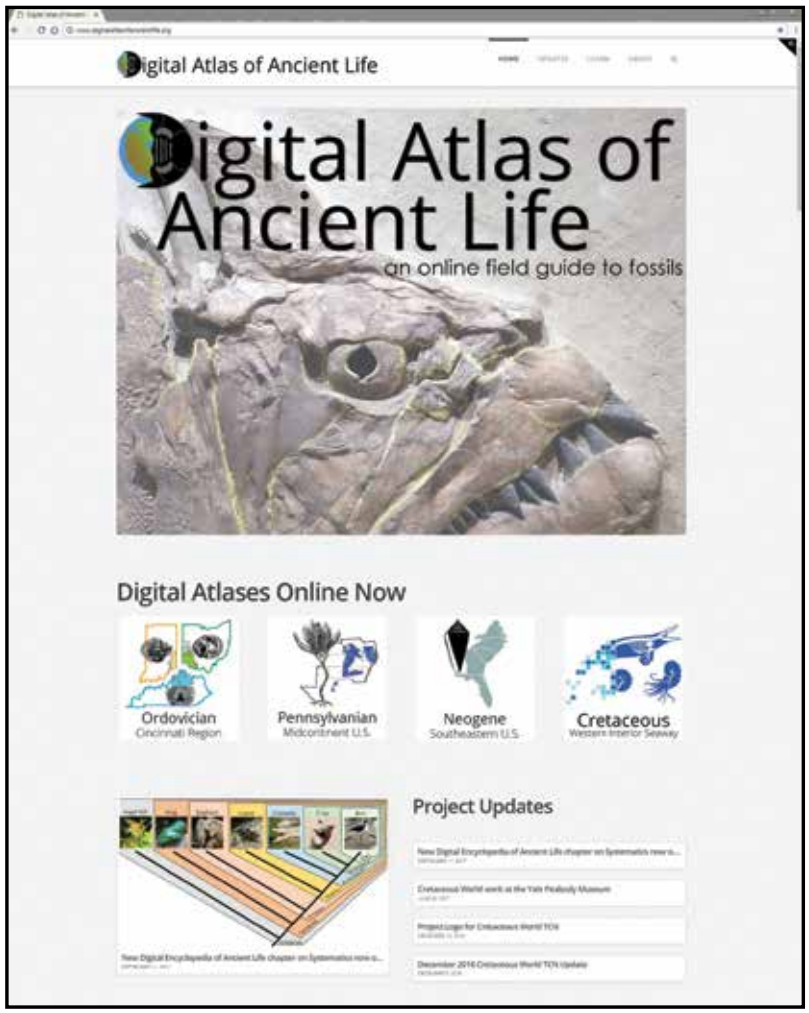
- **Western New York Environmental Alliance (WNYEA)**
  PRI is a member of Western New York Environmental Alliance (WNYEA), an alliance of more than 100 groups and institutions who work to resolve environmental issues

Director of Teacher Programs Don Duggan-Haas assisting high school students during the 2017 Western New York Climate Summit at Buffalo State College in June, 2017.

in western New York. Don Duggan-Haas serves on WNYEA's Climate and Energy Working Group, as well as its Education Process Group.

- **Western New York STEM Hub (WNY STEM)**
  Don Duggan-Haas participates in the Western New York STEM Hub, an initiative to support the teaching of science, technology, engineering, and mathematics in western New York. He is also an active member of the Western New York Science Leaders, a group engaged in science teacher professional development and curriculum materials development.

- **Tompkins County Climate Protection Initiative (TCCPI)**
  PRI is an active member of TCCPI, and Ingrid Zabel regularly attends their monthly meetings. TCCPI is a climate action and clean energy coalition in the Ithaca, NY area made up of community leaders from the education, business, local government, nonprofit, and youth sectors.



Digital Atlas of Ancient Life

PRI is now the home of the Digital Atlas of Ancient Life (www.digitalatlasofancientlife.org) project. This initiative—which is supported by the National Science Foundation and led by Director of Publications Jonathan Hendricks—provides free, online digital "field guides" to fossils from particular regions to help avocational and professional paleontologists, as well as teachers and their students, identify and learn about their fossil discoveries. Digital Atlases have already been produced for the Ordovician fossils from the Cincinnati region (www.ordovicianatlas.org), the Pennsylvanian of the midcontinent United States (www.pennsylvanianatlas.org), and the Neogene of the southeastern United States (www.neogeneatlas.org). An all new Atlas, which focuses on Cretaceous fossils from the Western Interior Seaway—which divided North American in two during the age of the dinosaurs and covered places like modern Kansas below a shallow ocean—is currently under development (www.cretaceousatlas.org).

Stephen Durham (Cornell, Ph.D., 2017), Vicky Wang (PRI collections assistant), and two digitization assistants—Rachel Casterline (TC3) and Isaac Bilinski (SUNY Geneseo)—assisted Hendricks over the past year with production of new digital content for the Neogene and Cretaceous atlases.

An additional resource that is being produced as part of this project is an all new, open access, online "textbook" about ancient life. It is being written by Hendricks, in collaboration with his colleagues. Initial chapters on the Nature of the Fossil Record, Systematics, and Gastropoda are now online and may be accessed at www.digitalatlasofancientlife.org/learn/.

Outreach on Climate Change

The goal of PRI's efforts in climate change education is to present information that will allow individuals to make informed choices about the use of energy and natural resources. Through exhibitions, curricula, presentations, professional development, website resources, citizen science projects, and more, we help people make sense of present and future change contrasted with climate change over the geologic time scale.

In April 2017 PRI published *The Teacher-Friendly Guide to Climate Change*, the 10th volume in PRI's Teacher-Friendly Guide series, which covers both the basics of climate change science and the cognitive issues that make teaching climate change challenging. The book is available for purchase or free download at climatechange.teacherfriendlyguide.org. In June of 2017 PRI launched the Teach Climate Science campaign which will run through May 2018 to raise funds to send books and CDs to secondary school science teachers both in the Northeastern US and nationally.

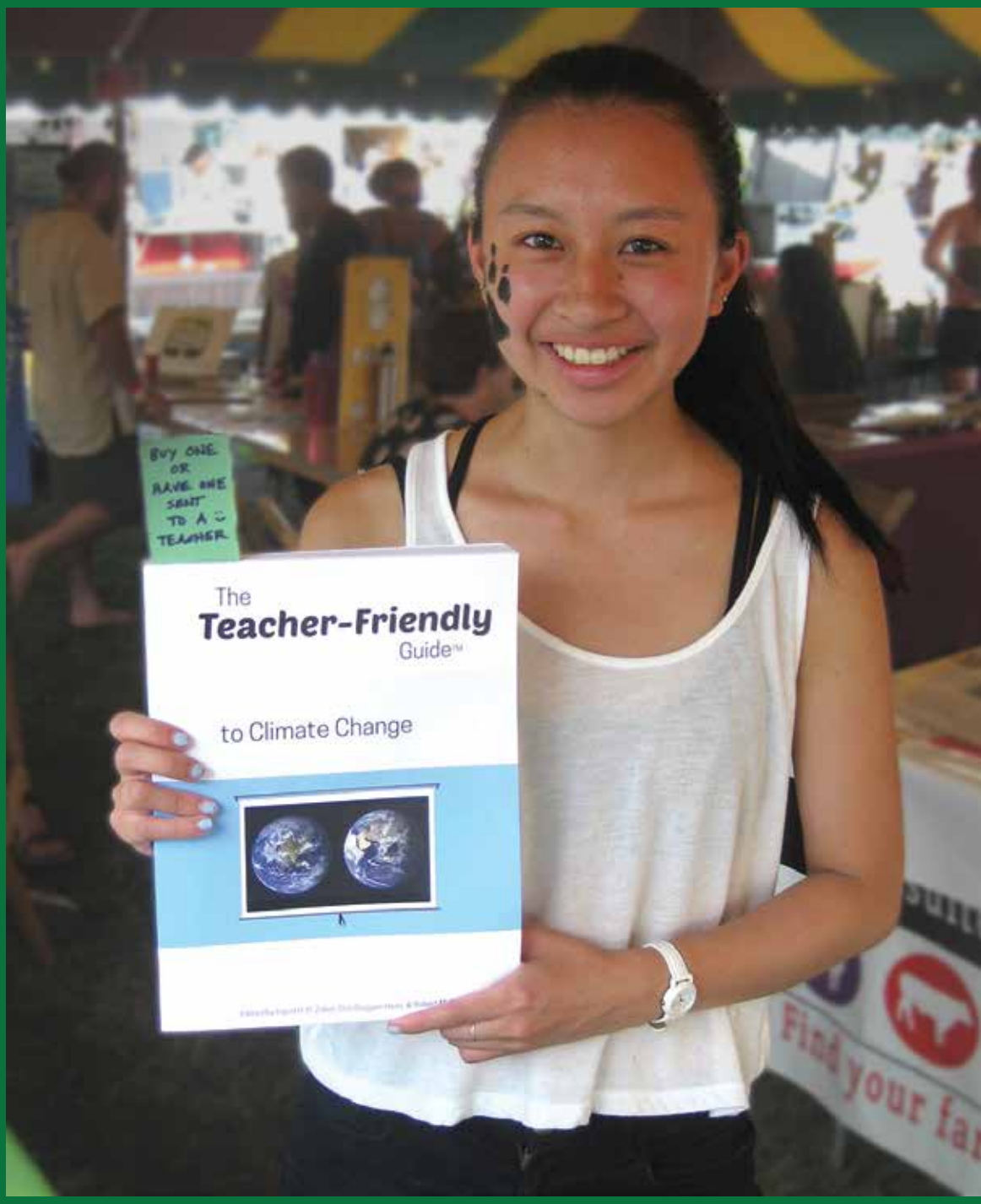
Exhibitions at the Museum of the Earth and Cayuga Nature Center present climate change and evolution

Spreading the science about climate change to counter misinformation

In April 2017 PRI published ***The Teacher-Friendly Guide to Climate Change***, the 10th volume in PRI's Teacher-Friendly Guide series, which covers both the basics of climate change science and the cognitive issues that make teaching climate change challenging.

After learning that a publication full of misinformation on climate change was being sent out by a conservative think tank to over 300,000 teachers across the country, PRI launched the Teach Climate Science campaign in June of 2017. The campaign will raise funds to send our Teacher-Friendly Guide to Climate Change books and CDs to every public high school science teacher in the country., and is scheduled to run through May 2018.

Alexandra Moore, a Senior Education Associate at PRI, is spearheading the effort. Along with a general fundraising campaign, she has been working to raise awareness nationally, including being featured in a recent Sierra Magazine article, and has started an innovative program to encourage people to purchase a copy of the book to be sent to their favorite teacher.



Cynthia Chu, Cornell Environmental Engineering class of 2020, with her copy of the Teacher-Friendly Guide to Climate Change that she purchased to have sent with a handwritten thank you to Jericho High School teacher Reena Bhasin.

Applying Math to Climate Change

Crystal Theesfeld's pre-algebra class at New Roots Charter School, a public high school in Ithaca, New York, had never gone on a math field trip before. Nor had any of the other math classes at the school. But one spring day in early May the students went on a field trip to the Cayuga Nature Center to take on a big subject: responding to climate change.

The students climbed off the school bus, grabbed their clipboards, and got to work. One group focused on the Nature Center's driveway, which is facing erosion from increasingly heavy rainstorms. Students measured the dimensions of the driveway so they could calculate its surface area and evaluate three options: adding more gravel, putting down permeable pavement, or building bioswales alongside the driveway to soak up the rain. They applied unit cost amounts and came up with cost estimates for the three driveway improvement options.

Another group focused on the costs and benefits of switching all the Nature Center's lighting to LED light bulbs. They did a thorough assessment of the many different lights in the building, going from room to room and counting up bulbs. Back at school, they did calculations that helped them evaluate the tradeoffs between bulb cost and bulb lifespan. They found that although LED bulbs can cost more than incandescent bulbs initially, the energy savings translate to cost savings quickly.

The third and final group looked into the idea of generating the Nature Center's electricity locally, using an array of solar photovoltaic (PV) panels. They were given the Nature Center's annual electricity usage data, and asked to figure out if the Nature Center's needs could be met by covering the roof of the lodge with solar PV panels. To do this they had to measure the surface area of the lodge's multiple roofs…without going up on the roof. This involved making measurements and estimates on the ground, using the symmetry of the lodge to reduce the number of measurements they had to make, and using the Pythagorean Theorem on roof ends to calculate roof dimensions.

PRI's Associate Director for Outreach, Robert Ross, talking with teachers in the Taughannock Falls gorge during a Master Teacher VFE Workshop.

concepts in an approachable way for visitors, and include displays on local and global climate in the Cayuga Nature Center's Leopold Climate Room and the Museum of the Earth's glacier exhibition. PRI participates with regional organizations and alliances to promote public literacy in climate change and associated environmental issues and topics, including CLEAN and WYNEA. We are an outreach partner of Cornell University's Atkinson Center for a Sustainable Future, and a member of the Tompkins County Climate Protection Initiative (TCCPI) coalition. For teachers of Earth sciences, we provide workshops that help educators address controversial issues when teaching about climate change.

Teacher Professional Development

- **Teacher-Friendly Guides™**
  The full seven-volume series of Teacher-Friendly Guide to the Earth Science of the US was completed in time for the Geological Society of America's Annual Meeting in October 2016, and was unveiled at the PRI reception. These Guides are available at www.teacherfriendlyguide.org, including *The Teacher-Friendly Guide to Climate Change*, published in May 2017. PRI has initiated the "Teach Climate Science" fundraiser to support the distribution of the Teacher-Friendly Guide to Climate Change to every US high school and high school science teacher.

- **Science Teacher Association of New York State (STANYS)**
  PRI continues a tradition of strong presence at the Annual Meeting of STANYS. Rob Ross, Don Duggan-Haas, Ingrid Zabel, and Maureen Bickley attended this year's meeting in November 2016. PRI staff led five workshops at the conference, with Zabel discussing the New York Climate Change Science Clearinghouse as a resource for teachers, Duggan-Haas speaking about adoption of the Next Generation Science Standards, *The Teacher-Friendly Guide to Climate Change*, and Critical Zone science, and Don, Rob, and Maureen speaking about doing Earth and environmental science fieldwork.

- **New York Earth Science Teachers Association (NYESTA)**
  PRI has been involved in New York Earth Science Teachers Association conferences, helping to host the first meeting in 2014. Don Duggan-Haas received their Distinguished Service Award at the second conference in July 2015. He assisted with the planning and hosting of this year's meeting at SUNY Fredonia, helping to coordinate trips to Niagara Falls and the Penn Dixie Fossil Park and Nature Preserve.

Teachers picking up fossils and other teaching material donated by PRI during our annual Teacher Resource Day.

- **Teacher Resource Day**
  For more than 20 years, PRI's annual Teacher Resource Day has provided free specimens and other resources for teachers and educators to use in their classrooms. More than 70 participants attended Teacher Resource Day in October 2016, highlighted by presentations by WSKG Director of Science Programming Nancy Coddington and Cornell CZO post-doctoral researcher Justin Richardson.

Outreach on Evolution

Evolution is central to almost everything we do at PRI. Evolution Education Manager Andrielle Swaby has been focusing on expansion of evolution-centered programming at the Nature Center. The "Evolution in Your Backyard" project highlights familiar local organisms, with a focus on adaptation, ecology, and evolutionary relationships. For the first interactive offering, Swaby designed a program that focuses on the evolutionary relationships of squirrels to teach about evolutionary trees, using skeletal anatomy as an example of an evolutionary building block that enables scientists to group species and make predictions about relatedness.

New animal signage and exhibits at the nature center focus not only on adaptations, but also their evolutionary relationships. The new signs at the animal enclosures' are illustrated with evolutionary trees inspired by our participation in the Tree Room project, an Institute of Museum and Library Services-funded project to improve public understanding of evolutionary trees. The exhibit has an introduction to evolutionary relationships and evolutionary trees on each of the enclosures.

From December 2016 to February 2017, PRI partnered with the Tompkins County Public Library (TCPL) for several months of exhibits and educational programming on human evolution. The partnership was built around a Smithsonian traveling exhibition hosted by the Library called *Exploring Human Origins*. Programming started with a teacher workshop on July 13 at the Library, given by two Smithsonian staff. PRI's exhibition at the Tompkins County Public Library, "You Are Here: Exploring Human Evolution" was on view at TCPL from February

Part of the "You Are Here: Exploring Human Evolution" exhibit on display at the Tompkins County Public Library in February, 2017.

The Wilderness Campus at Caroline Elementary School in Slaterville Springs, New York.

Bringing Nature Education to Local Elementary Schools

Matt Sacco working with elementary school students.

Matt Sacco, Director of Nature Center Programs, has been working collaboratively with Caroline Elementary School to expand programming at their Wilderness Campus. This educational trail system utilizes hands-on programming, including the use of taxidermy specimens and trail cameras, to educate students about local ecology. Lesson plans align with the Next Generation Science Standards and Common Core.

Working with First Grade classes at Caroline Elementary School and Belle Sherman Elementary, Sacco has students using motion-activated trail cameras to investigate what types of animals live around their school. Students, for example, have spent time looking at animal tracks and writing their hypotheses about what they think made those tracks. The trail cameras then are used to provide evidence to test their hypotheses, such as images of a bobcat, fox or deer. The students are also given the opportunity to take the camera home for a few nights. This gives them the chance to be the field expert and teach their family members what they know about using camera traps and animal behavior. One student wanted to guarantee that the camera would take pictures so she positioned the camera in front of her cat door. During the deer heart dissection, one 5th grade student said, "This is awesome. This is why I am going to be a doctor." By engaging teachers and students in direct, fun, reality-based learning about the natural world, the CNC inspires students to take on both local and global environmental issues in support of a sustainable future.

Photo of a deer from Matt's trail-cam.

Director of Nature Center Programs Matt Sacco at the Nature Center demonstrating how humans would be able to cut meat off an animal bone using stone tools during the Darwin Days Paleolithic Family Day, February, 2017.

through the end of March. The exhibit featured a large variety of human skulls and other specimens and was created in collaboration with CU and IC anthropology departments. Visitors learned about how biology, culture, and environment intersect to make us who we are.

Darwin Days 2017: Exploring Human Origins ran from February 12-18 in conjunction with our human evolution exhibit at TCPL. The event series was coordinated by Andrielle Swaby, and included a screening of *Inherit the Wind*; a panel discussion on the evolution of human sociality; a Science Cabaret presentation about the art of showing human evolution; a keynote presentation by Dr. Ian Tattersall of the American Museum of Natural History on the origins of human cognition; Darwin trivia night; and "Paleolithic Family Day" featuring a demonstration about the history of flint-knapping and its cultural significance.

"You Are Here: Exploring Human Evolution" exhibit on display at the Tompkins County Public Library.

PRI Director Warren Allmon giving the Science Cabaret presentation during the 2017 Darwin Days celebrations.

A demonstration of flint knapping during the Darwin Days' Paleolithic Family Day.

Exhibits

Combining real specimens with expert design and fabrication, our award-winning exhibits create lively and engaging educational experiences for the general public at local, regional, and national levels. Exhibitions at both the Museum of the Earth and Cayuga Nature Center provide unique and memorable learning opportunities for visitors of all ages and backgrounds. The permanent, temporary, traveling, and off-site exhibits produced by PRI are making Earth science accessible to all by exploring the 4.5 billion years of Earth's history through art, science, and PRI's world-renowned fossil collections.

Traveling Exhibitions

Maize: Mysteries of an Ancient Grain

This exhibit, funded by the National Science Foundation, explores the evolution of maize and why for thousands of years it's been one of the most significant crops for humankind—and why it continues to surprise us. Visitors explore some of the newest discoveries in modern genetic research that helps scientists better understand the evolution of maize and how that knowledge can improve everyday life, at both a local and global level.

This year the exhibit has traveled to the Marion County Public Library in West Virginia, Flint Hills Discovery Center in Kansas and the Stamford Museum & Nature Center in Connecticut.

Did Dinosaurs Poop?

This award-winning exhibition presents a fun, colorful approach to learning about fossils and the diets of various dinosaur species. It is currently at the Ecotarium in Worcester, Massachusetts until January 2018.

PRI's traveling exhibition "Maize" on display at the Stamford Museum and Nature Center, Stamford, Connecticut.

Museum of the Earth

The Devonian World exhibit in the Museum of the Earth.

PRI has two educational venues, the Museum of the Earth and Cayuga Nature Center. The Museum tells the story of life on Earth through thoughtful and innovative displays of the fossil record; the Nature Center tells us the story of life on Earth today, both in the lodge and in the surrounding forests and fields, as it unfolds in our own backyards.

Woven through both venues are the themes of climate change, evolution, and personal awareness, calling the visitor to establish a connection to the Earth. Richard Louv states a need for just this in his book the *Last Child in the Woods*:

> *"without that connection to nature, people lose interest in protecting it."*

At PRI we aspire to be a resource for connecting people to the beautiful world around us and to cultivate a passion for the environment and sciences in our visitors. Whether displaying the Earth's treasures in indoor exhibits or through the stunning 32 acres of old-growth forest that make up Smith Woods, our public venues are a vital part of the institution and its mission.

PRI's award-winning Museum of the Earth provides meaningful learning experiences about the rich history of life on Earth to a range of audiences, from local students and their families to visitors from around the world. Exhibit artistry, scientific collaboration, and various interactive programs bring the story of prehistoric Earth to life.

Permanent Exhibition Upgrades

Carboniferous exhibit upgrades

The exhibits department finished upgrades in the Museum's Carboniferous gallery and successfully incorporated the tree models transferred from the Smithsonian Institution National Museum of Natural History in 2014. Our volunteer Ron George scenically painted the reattached tree branches and assisted in the installation. In addition, we partnered with renowned model-maker Terry Chase, who fabricated a new giant dragonfly model and lycopod tree trunk for this exhibit, marking the completion of the "coal swamp" forest that was envisioned 15 years ago when the Museum was first designed, and providing a more immersive experience into this time period.

Terry Chase and Museum Operations Specialist Leon Apgar inspecting the giant dragonfly.

The Buzzsaw Sharks of Long Ago

Alaskan artist Ray Troll was fascinated by fossils of *Helicoprion*. Although first described in 1899 from a fossil found in the Ural Mountains of Russia, most of the world's still-rare specimens of *Helicoprion* have been unearthed in Idaho's phosphate mines. In 2013, a significant breakthrough led by Idaho State University researchers collaborating with modern shark specialists and Troll, a self-professed *Helicoprion*-obsessed artist, shed important new light on the weird animal. The exhibit, from the Idaho Museum of Natural History, tracked the unfolding perceptions of a big, bizarre prehistoric whorl-toothed shark, through a wide array of spectacular *Helicoprion* fossils integrated with original artworks by Ray Troll. Also featured was a dramatic life-sized model of the animal as envisioned by renowned paleo-sculptor Gary Staab. The Museum's exhibit featured the model of the shark bursting through the wall. The exhibit also included a mechanical interactive jaw, children's activities, a short documentary, and more. The exhibit was a unique combination of science, art, music and humor that explored the many ways people come to know the natural world through fascinating animals and the quest to unravel a provocative mystery. *(see photo on page 29)*

Special Exhibits

Stanley Metzloff Retrospective

The "Into The Depths: Marine Paintings By Stanley Meltzoff" special exhibit, a retrospective of the work of Stanley Meltzoff, was in the Museum's BorgWarner Gallery in the Fall of 2016. Meltzoff was a widely-recognized master painter of the underwater world. As a child on the New Jersey shore, he was fascinated by aquatic life and began skin diving and spearfishing at a young age. He was also an early adopter of scuba diving and underwater photography. His breathtaking depictions of fish in their natural environment turned the world of sporting art upside-down. Meltzoff was the first—and one of the best—to truly capture the light, motion, and dramatic action of undersea life.

Part of the "Into the Depths" special exhibit, a retrospective of the work of Stanley Meltzoff.

Museum Docent Allan Meritt talking with children during a Kids Discover the Trail! program.

Special Events

The Museum hosted a variety of special and annual events during the fiscal year to provide engaging educational experiences, including:

- 28 Million Years Later: A Prehistoric Puzzlehunt
- DinoEggstravaganza
- Fossil ID Days
- Fossil Mania 2016
- Holiday, Winter, Spring, and Summer Break Programs
- Museum In The Dark
- History of Life courses
- Deep Sea Fishing: A Mirror to a Fragile Ecosystem
- Smithsonian Museum Day Live

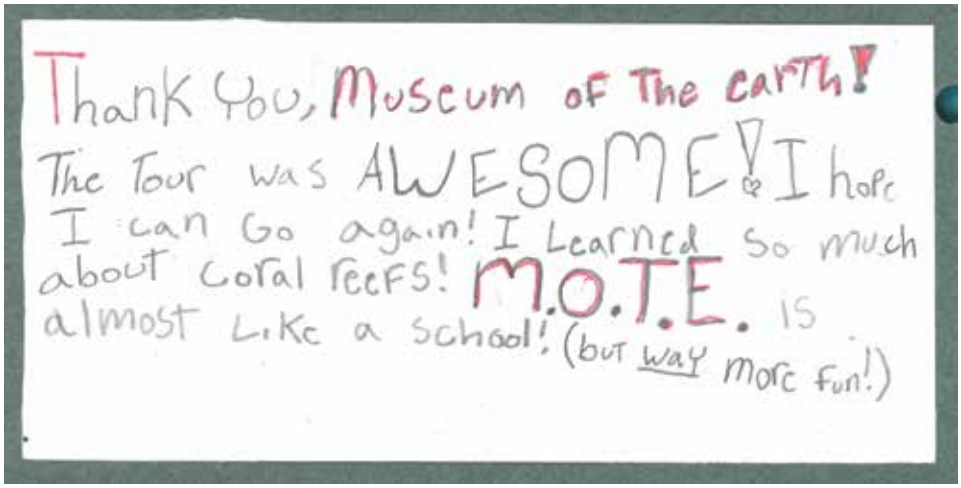
School and Group Programs

K-12 Field Trip Programs

The Museum offers many program options for K-12 students. These programs, incorporating subjects that correspond to Museum exhibits such as local Devonian fossils, dinosaurs, coral reefs and glaciers, enhance students' visits and curricular goals. In all, over 3,800 students were served through almost 200 programs during FY 2017.

Seasonal Break Programs

The Museum hosts public educational hands-on programs during local Winter, Spring, and Summer school recesses, as well as extra holiday programming around Christmas and New Year's. Programs attract



A letter of appreciation to Museum Education Manager Maureen Bickley from a visitor on a school trip.

different audiences, ranging from young children to older adults and educators.

Special Programs

Kids Discover the Trail! (KDT)

As a member of Ithaca's Discovery Trail, the Museum provides fun, hands-on educational programming for every 1st grade class in Ithaca, Trumansburg, Groton, Newfield, and Lansing School Districts. Through KDT program the Museum reached over 800 students during FY 2017. Learn more at www.discoverytrail.com.

Ithaca Loves Teachers

The Museum of the Earth is a participant in Ithaca Loves Teachers, an annual teacher appreciation week that aligns with Winter Recess for the Ithaca City School District and focusses on thanking teachers through special programming and discounts.

Edication and Operations Coordinator Kelsey Capuso doing a Summer Storytime hour for young children at the Museum.

Part of the "Buzz Saw Sharks of Long Ago" exhibit on display during the Spring of 2017.

Cayuga Nature Center

Cayuga Nature Center cultivates awareness, appreciation, and responsibility for the natural world through outdoor and environmental education. PRI merged with the Nature Center in 2013, and the Nature Center is critical to PRI's mission in several ways, including our goal to create a premier educational center for teaching and learning about evolution and the impact of climate change on the fauna and flora of Central New York. Each year we reach thousands of people through public programs, school programs, and camps. Through the **Kids Discover the Trail!** program, we reach 800 Tompkins County 5th graders each year who participate in the Nature Center's TEAM challenge course.

Daisy, the red fox, one of our Animal Ambassadors

Permanent Exhibition Upgrades

This year we expanded and updated the exhibits at CNC and have plans to continue into next year with our large-scale Cayuga Lake Aquarium project, and additional enhancement of our live Animal Ambassadors collection.

The soil "monoliths" created by Intern Liza van Kapel in the Layers of Life exhibit at the Nature Center.

Revamping the Layers of Life exhibit

We have expanded and revamped the Layers of Life exhibit on forest ecology to better convey the themes that focus on the treetops down to the soil, including new exhibits on Smith Woods and on Soils in Tompkins County. The soil exhibit was compiled by intern Liza van Kapel, who came from Wageningen University in the Netherlands and worked with Cornell professor Jonathan Russell-Anelli and post-doc Justin Richardson to construct this new exhibit.

New exhibit on Ticks and Lyme Disease

We have installed an exhibit on "Ticks and Lyme Disease", which is an important public health issue in Central New York. This exhibit includes information about tick natural history as well as Lyme disease and other tick-borne diseases. A detailed tick model, 70x the actual size, is part of the exhibit on tick natural history. Taxidermic mouse specimens illustrate other vectors

of tick-borne diseases. As part of the exhibit, we have provided extensive take-away literature for visitors about Lyme disease and its spread, where it is found, and how it is prevented, diagnosed, and treated. In addition, we have a workbook for kids and their parents from the New York City Department of Health that contains fun activities and educational information about ticks.

We also partnered with the Tompkins County Health Department to provide an in-service training for staff about preventing tick bites, removing ticks, and what to do if someone thinks they might have a tick-borne disease. In close proximity to the Tick and Lyme Disease exhibit, we have installed a redesigned deer exhibit that further makes the connection between Lyme Disease and the vectors that carry it.

Manager of Animal Collections Amanda Moshier with Ichabod, the Turkey Vulture.

Animal Ambassadors

To enhance the permanent exhibits on forest ecology, climate change, and evolution, Cayuga Nature Center is home to an expanding number of live Animal Ambassadors. The animals who call the Nature Center home are all non-releasable back into the wild due to of injuries or having been born in captivity. Our dedicated staff trains and cares for more than 30 species—from hawks and foxes to domino cockroaches and turtles. This year our collection of species native to the Cayuga Lakes bioregion has grown to include red fox, great horned owl, turkey vulture, red-tailed hawk, porcupine, and opossum, as well as a number of species of turtles, snakes, other reptiles, amphibians, insects, and smaller mammals. New signage for the live animals added this year allows visitors to learn about species ecology and evolution.

Climate and Environmental Change

Staff members Ingrid Zabel, Dayna Jorgenson, and Brian Gollands developed and ran educational programs for school groups, summer camps, and the general public on themes of local environmental concerns, climate change, and sustainability. This work was funded by the Park Foundation and included activities at the Nature Center and at Smith Woods.

Oakley, the Great Horned Owl.

The new pavilion at the Nature Center.

Summer Camp

Cayuga Nature Center's Summer Camp has been in operation longer than any other camp in the area. Each year we see over 400 campers ranging in age from 3 to 16 years. Many of these campers return to us each summer, excited to gain new knowledge and skills from our staff of Environmental Educators who serve as their guides to the natural world. By immersing campers in our local landscape we cultivate an appreciation for the flora and fauna around them.

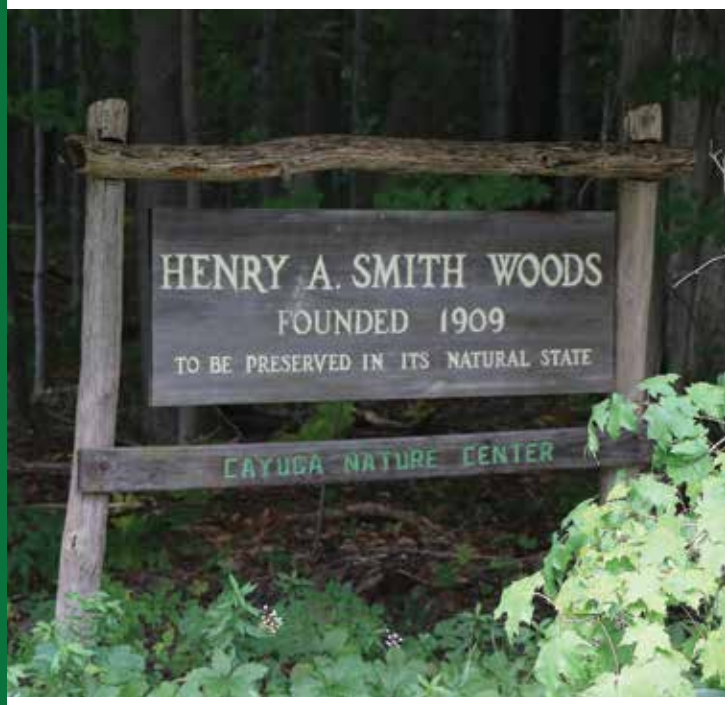
Through observation-based learning, we provide campers of all ages with hands-on experiences that fuel their desire for further exploration. By engaging campers in on-site conservation projects, we are encouraging them to be environmental stewards who will make more informed decisions regarding climate change and the future of our planet.

Research has shown that it only takes one positive adult relationship to make a lasting impact on a child's life. We pride ourselves in being the safe space and familiar faces who empower these children and help them maintain a sense of innocence and normalcy while here at camp. Parents have noted the value of what a week at Cayuga Nature Center can offer their child. Responses collected from our 2017 Camp Parent Survey revealed praise for our staff's ability to make lasting connections with campers, and our ability to offer diverse and enriching activities. As one parent said, "I love that I know so many of the employees who have been there for a long time. I trust CNC. I also love that my little ones come home understanding and using words related to ecology and other types of science, and really understanding how the natural world works."

One parent told us "This place is her summer home, it is where she is the happiest and she can just be herself."

Smith Woods

Henry A. Smith Woods is a 32-acre old-growth forest located just outside of Trumansburg, New York. It is one of the largest remaining flat tracts of old growth forest in central New York. This small but spectacular place, with its enormous trees, dense forest canopy, and never-plowed ground, is a glimpse into the past. A walk through this small forested area may be the closest one can get in the region to experiencing a landscape that European settlers first witnessed. Old-growth forests are important both ecologically and culturally, providing a unique habitat and embodying local history. Sadly, these forests have declined every year since European settlement of the continent. According to the Old Growth Forest Network, only 1% of original forests in the Northeast US remain. Most Americans will never get to see an old-growth forest.



Henry Atterbury Smith (1822-1891) was a businessman from New York City who purchased the land that includes Smith Woods as a summer residence. Although he visited the property sparingly, he was a well known member of the Trumansburg community. In 1909, this undeveloped forest fragment was left to the Village of Trumansburg by Smith's sons to be preserved as a public park forever. The purpose of the park is "the preservation of the park in its natural state and for educational and recreational purposes".

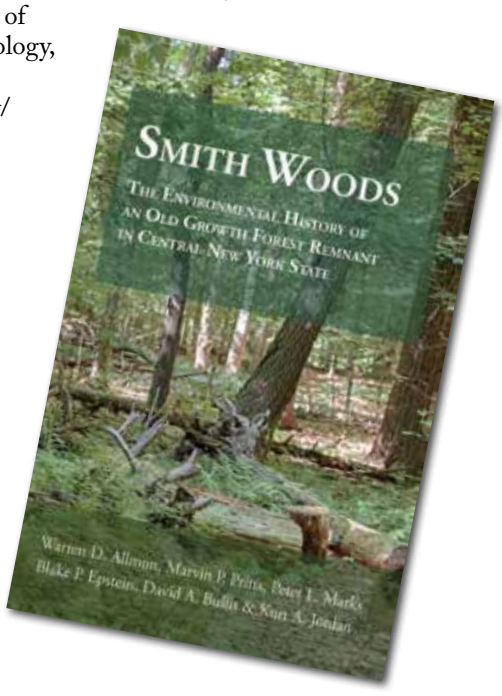
In 2007, ownership of this forest was transferred to Cayuga Nature Center to continue its use as an educational site. Smith Woods then came under the care of PRI when we merged with Cayuga Nature Center in 2013, and we have committed ourselves to preserving the integrity of the forest in keeping with the original intent of the trust. Since the transfer, a loop trail was created and Cayuga Nature Center staff have continued to uphold the educational mission of the park through school visits and public hikes. Smith Woods is open to the public year round.

What is an Old-Growth Forest?

An old-growth forest, also known as a primeval or virgin forest, is one that does not have any significant disturbance, particularly human, and which usually has unique biodiversity features. Most forests in North America are considered secondary forests, in that they have been cut down and have since regrown. Old-growth forests are generally heavily stratified; they have very distinct and different layers. It is because of the diverse stratification that these older forests can sustain various species of animals and plants and allow them to live in the same place at the same time.

Old-growth forests often have large living trees as well as standing dead trees. They also contain layered canopies with tree-fall gaps and a woody forest floor. These forests often have communities of plants and animals that have survived over long periods of time, sometimes even rare species that are not found in the more common younger forests.

PRI published a book about our old-growth forest in March, 2017 entitled *Smith Woods: The Environmental History of an Old Growth Forest Remnant in Central New York State*. The book's aims to increase awareness about Smith Woods and honor its history. The book was a collaboration of experts in geology, plant science, anthropology/ archaeology, and ecology.



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Leon Apgar, Maintenance and Operations Specialist
Maureen Bickley, Museum Education Manger
Helaina Blume, Director of Exhibitions
Patrick Branigan, Visitor Services Manager and Volunteer Coordinator
Maija Cantori, Director of Visitor Services
Kelsey Capruso, Education and Operations Coordinator
Heather Delaney, Visitor Services Associate
Greg Dietl, Director of Collections
Don Duggan-Haas, Director of Teacher Programs
Dave Fass, Visitor Services Supervisor
Brian Gollands, IT Manager
Matthew Griffin, Visitor Services Associate
Michael Griswold, Facilities Manager
John Gurche, Artist-In-Residence
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Jonathan Hendricks, Director of Publications
Dayna Jorgenson, Environmental Education Manager
Bill Klose, Research Associate
Georgia Lesh, Director of Development and Marketing
Michael Lucas, Associate Director for Finance and Administration
Pam Millar, Membership and Development Associate
Amanda Moshier, Manager of Animal Collections
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Robert Ross, Associate Director for Outreach
Matt Sacco, Director of Nature Center Programs
Amanda Schmitt, Assistant to the Director
Leslie Skibinski, Collections Manager
Kelley Snedeker, Visitor Services Associate
Andrielle Swaby, Evolution Education Manager
Vicky Wang, Collections Assistant
Savannah Wilson, Animal Education Manager
Ingrid Zabel, Climate Change Education Manager

We would like to thank the following colleagues who moved on during FY 2017:
Wade Greenberg-Brand
Sarah Grove
Kevin Lanigan
Mark Lucas
Cienna Lyon
Alana McGillis
Carlie Pietsch
Beth Stricker
Marissa Zuckerman

2017 Summer Camp Staff

Rachel Hallock, Assistant Camp Director
Kathleen Harrington, Camp Health Director
Alex Mitchell, Youth Services Administrative Assistant

Kelsey Brewster, Environmental Educator
Seneca Brill, Environmental Educator
Victoria Chamberlain, Environmental Educator
Jordan Gattine, Environmental Educator
Alana McGillis, Environmental Educator
Brian Parks, Environmental Educator
Tara Perry, Environmental Educator
Madison Searles, Environmental Educator
Katy Stringer, Environmental Educator

Katelin Nelson, Lead Preschool Educator
Lisa Gould, Preschool Educator
Brianne DeVaul, Preschool Educator

Jack Masters, Youth Volunteer
Wren Martinson, Youth Volunteer

This year PRI has started working with Challenge Industries to hire individuals with obstacles to employment for the front desks. The two young women, Heather and Kelley, have been wonderful to work with, are dedicated to learning, and have gifted us with invaluable information about being inclusive to individuals with special needs.

Internships / Work Study

PRI internships, assistantships (paid internships), and work-study opportunities are a great way for college students to gain experience in a unique environment, while contributing a great deal to the mission of our organization. These internships are also a wonderful resume builder, and occasionally a student will change their study focus after completing our internships. The students during the school year commute from local colleges such as Cornell University or Ithaca College, but during the summer we get talent from all over the United States, and even overseas. These students find working with PRI staff a wonderful and fulfilling experience.

Interns

Maria Altier
Emily Barbay
Maeve Bowdish
Maggie Butler
Claire Derry
Ann Dunn
Julie Erickson
Mikaela Fundaun
Maddie Gaetano
Siddharth Gavirneni
Michael Goodman
Sam Johnson
Cory Kimmell
Whitney Lapic
Limin Li
Matthew Lin
Tal Mintz
Cavan Mulligan
Sarah Noell
Kelly OShaughnessy
Sarah Ousley
Hannah Owh
Lisa Peck
Emily Pfeil
Rachel Rosenburg
Elena Stiles
Sarah Stuart-Sikowitz
Shawn Taylor
James Tupper
Liza van Kapel
Stephanie Waite
Megan Woodrow
Amy Zhang

Assistants

Elizabeth Altier
Isaac Bilinski
Michaela Brew
Rachel Castrerline
Ming Khan
Michael Zelko

Work-Study Students

Eleanor Bent
Grace Burgin
Kelly Crandall
Daniel Farthing
Jordan Gattine
Agnes Goldrich
Leah Hoffman
Zach Keller
Grace Marcelo-Rameriz
Ure Obioma
Tyler Stepke
Rory Strauss
Anna Ullmann
Lillian Zhang

Colleges and Universities

Cornell University
Binghamton University
Colorado College
Ithaca College
Mesalands Community College
Mt Holyoke College
Oberlin College
Rochester Institute of Technology
St. Lawrence University
SUNY Geneseo
SUNY Oneonta
SUNY Oswego
Tompkins-Cortland Community College
Tulane University
University of the Andes (Colombia)
Wageningen University (Netherlands)
The College of William and Mary

Volunteers

Volunteers fill vital roles throughout our institution. With their selfless enthusiasm for the history of life on earth, each volunteer brings talents and interests that contribute to the diversity of our organization's expertise. From the youth who apprentice to care for our animals, to the professors who lend their passion for earth science to our informal educational programming, our ability to fulfill our mission is strengthened with each individual that volunteers. In 2017, we had more than 200 volunteers contribute nearly **8,000 hours** to PRI. At the same time that these volunteers brought new and exciting expertise to the institution, they also collectively offset one of our largest overhead expenses by roughly $190,000 (per an annual estimation of the value of volunteers by Independent Sector). Our thanks to all the following volunteers:

Alexandra Allmon
Annastasia Alvarado
James Alvarado
Zebediah Alvarado
Sally Anderson
Kyra Bean
Otto Beer
Noel Bentley
Deborah Bilinski
Dan Brewton
Deanna Brodsky
Janice Brown
Peg Burlew
Dick Burlew
Megan Buteau
Alexandra Buton
Amy Carey
Pat Charwat
Larry Chase
Sam Cherney
John Cusano
Amy Cusano
Paula Cusano
Barbara Dimock
Erin Doyle
Lenore Durkee
Elizabeth Edgerton
Jose Escobar
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Chloe Faehndrich
Surya Fitzgerald
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Emily Healy
Linda Hindall
Melissa Hodde
Kristi Holley
Julia Hoshino
Arjun Iyer
Matthew Jasinski
Larry Jensen
Mohan Jewet
Viola Jones
Melody Keifer
Amanda Kelly
Shelby Klemann
Bill Klose
Frank Kozlowski
Debbie Krueger
Alexandros Laskaris
Bill Law
Limin Li
Curt Lindy
Skyler Maasen
Sam MacMillan
Michael Mann
Mike Marano
Gene Marks
Sam Martin
Wren Martinson
Arthur Masloski
Andrew McNeil
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Allan Meritt
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Anita Michalak
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Aaron Minehan
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Eric Poysa
Alex Quintos
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Mark Sacco
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Benny Smith
Annabelle Smith Pamela
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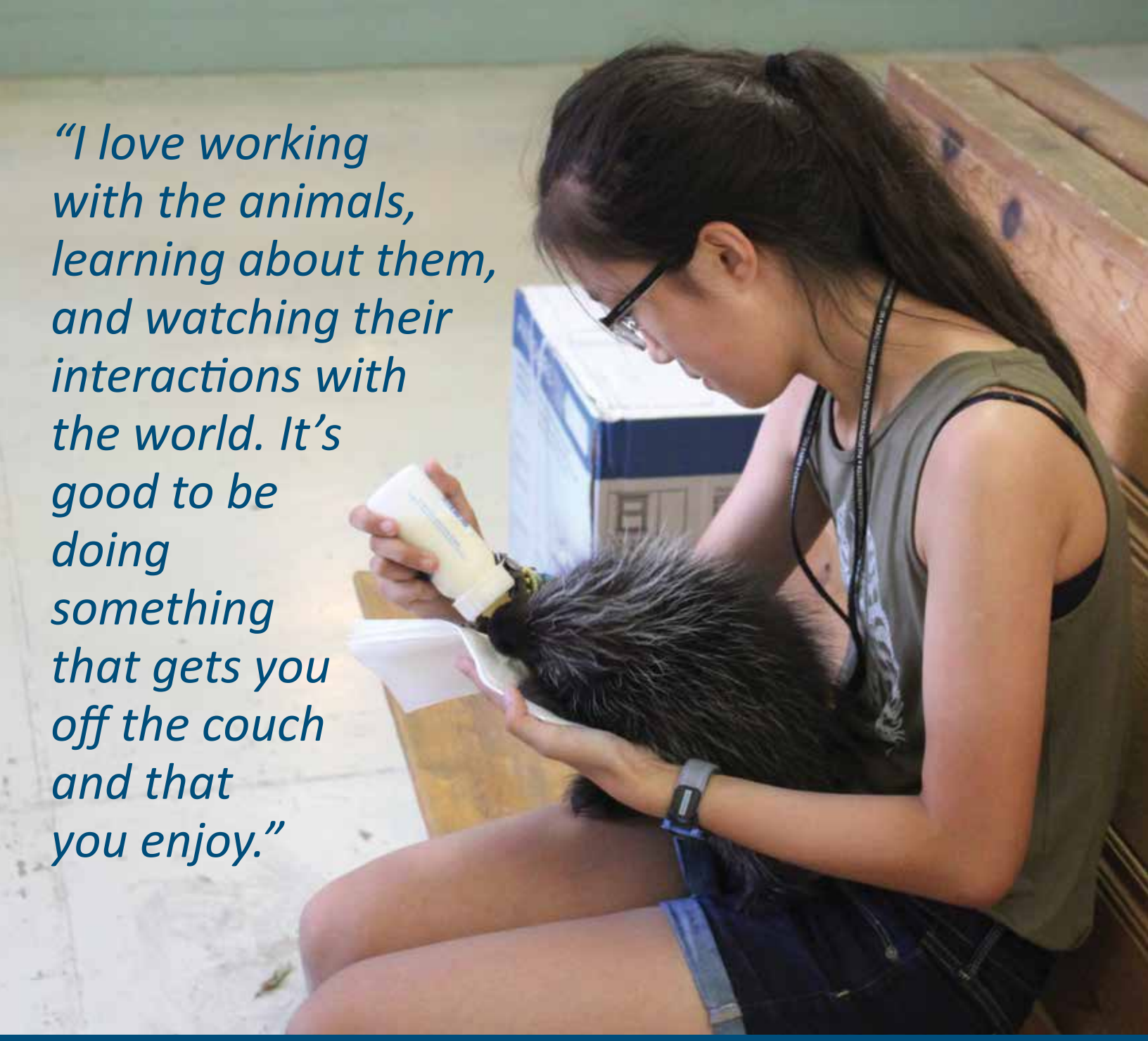
Charlie Stone
Serena Takada
Regi Teasley
Jennifer Tegan
Ellen Valentino
Peter (PJ) Voudouris
Emily Waldenman
Anita Welych
Martin Welych-Flanagan
Cathy Whalen
Don Wilson
Anna Wilson
Caroline Wollman
Chris Young
Rose Zabel

Our thanks also go out to the following volunteer organizations and initiatives:
Americorps
Cornell Alpha Phi Omega
Cornell Greeks Give Back
Ithaca College Into the Streets
Ithaca College Protestant Community
Ithaca College Service Saturdays
Ithaca College Believe in Love
Dryden High Serteen Club
Franzisca Racker Center
The Learning Web
Unity House of Cayuga County
United Way of Tompkins County



"I love working with the animals, learning about them, and watching their interactions with the world. It's good to be doing something that gets you off the couch and that you enjoy."

Wren Martinson, Volunteer

Wren began coming to summer camp, where she eventually joined our Counselor in Training program. It was here that she got a glimpse of what it was like to care for our animals, and we were elated when she decided to join as a volunteer in our Animal Caretaker Apprenticeship program. In over two years of volunteering, Wren has contributed to the basic care of nearly all our animals. She has also contributed much time (and patience) to their enrichment, to help ensure our animals are amiable toward visitors and prepared for public programming. Wren likes to volunteer at the Nature Center to be more involved and to give back to her community. She does much of this during the summer, in tandem with playing the clarinet and participating in her school's robotics club, but continues volunteering on the weekends through the school year as time allows.

Donors

Annual Fund

Darwin Society $10,000+

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Bruce and Heather Lane
James Morin and Myra Shulman
Kurt Over
Estate of Suzanne E. West

Devonian Society $5,000-$9,999

Susan Fleming
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Cayuga Society $2,500-$4,999

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In-kind gifts

Warren Allmon and Jennifer Tegan
Atlas Bowl
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Barbara Page
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The Falls Restaurant and Tavern
Ingrid and Mark Zabel
Marissa Zuckerman

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Sunny Days
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In honor of Marvin Pritts

In memory of

H. Allen and Jane Curran
In memory of Michele Aldrich
Teresa M. O'Neill
In memory of Brian J. O'Neil

Whitney Lapic, Summer Research Intern

Whitney is a Mount Holyoke student studying geology and paleontology. While attending the annual Geological Society of America conference in 2015, Whitney met a PRI staff member at our table. Maybe the Paleozoic Pals plushies attracted her, but she stayed and talked about interesting opportunities at PRI. She later contacted our intern coordinator about a possible summer internship for 2017. She was accepted into the Research Internship where she worked with Dr. Greg Dietl and his graduate student Steve Durham over the summer. Whitney accumulated around 340 hours in the lab, and participated in two of the summer fossil collecting trips.

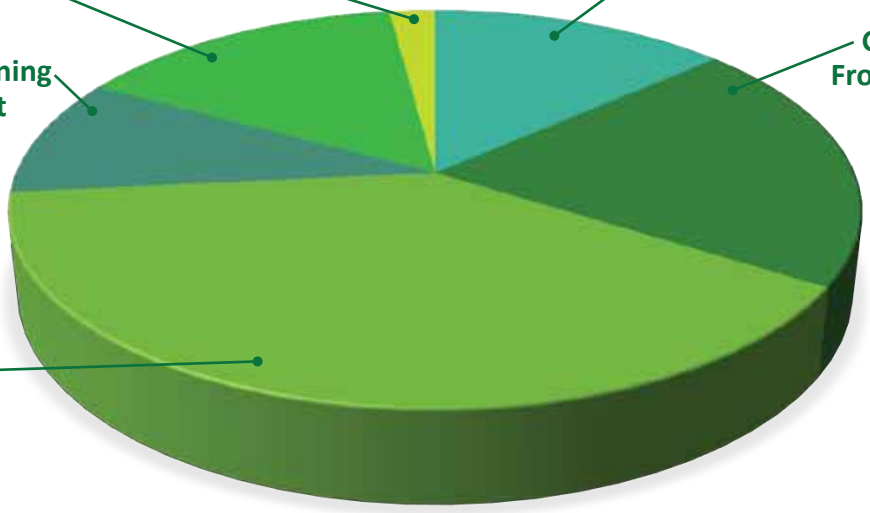
Whitney also has a strong interest in insects and made connections with Brian Gollands, PRI's IT Manager and resident entomologist. They hope to collaborate in the future and she may contribute some of her insects to our animal collection. Our interns leave a mark on us through their time partaking in PRI internships. Our intense commitment to college student education and participation means our interns and volunteers grow as a result of the interaction, too. Whitney has said that she hopes to possibly return to complete her PhD at Cornell with Dr. Dietl.

Whitney fossil collecting at Rickard Hill, NY.

Financial

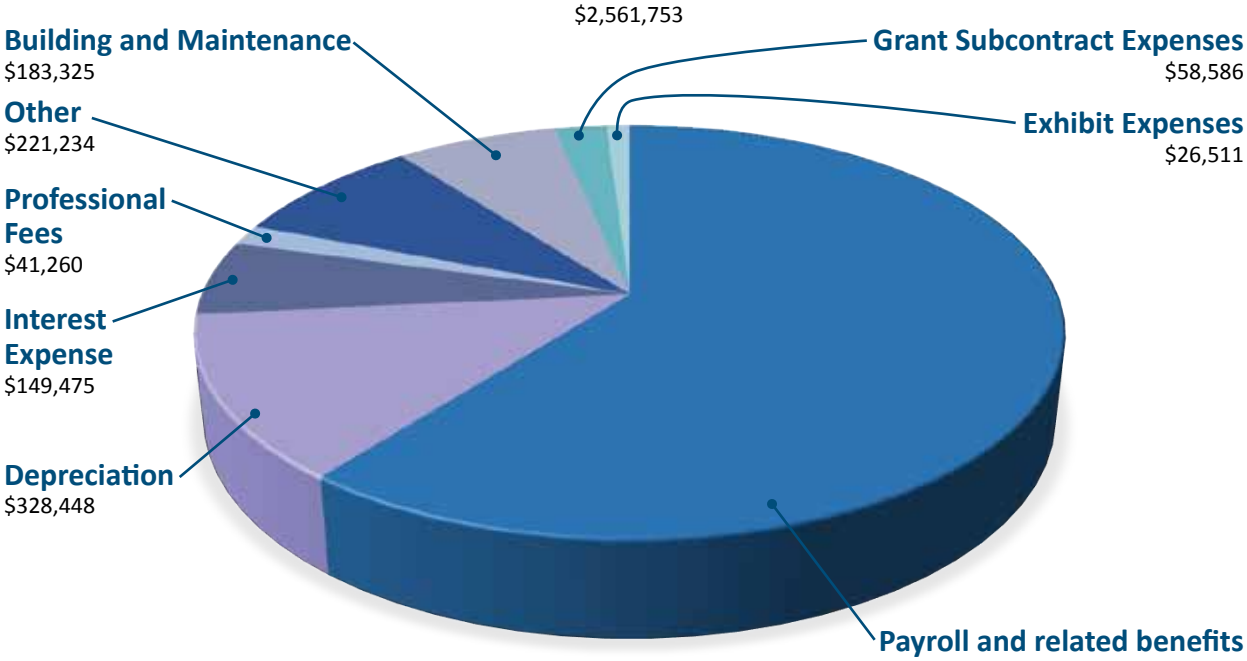
Revenue

$2,568,217



Expenses

$2,561,753



Palmer Hall

Named in honor of Katherine Palmer (Director, 1952-1978), Palmer Hall is the Institution's main building, housing PRI's collections, laboratories, library, and offices.

Cayuga Nature Center

The Cayuga Nature Center's education programs and exhibitions focus on the natural history of the Cayuga Lake basin, and are conducted in the Lodge and on the 120 acres of woodlands and fields. Our live Animal Ambassadors enhance the learning experience.

Museum of the Earth

Opened in 2003, the Museum of the Earth is home to temporary and permanent exhibitions that teach thousands of visitors each year about the history of life on Earth.

Smith Woods

Located in Trumansburg, NY, Henry A. Smith Woods is the largest plot of old-growth forest in central New York. More than 32 acres in size, Smith Woods serves as a education resource for elementary through graduate students and a unique laboratory for researchers.

PALEONTOLOGICAL
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PRI (Palmer Hall)
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