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Conservation Paleobiology – Reading the Fossil Record to Guide Tomorrow's Ecosystems

By Mikayla Rovenolt

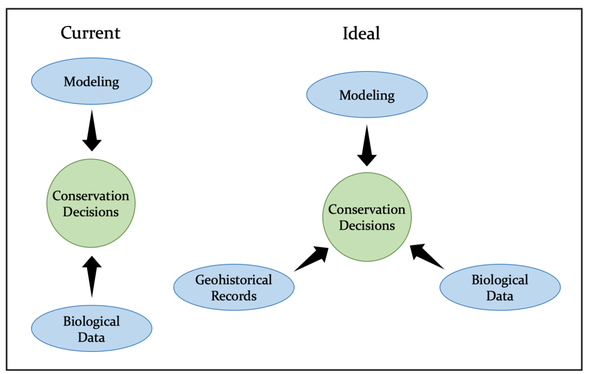
Not far from Downtown Ithaca, New York, at the Paleontological Research Institution (PRI), an internationally recognized scientist digs for answers to some of today's most pressing environmental crises. Dr. Gregory P. Dietl, Curator of Cenozoic Invertebrates and Director of Collections at PRI, and an adjunct associate professor of Earth and Atmospheric Sciences at Cornell University, is a leading voice in conservation paleobiology.

This emerging field uses the fossil record and other geohistorical archives—shells, bones, pollen, sediment cores—to provide the long-term context that modern ecology often lacks. By studying what ecosystems looked like before and during past environmental upheavals, Dietl and his colleagues help conservationists set realistic restoration goals, assess true human impacts, and plan for an uncertain future.

At PRI, Dietl oversees vast collections of Cenozoic—the past 66 million years of Earth's history—marine invertebrates while leading research that bridges paleontology and conservation biology. Through exhibits at the Museum of the Earth and collaborations with students and colleagues, Dietl shows how Ithaca-based science is shaping worldwide efforts to protect biodiversity and ecosystem services like clean water, coastal protection, and food security.

"Long-term data help us make more informed decisions," Dietl said in an interview with the *Ithaca Times*. "Think about the stock market: Nobody wants to invest based only on what happened today. You want to understand the bigger trends over time. In ecology, we often lack that historical perspective, and conservation paleobiology helps us reconstruct it."

Gregory Dietl, Curator of Cenozoic Invertebrates at the Paleontological Research Institute, Ithaca, New York. (Photo: Mark Syvertson)



Introduction to Conservation Paleobiology. (Graphic: Greg Dietl)

Conservation paleobiology fills a critical gap. Traditional ecological monitoring covers only decades—too short to capture the full scope of human-driven change. Many ecosystems were already altered by overhunting, deforestation, or pollution long before scientists began systematic surveys.

Fossils and death assemblages (accumulations of recent dead shells or bones) act as natural archives, offering baselines that stretch back centuries or millennia. As Dietl and co-author Karl W. Flessa wrote in a 2011 review in *Trends in Ecology & Evolution*, this approach lets scientists "put the dead to work" for conservation policy and practice. Their 2017 book *Conservation Paleobiology: Science and Practice* (University of Chicago Press), which Dietl co-edited, further solidified the field's framework.

One of Dietl's signature projects—the Historical Oyster Body Size (HOBS) project—illustrates the power of conservation paleobiology. HOBS is a collaboration between PRI and the Florida Department of Environmental Protection (FLDEP) that uses buried shells of oysters to reconstruct the historical condition of Florida's oyster reefs in protected areas managed by the state. In many places, long-term monitoring data either do not exist or have only recently begun, making it difficult to know how much reefs have changed over time.

Trillions of seashells have accumulated on the cheniers in the northern Gulf of California, in Baja California (Mexico). (Source: www.priweb.org)

The project takes advantage of the fact that dead oyster shells buried beneath living reefs retain a kind of ecological "memory" of past environmental conditions. By sampling these shell deposits, Dietl and his FLDEP colleagues can compare modern oyster populations with reefs that existed decades earlier, with some records extending back to the 1950s. That historical perspective showed that some reefs declined in oyster body size over time, while others remained stable or even increased—patterns that would have remained hidden without the geohistorical record preserved beneath the reefs.

The findings are helping environmental managers better understand long-term reef change and set more informed conservation and restoration goals for the oysters and the ecosystems they support. The HOBS project also highlights a common challenge in conservation biology: the gap between scientific research and its use in management decisions.

"There was a need for historical information on oyster body size to be integrated with existing monitoring data, and we provided that," Dietl said. "Without it, there simply wasn't enough information for size—a key indicator of oyster condition—to be included in the FLDEP's trend analyses."

Closer to home, in the Long Island Sound, Dietl is leading an ongoing New York Sea Grant-funded project examining how marine life has responded to decades of efforts to reduce nitrogen pollution in the Sound. Excess nitrogen has long fueled summertime "dead zones" with low oxygen levels, harming bottom-dwelling organisms and degrading habitat conditions. Although water quality improved after major nitrogen reductions were implemented in the early 2000s, little long-term biological monitoring was conducted to determine whether marine life actually responded to those improvements.

To address that gap, Dietl, Cornell Ph.D. student Matthew Pruden, and John Handley from the University of Rochester are analyzing dead mollusk shells collected from seafloor sediments across the Sound. Much like the oyster-shell work in Florida, these shell accumulations preserve an ecological "memory" of past environmental conditions, allowing environmental managers to compare modern habitat conditions with those that existed before restoration efforts began.

Results to date show signs of ecological recovery in parts of eastern Long Island Sound, where low-oxygen events have declined, while some western areas closer to New York City show little improvement despite cleaner water, likely because polluted sediments continue to affect bottom habitats. The project demonstrates how preserved shell records can provide a cost-effective way to evaluate long-term restoration outcomes when historical monitoring data are limited or unavailable.

Dietl added that the Florida oyster and Long Island Sound examples illustrate how he, and other researchers are trying to bridge the gap between research and implementation by tailoring research to the needs of environmental managers.

Dietl's conservation paleobiology program extends beyond research to include public outreach. His HOBS Project is featured in a Museum of the Earth exhibit.

The exhibit, developed with Jaleigh Goben, a Ph.D. student in Dietl's lab, and others, shows visitors how paleontological methods inform oyster restoration. Parallel stories are also told: pollen records revealing pre-settlement fire regimes in the western U.S., ancient bird bones predicting extinction risk on Pacific islands, and Adirondack lake sediments reclassifying yellow perch as native rather than invasive.

"This experience led me to pursue a Ph.D. combining conservation paleobiology and science communication, which has since evolved into an interest in the power of conservation storytelling to spark conservation action," Goben said.

These examples, drawn from Dietl's broader program at PRI, make abstract science tangible for Ithaca visitors and underscore local relevance. New York's own lakes and forests benefit from the same toolkit.

Dietl is also passionate about training the next generation of conservation paleobiologists. He has mentored students at Cornell while helping shape broader conversations about how students should be trained. Working with Tricia Kelley, from the University of North Carolina Wilmington, Dietl helped establish the Pathways Working Group, which focuses on identifying the skills needed for careers in conservation paleobiology.

The effort goes beyond traditional scientific training to include skills such as knowledge pluralism—the ability to bring together scientific, local, and other forms of knowledge to improve conservation decisions.

"The hope is for conservation paleobiology to become part of the standard conservation toolkit," Dietl said. "That will happen as more students bring these approaches into conservation careers and demonstrate their value in practice."

His work has earned fellowships from Yale's Gaylord Donnelley Environmental Program and Cornell's Atkinson Center for Sustainability. Through PRI's collections Dietl ensures that Ithaca's scientific resources serve both researchers and the public.

As climate change accelerates and habitat loss and biodiversity decline, conservation paleobiology offers hope grounded in evidence. Dietl's research proves that the past is not just a prologue, it is a practical guide. By listening to the stories preserved in shells and sediments, scientists like him help us restore what we have damaged and protect what remains.

For readers in Ithaca and beyond, his work at PRI reminds us that groundbreaking innovation can happen right here in our backyard, with implications that ripple across the planet. The dead, it turns out, have a lot to teach the living—if we are willing to listen.

One of Greg Dietl's collections. (Photo: Mark Syvertson)