California's graduate students in environmental sciences lag behind in technology, computation

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Rebecca Hernandez is a former a junior specialist at UC Riverside. Credit: R. Hernandez.

Researchers at the University of California, Riverside have conducted a study showing that many skills and practices that could help scientists make use of technological and computational opportunities are only marginally being taught in California's formal graduate programs in the environmental sciences.

The researchers found, too, that graduate students in the state were, in general, not engaged in data management practices. Of the students

surveyed who had already completed their [graduate degree](), only 29.3 percent had made their research data products available online. Further, one-third of the surveyed students whose research was in progress were unfamiliar with creating metadata for their data sets.

"These findings raised a red flag for us," said Rebecca R. Hernandez, the lead author of the [study published]() in the December 2012 issue of [BioScience](). "We conducted the study because we were concerned that early career and aspiring scientists were not being trained with the skills and tools they will need to handle large, complex data sets that have become 'normal' in scientific labs and institutions across the globe."

Hernandez explained that the findings suggest that scientists are not being trained as well as they could be in keeping up with the pace of technology and computation.

"At a time when jobs have become internationally competitive, scientists also need employable skills," she said. "Knowing basic programming or how to infer meaningful and accurate information from large data sets could be the difference between unemployment and a job offer. Moreover, data sets are useful beyond their initial application making them a valuable and powerful commodity. If graduate students are not trained in data archival methods, they may be less likely to archive data sets in future research endeavors, resulting in a huge loss of knowledge and opportunity to the [academic community]()."

Nearly 500 scientists participated in the UC Riverside study. Hernandez and colleagues conducted an online survey in June-August 2011 and solicited responses from master's and doctoral students in academic departments related to environmental or ecological sciences from 27 California universities, including 4 private schools, 9 public universities in the UC system, and 14 public universities in the California State University system.

The researchers focused on environmental sciences because the field includes biologists, plant scientists, geneticists, ecologists, modelers, oceanographers, earth system scientists, evolutionists, foresters, geographers, energy scientists, and others.

"To administrators and educators, our study suggests several areas that may enrich the education of environmental scientists, including coursework in the computer and information sciences; proficiency in programming, computation, and the analysis of large and complex data-sets; skills in the application of advanced technologies to the scientific method; interdisciplinary collaborations; and the understanding and practice of proper data management," Hernandez said.

The research team is hopeful that the study will embolden scientists at all career stages to be more proactive in getting the skills they need to solve environmental problems and imparting these skills to the next generation.

"We also hope more scientists learn about proper data management and commit to archiving their data online for everyone to freely use and re-use," Hernandez said.

The study was conducted while Hernandez was a junior specialist working for Michael F. Allen, the director of UCR's Center for Conservation Biology and the principal investigator of the research project. Currently, Hernandez is a Ph.D. student at Stanford University where she is examining processes that elucidate the functioning of the Earth system and cover a broad range of topics from global environmental change to renewable energy systems.

"I am supporting my analyses with advanced technologies, field methods, and computational programming," she said. "And yes, I plan to archive all my research data sets in online repositories!"