INVERNESS RESEARCH

FINDINGS FROM AN INDEPENDENT EVALUATION OF THE AMNH'S ONLINE SEMINARS ON SCIENCE COURSE

# ECOLOGY: ECOSYSTEM DYNAMICS AND CONSERVATION

Inverness Research initially studied the AMNH Seminars on Science (SoS) program for eight years, from its inception in 1998 to 2006. Since then Inverness has continued to evaluate newly developed courses. In 2019, Inverness Research evaluated the AMNH's newest online course, *Ecology: Ecosystem Dynamics and Conservation*. Below we present teacher survey ratings for *Ecology*, along with profiles of two teachers who took the course and used what they learned to enhance their teaching of Biology.

## I. SELECTED SURVEY RATINGS FOR *ECOLOGY*

Course takers report on our follow-up survey that ***Ecology*** has benefited them personally and professionally, and that their students also profit. We present below a small sample of our findings based on the responses of 38 learners from 11 states who completed our follow-up survey about the quality and value of the course. A majority of survey takers (79%) are K-12 teachers, but preservice teachers, informal science educators, and college instructors have also provided feedback about how the course has benefited them personally and as educators. Over one quarter of the survey takers (29%) took the course in part because of prior positive experience with AMNH's SoS courses, and over one third (39%) were attracted to the course because it was taught by AMNH scientists.

**What do teachers gain for their own learning from *Ecology*?** [1]

- *"additional background knowledge of science" (89%)*
- *"a rekindling of my passion for science and the work of scientists" (79%)*
- *"a bank of resources for my own learning" (76%)*
- *"a deeper insight into the work of scientists" (74%)*
- *"motivation to continue learning about the course topics on my own" (68%)*

**How do teachers apply the course directly to their classrooms?** [2]

- *"I used what I learned to create a unit for my students" (83%)*
- *"I made some course resources available to my students" (60%)*

[1] Unless noted otherwise, percentages represent teachers who marked 4 or 5 on a 5-point scale where 1 = Not at all, 3 = Somewhat, and 5 = A very great deal.

[2] For questions regarding student impacts, percentages represent teachers who checked "yes."

- *"I used the lesson plan I developed as my final project" (57%)*

**How does the course help strengthen teaching?**

- *"It provided me with hands-on, inquiry learning experiences that can serve as a good model for the kind of work I can have students do" (86%)*
- *"It introduced me to new kinds of materials and media such as simulations and websites that I can use in science" (81%)*
- *"It enhanced my ability to teach the science textbook/kit series/curriculum that my school has adopted for my grade and subject area" (69%)*
- *"I am better able to assist students in meeting our state or district standards" (64%)*
- *"It made me feel more confident teaching science" (64%)*
- *"It helped me to learn a new content area that I may teach in the future" (60%)*

**How do teachers say that this course helps their students?**

- *"Students better connect science in school with the real world" (70%)*
- *"The work of scientists is more real and understandable to students" (70%)*
- *"Students' understanding of the nature of scientific inquiry has increased" (58%)*
- *"Students are more curious about the course topic(s)" (52%)*
- *"Students' access to and knowledge of the latest research on the course topics has increased" (45%)*

**How does the course compare with other professional learning opportunities?**

- *"The course was more valuable than other professional development available to me locally" (86%)*
- *"The course is more valuable than other science-related online courses I have taken" (78%)*

**Do teachers recommend the course?** [3]

- *"I have recommended the course to colleagues" (54%)*
- *"I have shared the materials and resources with colleagues" (43%)*

[3] Percentages represent teachers who checked "yes."

## II. PROFILES OF TWO TEACHERS' USE OF *ECOLOGY* IN THEIR CLASSROOMS

We interviewed two high school teachers to learn about how they had applied what they learned from Ecology in their teaching. In schools 2,500 miles apart, both teachers drew from the Ecology course to engage their students in real data from Gorongosa National Park in Southeast Africa. Their students not only learned about relationships among animals and their environment, but also learned 21st century data analysis, graphing, and modeling skills.

In both classrooms, students were so motivated by what their teachers shared with them from the SoS course that they sought out ways they could participate in conservation work.

*The students really enjoyed seeing real images from somewhere they have never experienced. A few of them found other citizen science websites, as well. One student came the next day and said, 'I found one about penguins, and I sat up all night and counted penguins.' They felt like they were contributing to a project. It was really fun for them to visually see, hey, this is the place and these are the animals, and we are helping the scientists there keep track of them and try to help preserve their habitat. – Teacher account*

PROFILE 1

### EMILY, A BIOLOGY TEACHER IN TUCSON, ARIZONA

Emily B has a Masters in Plant Science and Education and has been teaching for seven years. She teaches at Walden Grove High School outside Tucson, AZ. Emily teaches entry level honors and AP Biology to 10-12th graders. Even though her school is in a rural area surrounded by orchards, she describes it as a suburban, middle class school because it is newer and draws from the local subdivisions. Walden Grove has approximately 1150 students, with 40% qualifying for free and reduced lunch. The student body is 45% Hispanic, 53% white, with the remainder comprising other minorities. Walden Grove's graduation rate is 92-97%. Emily says this is achieved through a significant investment in parent involvement and tutoring. The school is ranked as an A+ school in Arizona—and Emily adds that their dance team, PAC, performed on America's Got Talent!

**Affordable, accessible and well-organized**

Emily has completed two AMNH SOS courses as part of her Masters in Education—Evolution and Ecology: Ecosystems Dynamics and Conservation. She chose the Ecology course because it is one of the first topics she teaches in the school year. She also wanted her students to have a chance to learn about other ecosystems because the Tucson ecosystem is not represented on standardized tests.

Emily appreciated that the course was affordable, accessible and well organized.

> *It had clearly been run multiple times, which is good, and everything that I needed or [had] questions about was on the website. It was clear, it was well laid out. It was very accessible. Most of the readings were online. They had articles written by the people who had designed the course, and those were good.*

**Experienced educators and researchers teaching together**

Emily felt that there was a good amount of content available each week, but it was still doable. Though she took the course while she was working full time, she was able to get all of her assignments done on time. She appreciated that the course is taught by teaching experts as well as researchers.

> *They [teachers and researchers] did a really great job of participating in discussions and so that was really fun. If you had a question they could probably answer it and if they couldn't they are like hang on, let me ask a colleague and I will get back to you.*

**Engaging activities that translate easily to the classroom**

Emily was able to use the majority of the resources from the course in her classroom. She and her teaching partner have been modifying their curriculum to emphasize a student-directed approach. They also prioritize opportunities for team-work, communication, critical thinking and meaning making with models. The materials from the Ecology course go hand and hand with these goals and are engaging for students.

> *I was able to translate [the resources] into different activities whether they were readings or online activities or in-class activities. The vast majority of them we actually completed in class during the course of the school year.*

**AMNH course final project—a unit for the classroom**

The final project for the AMNH Ecology course is the design of a two-week unit. Emily was able to use the unit she designed in her next round of Ecology classes. Her unit starts with a look at animal behavior and trophic levels[4] and then has students explore the relationship of animals to their environment. As part of this exploration, Emily had the students use one of the key resources from the AMNH course—a Howard Hughes Medical Institute (HHMI) activity called Building Biological Pyramids. In this activity, students access the wild webcam website for Gorongosa National Park in Mozambique. The site has photo-sorting tools—by shape, coloration, etc. These tools help the students learn how to identify various animals in the photo data that is stored on the site.

> *Students get on the website and they start practice-identifying all of these animals. There are things that they have seen in the Lion King, and so they are like, 'this is great, I remember the impala in Lion King,' and they are right here on this picture. After awhile, the kids were consistently good at identifying the different animals. That they loved. They thought that was a blast. They wanted to sit and click on pictures all week.*

**Authentic opportunities for students to generate and analyze data**

Once the students are good at identifying animals, they go through batches of photos and identify animals to create data that is added to the database. Next the students identify different parameters from the photos to generate additional data. For example, they count how many different species they have identified, whether the individual animals are younger or older and their size. They also identify the habitat the animal is in: Is it grasslands or woodlands? What

[4] The trophic level of an organism is the position it occupies in a food chain.

kinds of plants are there? Is there water? They also identify producers and consumers.

At the end of this process, the students end up with a data table that includes all of the data they have generated. They then use this data to make an ecological pyramid that shows energy flow, relationships, and biomass. Because Emily's students are 10th graders, she simplifies this process:

> *We do analyze the students' data and just look at what is the most prevalent biomass. Is it the water ox, is it the grass, is it elephants, etc., and then, where is their energy coming from? Then what other things and resources did they see in those environments that were helping or not sustaining the environment? [For example,]how much water were they seeing? Was it cloudy or was it sunny? How was light entering?*

She then has the students make a resource web—another activity from the AMNH Ecology course—to show what is going into the environment and the impact. The students displayed their webs on large posters. Emily had them include five different animals, three different plant species, and the different ecological or natural resources present in the photos, e.g., water or light availability. Students also included the impact of humans on the ecosystem.

**Engaging students, contributing to on-going research**

The high-level purpose of Emily's unit is to have students collect data and build a model to represent the relationship between animals and their environment. Emily said the students loved seeing animals in their natural habitat, learning about Gorongosa National Park, and contributing to a research database. They also valued learning about how humans are impacting the environment.

> *I would say that the activities that I gained from [the course] were definitely engaging. The students got to see and learn more about ecosystems that they knew little about. They really enjoyed getting to engage with live data, as well as learning about the history of Gorongosa and the ways that humans are impacting that ecosystem… That is something that this generation has particularly bought into—what is going on with the earth? So in terms of engagement, that was huge.*

PROFILE 2

## DAN, A SCIENCE TEACHER IN HANOVER, NEW HAMPSHIRE

Dan F. teaches at Hanover High School, in the town of Hanover, New Hampshire, home of Dartmouth College and the largest hospital in the state. The school is relatively small, with about 160 students per grade, grades 9-12. Hanover High has low economic diversity, but a high cultural diversity because it enrolls the children of the diverse Dartmouth staff.

**Content that engages high-level students**

Dan has been teaching for 23 years, most of it as a high school teacher in Hanover. After working as a research scientist, he decided to become a teacher and received his Masters in Education at Cornell. He currently teaches Biology, Chemistry, and Physical Science. Dan said he has 'lots of high-flyer kids, so they are fun to teach, but also challenging.'

*A lot of them want to go on to things related to biology. They are engaged and concerned about grades. I am trying to use something like AMNH stuff with them, where it is more open-ended rather than getting the right answer, because they can memorize pretty easily, and so we try to go beyond memorization.*

**21st century content and skills**

Dan lives somewhat remotely and has a busy family life with five daughters, so he finds it much easier to do professional development online. He takes an AMNH SoS course every other year, and took four before enrolling in the Ecology course: The Diversity of Fishes, Evolution, Climate Change, and Genetics, Genomics, Genethics. He thought he might already know a lot of what was offered in the Ecology course, but was delighted that the course emphasized the 21st century content and skills his students will need as they enter the workforce.

*I was happily surprised that there was a lot of new simulation activities that were less like, 'hey let's go outside and dig and see what number of arthropods we find in the ground.' [The course] had a lot more data, so that seemed to be more applicable to where kids are going to find themselves now if they are going into biology—or if they are going into anything, there is just a lot more data to look at.*

**Exemplary pedagogy as well as college credit**

Dan particularly enjoyed that the course was 'professional development teaching you in a way you wish education [taught you].' He found it to be much more engaging than a university course where 'they lecture you and you write a paper at the end.' He also appreciated receiving college credit.

**Engaging simulations provide opportunities for authentic learning**

Like Emily, Dan found the Howard Hughes Medical Institute activity, Building Biological Pyramids, to be particularly engaging because it uses webcam data from Gorongosa National Park in Mozambique. He added the activity as a 3-day lesson within his Ecology unit for sophomore Honors Biology students as part of the introduction to the concept of biomes. The activity gave the students a chance to interact with the African Savannah in an engaging manner.

*The website gave them a chance to see real life, not just in a zoo, but here is what those biomes look like and where the animals can be found. I wanted them to get a more true picture about what the Savannah looks like. We are so far removed from that kind of country…I wanted them to engage more with ecology rather than just doing the 'oh, the desert is dry and hot and here is a plant that has adapted and here is an animal that has adapted.'*

The lesson began by having the students learn some introductory information about Gorongosa Park's history and development. The students then learned to identify animals from the different pictures.

*So they learn about the animals—[it's fun] especially if they hadn't seen some of those before. When I looked at it, wow, there are lots of different kinds of antelope types, you have to figure out, does it have stripes, or does it look like this or that? So that allowed*

*us to get a little bit deeper into one of the biomes that they are not familiar with in their lives.*

**Testing hypotheses using real data and cutting edge filtering tools**

Once the students were able to reliably identify the different animals, Dan asked them to generate a hypothesis they could test using the data set. For example, students focused on where animals are in the park, what time of day they come out, or whether they are near water or not. The students then had to search the data sets using an appropriate filter, a skill Dan had first learned in the AMNH course. They then graphed their results.

*They did come up with some good questions. For example, they were looking for babies, baby lions I think, and then they were trying to figure out how many pictures had a baby lion in them and a mother lion in it. So that was interesting…Also, you can see whether something is near water. So they thought elephants would be near water, so they looked for the occurrences of elephants near water and then elephants not near water. And surprisingly, they weren't near water most of the time. They came up with some good ideas. It was only a couple of days, and it was a more engaging way to do population density than go and count dandelions!*

**Inspired students continue exploring in their free time**

Dan's students enjoyed the lesson so much that several of them continued to explore the Gorongosa site in their free time at home.

*They found it engaging. They liked the picture thing and the open-endedness of it, like for some pictures, there isn't a right answer. You can't see what that animal is because it is too dark. And so that real life experience I thought was engaging for them too.*

**New research and tools**

Dan said that as a teacher he doesn't usually have time to learn about new tools and research, and that the AMNH Ecology course gave him the opportunity to do so. Next time he teaches Ecology he'd like use more of the simulations from the course, including one about balancing the needs of the Caribbean fishing industry and populations of endangered species.