Workshop Report: Citizen Science and the Wild
15 June 2017

Compiled by Alison Laurence, Ph.D. Candidate, History, Anthropology and STS, MIT

The interdisciplinary workshop on "Citizen Science and the Wild," which brought together historians of science, anthropologists, museum professionals, and scientists, convened in London at the Natural History Museum on 15 June 2017. It followed on scholarly conversations that began at MIT in June 2016 at "The Call of the Wild" workshop, which considered the cultural valences of "wildness" from the microbial wildlife that populates cheese to the inaccessible wilds of outer space. (Find here the report of that meeting: https://conscicom.org/2016/10/21/call-of-the-wild-mit-2016/) For this second gathering, Sally Shuttleworth, Professor of English Literature at the University of Oxford, Harriet Ritvo, Arthur J. Conner Professor of History at MIT, and Dr. John Tweddle, Head of the Angela Marmont Centre for UK Biodiversity at the Natural History Museum invited a diverse community of scholars and scientists to consider together meanings of the wild and the relationship of these wilds to citizen science. The workshop was funded by the Oxford-based project: "Constructing Scientific Communities: Citizen Science in the 19th and 21st Centuries" with support from the UK Arts and Humanities Research Council.

The workshop was divided into four thematic panels:

- Categorizing, Exhibiting and Conserving
- Collecting Communities
- Taming and Controlling
- Technology and Interpretation

Opening Remarks
Sally Shuttleworth and John Tweddle

John Tweddle welcomed workshop participants to the Natural History Museum, noting that we have convened at a time of change for the museum. The renovations to the museum's main hall are not merely superficial; the introduction of a blue whale skeleton, a massive installation that visitors will see immediately upon entering the museum, reflects a commitment to multiple scientific narratives: origins and evolution (of life on Earth and in the universe); biodiversity; and, sustainable futures. The renovation and the intellectual strands it highlights contribute to the Natural History Museum's goal of challenging people's relationship to the natural world and their responsibility towards it.

Panel 1: Categorizing, Exhibiting and Conserving

Wildish in the City
Harriet Ritvo, Arthur J. Conner Professor of History, MIT

'Beyond Bewilderness': Reclaiming the Truly Wild in the Anthropocene
John Durant, MIT Museum Director and Adjunct Professor in STS, MIT

Pleistocene Spectacle in the City of Angels
Alison Laurence, Ph.D. Candidate, History, Anthropology and STS, MIT

Is Natural History Museum-Led Citizen Science Really Helping to Conserve the Wild?
John Tweddle, Head of the Angela Marmont Centre for UK Biodiversity, Natural History Museum, and Lucy Robinson, Citizen Science Manager, Angela Marmont Centre

Workshop Report: Citizen Science and the Wild
15 June 2017

In a boardroom overlooking Hintze Hall (presently under construction) this panel of museum professionals, historians, and museum-goers offered perspectives on the role of natural history museums at a critical time of environmental change and described historical and contemporary relationships between museums and their publics. Harriet Ritvo reflected on natural history museums' interpretations of wildness as a museum-going citizen (more so than as a scholar), recalling an encounter with an unexpectedly familiar still life at the Royal Ontario Museum in Toronto. Upon entering the hall of taxidermied mammals Ritvo met a diorama of raccoons collaborating to empty a trashcan. This tableau would be entirely familiar to urban-dwellers, but it was unusual in a museum—unusual and perhaps undesired, both by museum personnel and museum visitors. The museum never produced any postcards of this particular diorama and within a few years the diorama itself (the work of a rogue curator) was removed, replaced by a larger and more exotic mammal. And yet, aren't raccoons (and their urban lifestyles) worthy of representation? The modern art world responds in the affirmative, with a recent example including Mark Dion's mixed-media "Concrete Jungle" installations uniting urban-dwelling animals and human refuse. In contrast, natural history museums tend to avoid displays that bring humans and animals together, upholding a particular vision of wildness (or, as the OED defines it, "living in a state of nature") that maintains literal distance from (certain) humans and obviously built environments. Perhaps this is why the Natural History Museum's uncomfortably familiar dog specimens have been "exiled" to the satellite location in Tring. If museums do feature local creatures, they are typically identified as such and segregated—for example, the display on fossil animals from Britain at the NHM, or the room dedicated to New England habitats at Harvard's Museum of Comparative Zoology. European and North American zoos, too, tend to abide by this preference for exotic animals and the segregation of local or domesticated ones. This distinction has serious consequences for liminal animals, i.e. those that are neither wildlife nor pets. They are not protected by regulations designed to maintain populations of "wild" animals and are often vilified by legislation enacted in the interest of infrastructure and human property. Thus, Massachusetts law requires that licensed contractors who catch raccoons must kill them rather than release them in a less human-populated locale. Such differential protections (and punishments) recall the early days of conservation before the perspective of ecology informed the movement. A more holistic understanding of the web of life that surrounds the built environment would improve people's estimation of creatures like raccoons—and perhaps would make an animal presently defined by many communities as pest more welcome in the museum.

John Durant revisited the concept of 'bewilderness,' a neologism coined by comedian and naturalist Bill Bailey that identifies "…a state of persistent and anxious perplexity about all things wild." At last year's Call of the Wild workshop, Durant made the case for our current state of 'bewilderness' by contrasting the relatively unremarkable shooting of orangutans by Alfred Russell Wallace in the 19th century with the 2016 shooting of Cincinnati Zoo gorilla Harambe, which ignited sustained public outrage. The 'memeification' of the latter has further confirmed Durant's assessment that 'bewilderness' is a predominating characteristic of living in the Anthropocene. As the relationship between humans and the wild becomes ever less clear and the planet itself is ever more imperiled, how do we respond? How should we respond? Lately 'we' have begun searching for a more traditional and comfortably removed version of the wild elsewhere. Dystopic science fiction adventures like *Interstellar* (2014) are rooted in the ecological assumption that, in the not-too-distant future, humans will have exhausted nature and must move beyond Earth. Cosmologists including Stephen Hawking have legitimized this assumption, predicting that humans will have to find another planet in the next hundred years, and technologists like Elon Musk have begun promoting travel to and cultivation of Mars as a romantically-tinged response. Durant called for alternatives to fatalistic abandonment when confronting the Anthropocene and its nature-culture entanglements, taking as a mantra Richard

Branson's statement, "There is no planet b." Natural history museums, sometimes at risk of promoting fixed and formulaic distinctions between nature and culture (or wild and domestic, etc.), have a role to play here. A few museums and artists have already begun to destabilize these dangerous binaries admirably. The Center for PostNatural History in Pittsburgh, Pennsylvania is dedicated to the advancement of knowledge related to the entanglements of culture, nature, and biotechnology. Lately it partnered with the Wellcome Collection in London to stage a compelling exhibit called "Making Nature: How We See Animals." Domesticated budgerigars (common parakeets) are displayed in the style of a natural history museum's research collections (bound and labeled) and a taxidermy fox, perhaps only sleeping, is not segregated by a diorama but shares the floor with visitors. Most arresting was "The Great Silence," an art installation created by Allora and Calzadilla with Ted Chiang, which gives voice to the non-human. It tells the story of Puerto Rico's Arecibo Observatory, which collects data for SETI and searches (vainly as of yet) for signs of alien life in the universe. But what of the life here on Earth? In the forests around Arecibo lives a critically endangered species of parrot famous for its ability to speak. It is this parrot that addresses viewers, asking, "Why aren't they interested in listening to our voices?" These exhibits provoke unease in visitors, as they should, Durant argues. And more such work that highlights the inextricable dependence of nature and culture is critical.

Citizen science initiatives at the La Brea Tar Pits began in 1969, according to Alison Laurence, when the Natural History Museum of Los Angeles County reopened pit excavation for the first time in over 50 years and deployed volunteers to excavate, clean, and process on site the microfossils that would allow museum scientists to reconstruct an ecological timeline of the Los Angeles Basin from the late Pleistocene to the present. Dig supervisor George Miller enrolled thousands of locals, and some vacationers too, including housewives, high school students, actors, retirees, and more. These volunteers became part of the tar pits exhibit in Hancock Park, a public green space in a bustling commercial and residential district of Los Angeles. People came to watch them work and when progress of the dig took the volunteers underground and away from view of the public, a closed-circuit television on loan from a local businessman allowed exhibition of the excavation to continue. Visitors to the park could also view life-size fiberglass statues of the sorts of creatures preserved in the pits. The sensational mammoth group (which featured a mother mammoth sinking in the lake pit while her helpless mate and offspring looked on) was widely publicized even before its installation. The male's journey to the park on a flatbed towed by its sculptor's Volkswagen Beetle and the female's journey into the lake via helicopter were reported well beyond the Los Angeles area. The spectacle of the tar pits, which combined indices of a pre-human past with icons of modernity and sometimes modern humans themselves, differed significantly from the earlier 20th century visions for Hancock Park. Beginning in the 1920s, museum officials envisioned reconstructing a Pleistocene wilderness—although what that wild looked like and which plants and animals could reside there was contested—which would offer an escape from the ever expanding metropolis. Over the decades plans evolved and by 1969 the museum had abandoned exclusionary approximations of wilderness for an inclusionary spectacle. When the museum halted the dig in 1972, citing financial straits, an army of volunteers protested by writing in to newspapers and contacting local politicians. The museum yielded to public pressure and agreed to keep the dig open. The excavation of the tar pits thus serves as both an example and warning to future citizen science projects. Digital volunteerism seems the dominant model of citizen science at present but for those museums looking to engage local populations in the tedious and messy labor of field science, the Pit 91 excavation remains an excellent model. But it is also a reminder that once a museum engages the public, these volunteers have a stake and may feel they ought to have a say in the museum's future projects.

Workshop Report: Citizen Science and the Wild
15 June 2017

Natural history museums have long involved the public in nature-based research and data collection projects. Theoretically, these programs should contribute to the museums' institutional missions, specifically environmental conservation. John Tweddle and Lucy Robinson sought to answer two questions embedded in this principle. Do contemporary citizen science projects led by natural history museum have outcomes that benefit conservation efforts? If so, in what ways do they impact conservation? Tweddle revealed that such projects are indeed having an impact. In an evaluation of recent projects there was clear evidence that a majority of projects (26 of 44) had direct or indirect outcomes relating to conservation. Most of these impacts have been indirect, generating published research that informs conservation efforts, raising awareness of environmental issues, educating a public that may adopt more eco-friendly habits, and contributing to policy-making. Tweddle contrasted ongoing species monitoring projects with BioBlitz events to demonstrate that the duration of a citizen science project relates to its outcomes. The longer term monitoring, by nature of its duration, results in longer-term public engagement and produces useful datasets. The blitz events (which in turn rely on an ongoing engagement with land owners and managers) can have more direct and more immediate impacts on site and species conservation efforts. In general, though, citizen science outcomes are difficult to track and frustrating to the citizen scientist constituency that participates in these projects out of a desire to "help nature." In order to keep this public engaged, museums may need to make such indirect impacts more visible. Tweddle used the "Orchid Observers" project to highlight both the potential and the challenges of citizen science as it relates to museum conservation efforts. The project has worked with the amateur naturalist community, and has combined field study and online participation to create a 200-year record of flowering times to understand how climate change is impacting the UK's orchids. "Studied to death" in the UK, scientists assumed that they understood the distribution of orchids well. But "Orchid Observers" confirmed that the more you look, the more you'll find. Citizen scientists all together identified 200 new populations of UK orchids, including a new range of the extremely rare-to-England Lady Orchid. The project uncovered data that its designers had not even hoped to find. But how can administrators be sure that this information (open access by principle) will be used to support conservation? Ultimately, they can't. But they can continue to search for more effective ways to measure impact and communicate that impact to their citizen scientists. Tweddle concluded with provocative questions (that the following day's conference on "Connecting with the Crowd" promised to take up): Does the citizen science matter if museums can't track conservation outcomes? Should museums change the way they administer programs and design projects in order to facilitate tracking?

Discussion Highlights:

- John Durant highlighted how animals that encroach on human infrastructure shape not only human-animal relationships but interactions among humans. If one's house comes under siege by raccoons, neighbors may worry that the animals will soon target their home. In Massachusetts, private individuals are not beholden to the legislation that requires these animals to be eradicated but anxiety may encourage them to pursue such measures independently. When animals go where they are not expected or wanted, humans must negotiate how to respond.
- Jamie Lorimer noted that a state of "bewilderness" resonates with post-truth culture and climate change denial, though that was not embedded in Bailey's original definition.
- Sally Shuttleworth suggested the popular trope of 19th century children's literature—talking animals—as a historical antecedent to the talking parrot in "The Great Silence." While the characters of *Black Beauty*, for instance, were given voice to speak out against animal cruelty and teach children care for all creatures, Ted Chiang's script forces audience (presumably adults) to consider more complex moral questions.

- Can theft and vandalism of museum objects be viewed as a form of citizen engagement? Gowan Dawson suggested that the tagging of the tar pits' male Imperial mammoth with a peace sign and other symbols of the Age of Aquarius (like the "souvenirs" that visitors broke off of the dinosaurs at the Crystal Palace park in the Victorian Era) shows that the public is responding powerfully, if not appropriately, to the exhibited objects and wants to engage more materially with them.
- The potential to alienate citizen scientists is a concern for museum practitioners. For example, when the good work of volunteers results in funding awards for future seasons, but the citizen scientists are no longer needed—for this particular project, at least. One way to maintain relationships with and leverage an enthusiastic volunteer community is to put them in touch with smaller, less well funded research and conservation groups like local trusts, and to create a network of volunteering opportunities.

Panel 2: Collecting Communities

Sedentary Naturalists and Collectors in the Wild: Hierarchies and Mutual Benefits
Gowan Dawson, Professor of Victorian Literature and Culture, University of Leicester

'Mere Collectors': Community and Identity in Nineteenth-Century Entomology Periodicals
Matthew Wale, Ph.D. Candidate, University of Leicester

Citizens of the Wild: Human Subjects of Studies in the Antarctic
Vanessa Heggie, University Research Fellow, University of Birmingham

Naïve Observers: Amateur Truffling in Late Twentieth Century Oregon
Peter Oviatt, Ph.D. Candidate, History, Anthropology, and STS, MIT

Gowan Dawson reached back into the 19th century when the dominant model of natural history was predicated on staying as far away from the wild as possible. The most prominent of these sedentary naturalists was Georges Cuvier, who boasted that he was able to survey the entire natural world from his study while those in the field could only see what was in front of them. In the British context, Richard Owen's practice closely resembled Cuvier's. These sedentary naturalists relied on collectors (often provincial figures and sometimes female) to gather and send back materials to the metropolis for study and to create the collections that would become the natural history museums in Paris and London. Dawson acknowledged the historical significance of these hierarchical relationships but argued that such hierarchies were not absolute. A survey of geology journals published in the latter half of the 19th century reveals how scientific periodicals reshaped relationships among professional naturalists and their amateur collaborators. When S. J. Mackie launched *The Geologist* in 1858, popularizing geology (and the theory of catastrophism while rejecting Darwinian evolution), eminent naturalists initially avoided its pages. Mackie's monthly periodical introduced an innovative feature akin to citizen science called "Notes and Queries" through which ordinary people could actively contribute to the construction of scientific knowledge. It was the promise of this reciprocal correspondence network (a concept developed by Matthew Wale) that persuaded eminent naturalists like Hugh Falconer to participate in a community of which they were initially skeptical. Falconer, for example, though once a collector himself, had become a sedentary naturalist. For him even Essex now was wild. *The Geologist* allowed him to gather data on the Essex wilderness from his comfortable study. Mackie went bankrupt and his publication folded in 1864. When Henry Woodward began publishing *The Geological Magazine* that same year, he maintained Mackie's "Notes and Queries" section, preserving in print the complicated social relationships through which scientific knowledge is constructed.

Matthew Wale set the stage for the growth of a fractured sort of citizen science within 19th century entomology by attending to the social tensions that characterized the field. Amateurs who participated in this arm of natural history were often disparaged as mere stamp collectors and the scientific worth of their efforts was questioned. *The Entomologist's Weekly Intelligencer*, begun in 1856 and aimed at a heterogenous community of individuals with an interest in insects, was the first weekly dedicated to entomology. It allowed for rapid communication among field observers—a frequency that (nearly) complimented the temporality of the objects of study—and yet there was skepticism as to the quality of the information being disseminated. How to separate the scientific chaff from the wheat? The use of taxonomy was what divided the (non-professional) 'entomologists' from those who merely collected insects. Two periodicals begun in 1864 to fill the void of the defunct *Intelligencer* demonstrate the social stratification of 19th century entomology communities. Edward Newman, who proudly proclaimed himself a "mere collector," offered *The Entomologist* to others like himself who understood the value of building a material archive. In contrast, *The Entomologist's Monthly Magazine* was geared toward a more scientifically-literate audience of elite amateurs. Both periodicals might be considered the mechanisms for an early form of citizen science, but what citizens did they attract and actively court? In particular, *The Entomologist's Monthly Magazine* is an early example of amateurization, a strategic fashioning of a scientific identity as a sort of professional amateur in order to distance community members from other types of amateurs. Societies too engaged in similar stratification. Professional naturalists praised the groups that avoided "mere collecting" and the commercial aspects of insect trade, while for others the sale of collections would have been necessary to finance a hobby. Thus, Wale in concert with Dawson asserted that periodicals facilitated the transfer of knowledge. However, he added, they simultaneously allowed for the construction of scientific identities and the splintering of amateur communities.

Through a survey of biomedical research programs in Antarctica from the early 1900s through the 1970s, Vanessa Heggie considered how scientific research intersects with categories of the wild and citizenship. Antarctica is a potent place in which to consider such intersections, as it is the only continent without an indigenous population and for legal reasons it has no citizens. The natural history research done there is perhaps best known (as that is what was typically publicized), but the self-tracking programs that asked human visitors to monitor their bodies in order to understand how humans might tolerate and acclimate to these sorts of environments were critical to supporting human presence in extreme climates. From the early 20th century there was an interest in the continent's bacterial environment. Of the small sample size available, fewer than expected suffered from respiratory ailments while there was an unexpected increase in dental problems, a phenomenon that ultimately was linked to the seasons. During the summer visitors could spend time outdoors while during the winter they were forced to shelter inside their base. In the 1950s, a physiology study interested in the impact of stressful environments on humans brought together an international research team. Participants tracked their lives on the continent, recording their physical and psychological states. Ultimately the team concluded that humans don't acclimatize to the Antarctic's type of cold, though this result was undermined by pushback against the duration and scale of the study. In the 1970s, research interests shifted from understanding the native environment toward using that environment as a laboratory to answer other questions, like the effect of sucrose compared to artificial sweetener on tooth decay. Taken together these research programs do not abide by a contemporary definition of citizen science, as the participants were not locals and were typically on the continent in their capacity as military personnel, scientists, or seafarers. (The type of "citizen" that could be recruited for this research was extremely limited by the location of the project.) And yet, despite the exclusivity of participation and the

remoteness of the experiments, biomedical research in the Antarctic was universalized. Funding for extreme climate expeditions in fact depended on the claim that the research conducted on these dangerous, expensive missions was relevant to everyday life.

Peter Oviatt introduced the social and scientific dynamics of the North American Truffle Society, established as a community for amateur truffle hunters in the late 1970s. Members of this extant community most often are middle-aged to retirees who worked in fields that did not use a scientific methodology. But these amateurs do collaborate with a small group of affiliated scientists. The amateur members of NATS hunted "the fungal unknown" in forests and city parks alike. Jim, the group's scientific consultant, trained members how to collect truffles without damaging the specimens (as these were for study not sustenance) and designed a data card for members to fill out that would capture key climatological and geographical details including: soil type, moisture availability, exposure type, exposure direction, and microhabitats. A key helped guide the amateurs' assessment of their finds. NATS members were thrilled to see their collecting work result in scientific papers and field guides and to have their family names preserved in the binomial classification of a new species they had discovered. The group was not scientifically 'productive' for long, as scientists could not keep up with the material sent their way and the group's interests shifted to edible species. Frank, a founding member of NATS who was scientifically trained (and might be considered 'amateurized' alongside Matthew Wale's elite entomologists), reflected on the contributions of the non-scientific amateurs, who often found things that seasoned trufflers might miss. Jim labeled the amateur gaze "naïve" to describe the potential of non-professionals to contribute to a scientific community. (Oviatt preferred the terms "leisurely" or "optimistic" to escape the pejorative connotations of naivety but honored his interlocutor's formulation here.) Like the 19th century communities of naturalists, a hierarchy (albeit one that is more nuanced) persists in NATS.

Discussion Highlights:

- Modern citizen science projects that rely on volunteers to analyze photographs or other digitized data have reversed the 19th century roles of the professionals and amateurs. Now the professionals are out in the field while the amateurs are sedentary participants. But the authority of scientists is (despite rising anti-expertise rhetoric) still preferential and thus the historical hierarchy is preserved. Observing this, Vanessa Heggie emphasized the importance of attending to class, race, and gender in histories of science.
- These papers presented a spectrum of individuals involved in citizen science projects or relevant antecedents, from working class Londoners who collected insects to "the same ten guys" who were participated in a range of Antarctic experiments. It is important to pay attention to constituencies and hierarchies in contemporary communities of citizen scientists as well as historical communities of collectors and others involved in the construction of scientific knowledge.

Panel 3: Taming and Controlling

The Social and Scientific Benefits of Local Community Monitoring and Eradication of Invasive Species
Eleanor Bors, Knauss Fellow, National Oceanic and Atmospheric Association and Woods Hole Oceanographic Institution

Does Citizen Science 'Tame' the Field?: A Risk-Based Analysis
Noelle Held, Ph.D. Candidate, MIT-WHOI Joint Program in Oceanography, and Emily Zakem,

Workshop Report: Citizen Science and the Wild
15 June 2017

Postdoctoral Researcher, Department of Earth, Atmospheric, and Planetary Sciences, MIT

Participatory Experiments in Mapping the Domestic Microbial Wild
Jamie Lorimer, Associate Professor in Human Geography, University of Oxford

Shark Seasons
Michaela Thompson, Giorgio-Ruffolo Postdoctoral Research Fellow, Harvard Kennedy School

How do humans interact with invasive species? What are the implications of these interactions for science? Eleanor Bors answered these questions using case studies of two invasive marine species: lionfish in the Caribbean, Gulf of Mexico, and beyond, and a shrimp invasive to the northeast coast of the United States. Bors explained that she tells stories about marine populations through genetics but she also consults the anecdotal and local observations of non-scientists. Beginning in the 1980s, lionfish invaded the Western Atlantic and quickly spread throughout the region. By the 2000s, they had spread up the U.S. Atlantic coast. This timeline and trajectory was based on public reports of lionfish sightings, which people reported to an online database. Because the lionfish degraded the existing ecosystem there was an urgency to the tracking. Eradication is likely impossible, but the population can be managed by consumption (see *Lionfish Cookbook: The Caribbean's New Delicacy*) and recreational hunting, including events like sanctioned spearing derbies. Those involved in the derbies in particular have contributed to the work of genetic scientists like Bors, though they might not know it, as the fish they have collected are frozen and sent to laboratories for study. Analysis of the genetic material from these specimens and complementary oceanographic studies align with the public's observational data. However, the scientific and observational narratives do not always align. The observational data of the invasive shrimp tells a story of shrimp invasion from New York up to New Hampshire. Genetic analysis of the shrimp suggests that there was likely a second introduction in New York. Does the fact that the volunteers' data is misleading undermine their contributions? In fact, Bors concluded, it does not. It was a rapid volunteer survey that determined the shrimp to be invasive to begin with that prompted her to study the species. Her genetic research simply provided more nuance. Reflecting on these cases and on her current position as a policy fellow for the U.S. federal government's National Oceanic and Atmospheric Association, Bors emphasized the significance of locals' observational data. Programs like the Arctic Invasive and Alien Species Strategy and Action Plan value Traditional and Local Knowledge (TLK) and mobilize local, indigenous communities to monitor invasive species. On the ground allies are essential at a time of environmental change.

Citizen science has a mediating role to play in the present alarmist, anti-science political climate. Noelle Held and Emily Zakem identified contemporary instances of public alarm that betray a simultaneous a fear of the wild (i.e. the unknown) and a lack of scientific literacy that could make those unknowns known. The mascot of this double fear might be "Purell parents," who slather the antibacterial gel on everything their children encounter and display anxiety toward the microbial wild. Paul Slovic's formulation of risk perception—contrasting an activity like riding a bicycle, which has a known risk and minor impacts, with the unknown impact and large scale of radioactive waste—serves as reference for this assessment. For years following the Fukushima meltdown in March 2011, people have refused to swim or eat fish caught on the West Coast of the United States for fear of being exposed to radiation. This trepidation prompted a researcher at Woods Hole Oceanographic Institution to design a citizen science project that asked "How Radioactive Is Our Ocean?" The public sent in water samples and the researcher measured the levels of cesium, a tracer of the Fukushima disaster. This project demonstrated the relative "undanger" of the meltdown's distributed radiation. Swimming in Pacific waters exposed the public to far less radiation than they would encounter by eating

everyday foods. Citizen science can reduce the public's unknown risk by offering data and reduce dread risk by contextualizing situations. Moreover, citizen science teaches (or tames) the scientists to tune their work and communication styles (sometimes in the most minor of fashions) to suit popular preferences, like eliminating the warmest and most alarming colors from graphs that will be released to the general public. The global scale of climate change is best understood by scientists who work with complex systems. However, these scientists can't measure or predict local impacts very well. Enrolling on-the-ground citizen scientists in the collection of "small data," may reduce their fear of the unknown and promote adaptation rather than anxiety with respect to the changing world around them.

The microbiome has gone public, according to Jamie Lorimer, who described its journey out of the laboratory and reported on an ongoing project that has developed participatory approaches to increase popular understanding of microbiology in order to trace health and hygiene practices. Scientific interest in the human microbiome emerged after completion of the Human Genome Project in 2003, when it was deemed that the human species was undetermined by its genome. A drastic departure from historical attitudes toward microbes (or germs) as unequivocally bad, scientists began to consider the microbiome an exciting new, if not final, frontier for natural history. The microbiome went public through popular science books, film, museum exhibits, art-science endeavors, and citizen or DIY science. Microbes have become familiar enough that sensationalist news sources have alarmed their readership by suggesting that their homes and bodies are, in fact, too clean and thus unhealthful. It is in the context of this paradigm shift that Lorimer began investigating the relationship of the Oxford public to the microbiome. Following a round of interviews with 14 households on the topics of hygiene and microbes, Lorimer led six group experiments that tasked participants with plotting what microbial life they expected to find in a place and to record what was actually found there. These experiments required participants to conduct a kitchen safari, to study the microbial colonization of their chopping boards, to discover their fridge ecologies (which was unsuccessful because the methods of detection were not sensitive enough to find life there), to study the impact of their cleaning products, and to determine effectiveness of their cleaning cloths on worktops (which turned out to be ecological restoration tools). Participants were encouraged to design the final experiment themselves; most focused on family pets. Lorimer's expressed goal was to get the public to think like community ecologists and while the just-completed exit interviews have yet to be analyzed, the practice of public engagement had already revealed a few things: Shifting popular conceptions of the human-and-beyond microbiome from pathogenic species to ecological community will be challenging. It is important for participatory research to engage publics before they are exposed to controversies related to the research subject. And finally, studies of the microbiome cannot be entirely public as they are linked with and reliant particularly on the technologies developed by private interests.

Citizen science of the sharks that have begun frequenting the waters off Cape Cod, Massachusetts, has yet to commence. Michaela Thompson offered a recent history of these sharks, parsed the complex interests in the Cape's waters and the marine animals that reside there, and invited advice on how to design citizen science initiatives that take into account these heterogeneous (and often conflicting) interests. In 2004, a Great White shark called Gretel (and occasionally Greta or Artemis) was trapped in an estuarine in Cape Cod. Despite an exciting news season in which Massachusetts Senator John Kerry was running for President of the United States and the Boston Red Sox were making a historic postseason run, the shark was plastered across local news sources and attracted reporters from around the world. Gretel spent two weeks trapped and in distress, ultimately guided to freedom by high pressure hoses typically used in the region's cranberry bogs. In 2004, Gretel was an anomaly; at present, 150 sharks regularly visit the waters off Cape Cod, likely attracted by an increased seal population

(which in turn is related to legislation protecting marine mammals). And while the Cape Cod shark story has been framed as an ecological success story, a tale of marine rewilding, an economic boon, a triumph of conservation in which predators have been embraced rather than vilified, Thompson cautioned that these sanguine portrayals ignore more complex dynamics. The recent history of the region's seals suggests that locals may soon turn against their charismatic predators. Initially the rebounding seal population was embraced by locals, particularly because it attracted tourists. But the seals have become a nuisance to fisherman and others competing for space and resources. How will locals treat the sharks when they no longer contribute to the region's economy? Sharks have drawn tourists to the area but it remains, primarily, a beach destination. The outer cape communities rely on beach tourism to keep their economies afloat. The parking stickers, expensive pieces of adhesive that are required to visit their beaches, generate millions of dollars every summer. What happens to these communities when sharks begin to dissuade people from visiting the beaches? Thompson predicted that the narrative around the Cape Cod sharks will change soon, especially if a shark causes a human fatality or inflicts serious injury—which is likely to occur in the next 5 years. With these dynamics in mind, what sort of citizen science initiative could involve these different constituencies in the study of sharks? How can citizen science increase access to these animals (which has lately been characterized by a pay-for-play dynamic)? Can citizen science help address concerns about responsibility and ownership?

Discussion Highlights:

- How did the animals labeled invasive arrive to their new ranges? In all discussions of indigenous species, humans are invisible.
- Citizen science projects tend to preach to the choir, attracting people who care about the natural world and value scientific research. How can these projects reach and convert the more skeptical and fearful communities?
- Scientists have moved away from simplistic determinations of good or bad bacteria, taking interest in ecology over composition. The market, however, prefers to focus on composition. For example, the emerging probiotic cleaning industry is attempting to standardize species and isolate their functions in order to develop marketable products.

Panel 4: Technology and Interpretation

Decoding the 'Wild': An Interdisciplinary Approach to Improve Our Ability to Detect Pain-Linked Facial Expressions in Cats (with the Help of Citizen Science)
Lauren Finka, Postdoctoral Research Fellow, University of Lincoln

Into the Zooniverse: Exploring the 'Wild' from Afar
Ali Swanson, Ecology & Citizen Science Postdoctoral Researcher, The Zooinverse, University of Oxford

Technology Answers the 'Call of the Wild': Cameras and Pixels Let People See and Understand the Natural World
Daniel Rubenstein, Class of 1877 Professor of Zoology, Princeton University

Lauren Finka introduced herself as a sedentary scientist whose research into feline pain detection through facial expressions is reliant on data collected by citizens. Building on her talk at the "Call of the Wild" workshop, Finka explained that cats are morphologically and behaviorally closely related to their asocial wild type ancestors. Therefore, cats may not express pain or distress because doing so would, in the experience of wild ancestors, trigger

conspecifics to monopolize resources and attract unwanted attention from predators. (Though, it is significant that domestic cats' vocalizations differ from their ancestors. They are trying to communicate; however cats' meowed language is not universal or well developed.) Feline pain is thus difficult to detect. Minute shifts in facial expressions may be the best avenue for assessing their pain. There is a long history of using the face as a key to the internal experience of people and other animals, from Charles Darwin's publication of *The Expression of Emotions in Man and Animals* (1872). But how can these expressions be translated? Lately, groups promoting welfare have developed animal grimace scales based on facial shifts linked to pain in humans—muscle constriction around the eyes, mouth, and cheeks. Can these scales be trusted to provide an accurate translation of the internal state of a species with a different evolutionary history? And, if so, can humans be trusted to properly identify the minute shifts of the feline face that communicate pain? A survey of veterinarians and cat owners revealed that both groups had the same likelihood of accurately detecting a cat that was in pain compared to one that was not. Finka noted how such surveys broke down presumed barriers of expertise between professionals and lay cat fanciers and introduced a third sort of expertise—algorithmic—that has lately entered the fray. CatFACS, a coding system that uses a biological systems-based approach promises to eliminate human bias and error when assessing feline facial expressions. The program maps and analyzes a cat's muscle movements and uses a computer algorithm to capture just the right perspective—since cats aren't always obliging enough to pose with their faces directly toward a camera. Differences that human eyes can't detect, the computer can. To date, the algorithm has performed at approximately 80% accuracy, significantly better than human observers. Still, the computer is learning and must pick up on the idiosyncrasies of different breeds. For examples, according to the program Persian cats are always in pain, a determination that raises important questions. Are they in fact always in pain? (Persians notoriously have health issues due to aesthetic breeding.) Or perhaps this breed has been selected to look like it is in pain, i.e. cute and vulnerable, because it taps into an instinct to care? Nor has the program completely eliminated humans from the project, as the training of the program relies on the public to submit images of cats for analysis. (A cat pain app is in development.) Because an excessive amount of Internet activity revolves around the public's interest in cats, Finka assumed that she would be overwhelmed by submissions. This was not the case; rather, the most effective way to solicit the necessary images was through building close relationships with a few individuals who contributed the bulk of the data.

The fastest growing discipline on the Zooniverse platform is ecology, offering citizen scientists a range of tasks from identifying snapshots of animals in their natural habitats to tracking blooms and leaf falls. In the context of climate change, Ali Swanson explained, public enthusiasm for ecology is heartening. Though, Swanson cautioned, it is important to determine what sort of enthusiasm for nature the Zooniverse projects inspire. Do digital citizen science projects in fact encourage the public to travel to the places that they have seen on their computer monitors? Do they desire a more literal encounter? Such concerns recall a paradox set out by the father of ecology, Aldo Leopold, in *A Sand County Almanac*. Leopold lamented, "All conservation of wildness is self-defeating, for to cherish we must see and fondle, and when enough have seen and fondled, there is no wilderness left to cherish." In the case of Zooniverse projects, the formulation is reversed. Once the public cares about (or cherishes) a place, they may want to cash in on that care by visiting it. How might Zooniverse allow the public to experience these places but tread lightly? Swanson's "Snapshot Serengeti" project has used its blog as a way to allow citizen scientists into the field. Scientists blogged about their methods and analysis, but often they wrote about daily life in the field, describing the discomfort of fieldwork, the distress caused by buffalo that stubbornly blocked access to the camp's toilets, the ubiquitous tsetse flies that bruised with each bite. They wrote about getting their truck stuck in the middle of a stinging ant nest and waking up before dawn in order to watch lions just lie

around. Thus while camera trap stories offered citizen scientists insights on the lives of the Serengeti's animal inhabitants, it was the blog that offered them the human experience. Swanson reported that, to her surprise, the volunteer community began using the site's forum to mimic the scientist-bloggers and share their own experiences of the "Serengeti." A lot of these discussions circled around identification and users tended to hone in on signs of tameness among Serengeti animals. (Collars on lions sparked discussion and users sometimes expressed disappointment that that these collared creatures no longer were wild, revealing a very strict definition of wildness.) Users also discussed how the animals got their names and reconstructed the histories of colonization, exploration, and research. Such an active forum is not universal across Zooniverse projects, which led Swanson to wonder if the scientists' personal narratives on the "Snapshot Serengeti" blog inspired such engagement among the citizen scientists. Moreover, have the volunteers derived more value through the forum? Do they feel more connected to the Serengeti because of it? Does an active blog and forum create a more authentic experience for digital citizen science?

Daniel Rubenstein reported on the successful policy implications of The Great Zebra and Giraffe Count, a citizen science initiative conducted in Nairobi National Park in 2015. Participants were outfitted with GPS trackers and cameras and sent off into the park to photograph its animal inhabitants. Some volunteers used the day to picnic (suggested by static GPS data) while others drove widely around the park. With the help of a computer program that analyzed 40,000 photographs and compared markings to avoid tallying an individual more than once, the count produced a reliable estimation of the park's population that could be used in policy conversations. Citizen science projects like this count are successful because people matter (and they know it). The have developed a relationship with their nearby "wild" and often become engaged advocates. For this reason, Rubenstein insisted, it is essential that scientists bring government officials (and land managers, NGOs, unaffiliated scientists, staff of the Kenya Wildlife Service, and more) into these projects. Recently the Kenyan government issued a conservation action plan that included a promise to support and fund citizen science monitoring projects in the future, which Rubenstein credited to involving local officials in the count. Officials have also recently agreed to allow for the temporary contraception of lions in a district with a high lion, low zebra count, a hotly contested allowance that will greatly contribute toward the goal of promoting the Grevy's zebra population from stable to increasing. Rubenstein added that citizen science administrators need to manage expectations of what the Kenyan wild is. Half of Kenya's landscape is used by pastoral people and their animals, a fact that may surprise and disappoint safari-goers expecting to see only wildlife there. In fact, Kenyan wilderness is a shared space. Gazelle, warthogs, and plains zebras all benefit from the presence of pastoral people's cattle. Only the Cape buffalo, a cattle relative, competes for resources with livestock. The recent zebra count revealed these animals were most populous in an area to which they had expanded only in 1975. What accounts for the unexpectedly high numbers there? Livestock. The zebras chose to relocate to a place with cattle. The lifeways of animals in Kenya resist simplistic categories of wild and tame. People must be trained to embrace this.

Discussion Highlights:

- Technologies developed out of citizen initiatives or as tools for the public can destabilize the established hierarchy of professionals and amateurs. Sally Shuttleworth predicted that users of the cat pain app would pester their veterinarians, even if their animal received a clean bill of health, if the app's algorithm determined the cat's face to show pain.
- Sometimes Zooniverse users answer their own questions, while also responding to the project's queries. For example, "Old Weather" asked volunteers to track climate data

using ships' historical documents. Independently, users began to track the number of sailors confined to sickbay and discovered for themselves an outbreak of Spanish Flu aboard one vessel. Attending to what volunteers choose to do may help citizen science project administrators design projects with built in audiences.

- Similarly, the Great Zebra Count keyed scientists in to some of the incentives that attract the public to participate in these projects. In addition to the opportunity to picnic in a wildlife preserve, the technology on loan was enticing. Of the 40,000 photographs taken, only 15,000 were usable. Participants were allowed to take home the photos they took and so pointed the camera at more than just the designated giraffes and zebras.