Citizen Science 2015 Conference
Oral Presentation Abstracts

*Presenting authors' names are **bolded***
Affiliations are US-based unless otherwise indicated

Wednesday, February 11, 2015

7:30-8:30am
Lobby, Main Level
Registration and Coffee

8.30-8:45am
Ballroom 220B
Welcome and Introduction

Rick Bonney, Cornell Lab of Ornithology, Cornell University - **CSA Board**
Lila Higgins, Natural History Museum, Los Angeles - **CS2015 Co-Chair**
Alison Young, California Academy of Science - **CS2015 Co-Chair**

8:45-9:45am
Ballroom 220B
Keynote Address

A PLACE IN THE WORLD–SCIENCE, SOCIETY, AND REFRAMING THE QUESTIONS WE ASK
Chris Filardi, Director of Pacific Programs, Center for Biodiversity and Conservation, American Museum of Natural History
The interplay between science and broader society is central to modern life. Citizen science is a natural upshot of this reality. From mariner input into early wind charts that revolutionized trans-oceanic travel, to the Christmas Bird Count or crowd-sourcing of sight records for imperiled species, relationships between societal needs and public participation in the scientific process have not only improved understanding of the world around us, but have also expanded the impact of science on our lives. The history of citizen science suggests we can do more. In a variety of contexts, broadening the process of how scientific questions are framed, and expanding who is involved in the framing, is transforming how we do science. Through a series of brief vignettes, this presentation will explore the potential impacts on society of broader public participation in the full life cycle of scientific inquiry – from framing questions and guiding data collection, to analyzing and communicating new knowledge. It is my hope to inspire active dialogue during the conference and beyond on the evolving role of citizen science in society.

Chris Filardi, Ph.D. is Director of Pacific Programs for the American Museum of Natural History's Center for Biodiversity and Conservation (CBC). Combining natural history, biodiversity research, and partnership with indigenous or local people, Dr. Filardi has a long history of conservation practice across the tropical Pacific and western North America. His work directing the CBC's Pacific Programs focuses on integrating research, mentorship, and direct conservation action to inspire large-landscape and marine conservation in partnership with place-based communities.

9:55-11:15am
Session 1A   Lower Level 20A
Symposium: Making Education and Lifelong Learning Connections

DEVELOPING A FRAMEWORK FOR CITIZEN SCIENCE IN EDUCATION—JOIN THE CONVERSATION!
Sarah Kirn (Session Chair), Gulf of Maine Research Institute; **Ryan Collay**, Oregon State University SMILE Program; **Mary Ford**, National Geographic Society; **Sandra Henderson**, Project BudBurst and Citizen Science Academy; **Nancy Trautmann**, Cornell Lab of Ornithology, Cornell University

The tremendous growth in citizen science projects and practice coincides with a national call for more integrated, engaged, and authentic science learning. In an ideal world, K-12 teachers and out of school educators alike would use participation in citizen science programs as a core strategy to achieve the full breadth of their learning outcomes. While some educators and some citizen science projects manage to achieve this ideal, doing so remains out of reach for most due in large part to isolation and limited resources. The Education Working Group of the Citizen Science Association proposes to use this symposium to invite the Citizen Science Association members, formal and informal educators, citizen science practitioners, and learning researchers to generate ideas to advance their draft Framework for the Establishment of Citizen Science Within the STEM Learning Ecosystem. Our purpose is to inspire growth and innovation in the use of citizen science in education to achieve a growing body of learning outcomes for an increasingly diverse audience of learners and participants. This symposium directly addresses the theme of Making Education and Lifelong Learning Connections.

In this symposium, working group members will present a draft case statement addressing the relevant movements in education, the cultural forces and factors influencing youth and adult learners, formal educators, and out-of-school educators. We will then engage the audience in small group work to solicit characteristics of exemplary practice from their own work - a conversation we will continue in a breakout session on day two.

Incorporating the ideas shared by Citizen Science Association members at this conference, the Education Working Group will revise the presented case statement and framework, and draft a research and development agenda for citizen science and STEM education.

9:55-11:15am
Session 1B   Lower Level 20B
Panel: Broadening Engagement to Foster Diversity and Inclusion

CREATING A WELCOMING, INCLUSIVE, DIVERSE AND JUST CITIZEN SCIENCE ASSOCIATION
Tim Vargo (Session Chair), Manager of Research and Citizen Science, Urban Ecology Center; **Rajul Pandya**, Thriving Earth Exchange, American Geophysical Union; **Monica Ramirez-Andreotta**, Assistant Professor, Soil, Water and Environmental Science, University of Arizona; **Linda Silka**, Director, Margaret Chase Policy Center, University of Maine

Please join us for a listening session/discussion hosted by members of the Citizen Science Association's Diversity and Inclusion Working Group. We will collect and discuss ideas and thoughts that could lead to practices and policies for the Association to move towards true democratization where all audiences and affiliations have the opportunity to become equal partners in the process of science.

9:55-11:15am
Session 1C   Lower Level 20C
Talks: Research on and Evaluation of the Citizen Science Experience

UNPACKING WHAT IT MEANS TO BE A CITIZEN SCIENTIST: TOWARD A SHARED UNDERSTANDING FOR DEFINING AND MEASURING ENGAGEMENT
Tina Phillips, Cornell Lab of Ornithology, Cornell University; Heidi Ballard, University of California, Davis; Jody Enck and Rick Bonney, Cornell Lab of Ornithology, Cornell University

Within citizen science, accurately measuring engagement, i.e., what participants actually do on behalf of a project, is important for assessing participant experiences and outcomes, which may be significantly influenced by the degree or level of engagement. Across the field, measuring engagement remains

somewhat simplistic, often relying instead on output measures such as the number of participants, rate of retention, the number of web page hits and downloads, and other baseline measures of recruitment, retention, and outreach. This has resulted in a lack of understanding about the ways and extent to which participants are engaged in self-directed citizen science projects.

The current work describes the first phase of a NSF-funded collaborative research project to define and unpack what engagement entails for adults participating in citizen science. Six projects were purposively selected to span the continuum of contributory, collaborative, and co-created projects. To initially characterize engagement, we worked with the six project leaders to develop a priori criteria for selecting a sample of participants who were likely to reflect the full range of engagement from high to low. Guided by sociocultural theories from the learning sciences, we conducted, coded, and analyzed data from 75 interviews that were then used to develop a metric to measure engagement levels among individuals across different projects. Results from this work will shed light on the complex dimensions of engagement in citizen science, as well as provide practitioners with a standard way to measure engagement. Phase two of this research will use the metric to facilitate cross-programmatic analyses between the projects to better understand the relationship between participant engagement and intended learning outcomes.

TRACKING THE FLU: MOTIVATION AND UNDERSTANDING OF A COMMUNITY OF FLU-REPORTERS

Anne Land-Zandstra, Leiden University, The Netherlands

The Great Influenza Survey is an interactive and participatory monitoring system for influenza-like illness in the Netherlands. During the flu season from November until May, thousands of citizen scientists report their flu-like symptoms, allowing researchers to track flu activity geographically and through time. Since its start in 2003, this citizen science project has gathered a loyal participant base that faithfully reports their symptoms every week during the flu season.

This study examined participants' experience, motivation, and understanding. In particular we were interested in the differences between long-term versus relatively new participants. We conducted an online survey with over 1600 flu reporters asking them about their experiences, their reasons for participation, their knowledge and learning, and their attitudes towards science.

On average, participants were middle aged, female and had finished higher education. The majority of participants had no previous experience with citizen science or scientific research. Over 80% of study participants reported their symptoms every week during the flu season. The most important reasons for people to participate was because they want to contribute to science and because they are interested in science and health. Participants of this study had a good understanding of the flu and reported that they had learned something through their participation in the project.

Long-term contributors were more likely to indicate contribution and interest as reasons to participate. In terms of perceived learning impact, long-term contributors were slightly more likely to report having learned about flu and epidemics through their participation. In addition, people who had been involved longer, were more likely to report symptoms every week and to read the newsletter.

Findings of this study may inform the field of citizen science at large in understanding what makes participants stick with a citizen science project for longer periods of time.

HOW DOES PARTICIPATION MATTER? PARTICIPATION, EMPOWERMENT AND DEVELOPMENT OF SCIENCE IDENTITY

Heidi Ballard and Lina Yamashita, University of California, Davis; Tina Phillips and Rick Bonney, Cornell Lab of Ornithology, Cornell University

Few studies have examined how participation in citizen science affects participants' perceptions of their roles in, use of, and contributions to science, particularly across different types of citizen science models. In our first year of a 3-year study, we explored the relationship between quality of participation during citizen science and the development or reinforcement of specific aspects of science identity across a wide spectrum of citizen science projects. Quality here refers to the qualitative aspects of participation, including the amount of power and agency participants have in any given stage of the research or monitoring process.

Across diverse projects within the U.S. focused on birds, precipitation, air and water quality monitoring, pollinators and eels, we conducted over 75 interviews with participants representing low, medium, and high level or "degree" of engagement, as collectively defined by the leaders of the 6 citizen science projects. Using previous research on science identity and activity theory, we focused analysis on understanding how their participation in citizen science helped to develop and/or reinforce specific aspects of science identity, including their feelings of competence in science, interest in science, recognition from others as someone who understands science, and self-efficacy and empowerment regarding understanding and contributing to science.

Our initial findings indicate that depending on the quality of participation and participants' interests, the development or reinforcement of science identity is possible at all levels of engagement. Whether leading a local air quality monitoring team, or sporadically submitting monarch larvae monitoring data, many participants expressed deep feelings of empowerment and self-efficacy in their ability to contribute to and use science to address environmental problems. This work has implications for the design and evaluation of citizen science projects, as well as better understanding of how science learning and identity development occurs in informal settings.

MEASURING PARTICIPANT ENGAGEMENT IN SHORT-DURATION CITIZEN SCIENCE EVENTS SUCH AS SPECIMEN COLLECTION IN NATIONAL PARKS

Bill Zoellick and Hannah Webber, Schoodic Institute at Acadia National Park; Abe Miller-Rushing and Michael Marion, National Park Service

Citizen science programs in National Parks and other recreational settings have the potential to introduce scientific ideas and concerns to people who might otherwise not engage in science-related activities. This is especially true for families, for whom parks provide an opportunity to explore topics where a child's deep interest opens opportunities for rich shared learning. Work at Acadia National Park this summer provided examples of such opportunities: a bioblitz where people of all ages with an interest in beetles helped sort specimens for the park while learning from taxonomists and looking at lots of beetles; dragonfly larvae collection to help monitor mercury; and a workshop that explored the feasibility of using interested amateurs to clean up and look up DNA barcode sequences. Such programs appear to offer important opportunities to activate new interest in science and to build on pre-existing interests for potentially large numbers of people. However, evaluating the effects of such programs through surveys, pre and post-tests, and interviews is difficult due to the short event duration. People are on vacation, they don't want to spend time responding to surveys, and effect sizes are small. This presentation summarizes findings from use of a participant observation protocol that draws on research methods from museum studies to develop a measurement tool that can be used in short-duration citizen science programs. The measurement model asserts that engagement in science learning will be evidenced by a progression from INITIATION behaviors associated with learning a process, to DOING behaviors associated with competent performance, to BREAKTHOUGH behaviors where participants provide evidence of making personal connections to the activity. Rasch model analysis is used to test the fit between observations and the model for the 3 Acadia National Park events identified above.

COSMOQUEST: MOTIVATIONS & NEEDS OF CITIZEN SCIENTISTS

GeorgiaBracey, Southern Illinois University Edwardsville; Nicole Gugliucci, Justine Breedon, Houston Southard, and Pamela Gay, Southern Illinois University Edwardsville

At the core of citizen science is a community of people who volunteer their spare time and/or resources to the pursuit of science. In order to purposefully attract audiences to our projects, we need to understand what motivates people to do science instead of other (perhaps more enjoyable) tasks. In this talk we present the results of approximately 50 interviews of members of the CosmoQuest community. We explore through a grounded theory analysis the factors that motivated these volunteers to begin their participation, why they continue to participate (or not), and what aspects beyond science opportunities (e.g. social and educational activities) do or do not factor in.

These interviews use an instrument that parallels the interview instrument used in earlier research with Moon Zoo participants, and we will compare our results with the results of this earlier project that existed within a science-only environment. This will allow us to explore how the inclusion of materials beyond just the science projects and related forums may (or may not) allow us to attract participants with a more diverse set of motivations.

The results of these interviews will also be compared with the results of a larger scale online survey, thus allowing us to measure the frequency of different motivations in the broader community, and to explore how different factors of design effect different people.

Finally, we will study how motivation correlates with behavior by looking to see how people with different motivations use the site in various ways.

9:55-11:15am
Session 1D   Lower Level 20D
Panel: Broadening Engagement to Foster Diversity and Inclusion

RE-IMAGINING CITIZEN SCIENCE FOR KNOWLEDGE JUSTICE—A DIALOGUE
Angela Guimarães, Pereira European Commission; **Eric Holt-Gimenez**, Food First, US; **Alan Irwin**, Copenhagen Business School, Denmark; **Erinma Ochu**, Wellcome Trust/Manchester University, UK; **Cindy Regalado**, University College London, UK; **Tom Wakeford** (Session Chair), Coventry University, UK
Drawing on the breadth of experience at CS2015 we invite you to join us in a participatory and critical exploration of citizen science in practice. For it to be useful in addressing our urgent ecological and social crises, many of us believe citizen science needs to shed its heritage of scientism. This is the myth that science, especially physical science, is the only source of knowledge.
Scientism emerged as a philosophy at the height of European colonialism in the mid-nineteenth century. Today, some of those undertaking some of the most prominent citizen science initiatives appear to accept one or more of scientism's three-fold manifesto:
1) All questions, from whatever source, can be answered by physical science;
2) Knowledge claims of physical science are based on a superior mode of reasoning and will therefore always overrule claims based on any other knowledge system;
3) Scientists are uniquely placed to know the right questions to ask, rendering those posed by non-scientists as ultimately meaningless.
We will facilitate an open discussion of how researchers in general, and citizen science practitioners in particular, might be enabled to reject scientism. This will better enable collaborations that embrace the insights, cosmo-visions and enthusiasm of those who have been excluded from having their ways of knowing seen as valid in the past.

9:55-11:15am
Session 1E   230A
Talks: Best Practices for Designing, Implementing, and Managing Citizen Science Projects and Programs

SEVENTEEN YEARS OF MEASURING RAIN—EXPERIENCES FROM COCORAHS (COMMUNITY COLLABORATIVE RAIN, HAIL AND SNOW NETWORK)
Nolan Doesken, Henry Reges, Zach Schwalbe, Julian Turner, and Noah Newman, Colorado State University/CoCoRaHS; Anthony Bergantino, University of Wyoming/CoCoRaHS
The quality, quantity and availability of precipitation data collected by CoCoRaHS volunteers, over time, has made it a primary data set for tracking and studying rain, hail and snow patterns across the U.S. It is nevertheless an ongoing challenge to recruit, train, and engage willing volunteers from all areas of the country in the process of manually observing and reporting precipitation. Furthermore, the playing field (society, demographics, technology and media) is continually changing. We will briefly describe how and why CoCoRaHS scaled up from a local community project to an international citizen science network and what we gained and lost in that process. We will look at participation metrics—specifically recruiting and

retention of volunteers. No single recruiting method has worked uniformly well in all parts of the country, and dozens of approaches have been successful to varying degrees. Partnering with the National Weather Service and their field offices across the country has been the single most effective mechanism for network expansion. Retention is more complicated since it is not just a function of "initial interest." About 65% of initial applicants engage in taking measurements, and of these, a much smaller percentage become long-term, year-round observers. Several retention metrics will be shown, and we will discuss how this information is used in program planning and implementation.

HOW MUCH IS TOO MUCH? LESSONS IN REALISTIC VOLUNTEER EXPECTATIONS FROM THE FRONT RANGE PIKA PROJECT

Amy Masching, Denver Zoological Foundation; Megan Mueller, Rocky Mountain Wild; Brian Fauver, Denver Zoological Foundation

The Front Range Pika Project is a citizen science program that engages the public in conservation research on the American pika in Colorado. Pika Patrol volunteers follow monitoring protocols to collect data about pikas and their habitat at high altitude field sites, thereby informing efforts to assess whether pikas are impacted by climate change. Created in tandem with other pika citizen science programs, the Front Range Pika Project provides long-term data to aid the conservation of this little-understood alpine species and its associated habitats.

Through the course of five field seasons, we've learned countless lessons, including some related to setting realistic expectations for what citizen scientists can and cannot accomplish. Aside from improving this individual program, these lessons are important for the broader conversation on scientific rigor in citizen science. How complicated can volunteer tasks be without compromising the quality of the data collected? How much training is needed to ensure volunteers feel confident in their responsibilities? How do we make sure the data collected is useful and rigorous without overwhelming volunteers with too many protocols? This talk will share answers to these questions and ideas for best practices gained through the Front Range Pika Project's experience.

KEEPING CITIZEN SCIENTISTS INTERESTED: THE IMPORTANCE OF TASK WORKFLOW DESIGN

James Sprinks, Robert Houghton, Steven Bamford, and Jeremy Morley, University of Nottingham, UK

Over the last 5 to 10 years, citizen science has grown to include projects involving a range of different scientific issues and disciplines. Not only can these projects be defined by the discipline they involve, but also by the different psychophysical tasks and judgments they require of the user. These two methods of differentiation can often be at odds with each other, for instance it could be argued that classifying a galaxy type compared to a known catalogue is very similar to identifying a hieroglyphic compared to the known alphabet, even though the disciplines of astronomy and ancient Egyptian history are clearly different. A hierarchical task analysis of twelve Zooniverse citizen science projects was carried out comparing the types of task, user judgments, task complexity, and user freedom involved for each. It was found that these factors vary considerably across the platforms, independent of the discipline involved. Although part of this variance can be explained by the specific science case needs and associated data requirements, it is clear that as of yet the citizen science community does not have a 'best practice' framework for task workflow design. Furthermore, comparing these findings with website visitor analytics for each platform revealed relationships between task workflow design factors and user behaviour measures such as the number of return visits, time spent classifying and total person hours spent on the site. Beyond the initial motivations for visiting a citizen science platform, in order to keep citizen scientists engaged with the project over time one of the aspects that platform developers and science teams must be aware of is that of the task workflow design of the site, specifically in terms of the types of tasks, required judgments and user autonomy, and how it effects both the user experience and the scientific results collected.

TAKING CITIZEN SCIENCE TO NEW HEIGHTS IN AFRICA: LESSONS FROM THE ANIMAL DEMOGRAPHY UNIT, UCT

Sally Hofmeyr, University of Cape Town, South Africa

Life is busy and getting busier. Travel is expensive and getting more so. In the face of these challenges, how do we motivate long-term citizen scientists to keep going, and how do we convince new ones to start, when doing so takes time and often requires travel? In the Animal Demography Unit (at the University of Cape Town, South Africa), where we manage a large and increasing number of long-running citizen science projects, we have found many ways of doing this, with impressive results. For example, our second Southern African Bird Atlas Project (SABAP2) has been running for seven years – this project requires a substantial commitment of time and energy. In spite of this, rates of data submission are increasing. We make extensive use of social media, in a range of ways, to maintain daily contact with our large team of citizen scientists, and to recruit new ones. We have also been experimenting with running Citizen Scientist Days and a range of other types of public engagement exercises, with great success. In this presentation, I examine project participation in relation to the timing and type of outreach and communication activities, to draw some lessons about the most effective of these activities. In this age of fast-paced change, however, we've also learned the importance of 'keeping it fresh' when it comes to communication, and particularly social media. I will present our current research into methods for citizen science outreach, as well as into academic attitudes to popular science communication, and how this relates to citizen science participation.

DATA CAMPAIGNS FOR SUSTAINING ENGAGEMENT IN LONG-TERM CITIZEN SCIENCE

Robyn Bailey and David Bonter, Cornell Lab of Ornithology; Caren Cooper, North Carolina Museum of Natural Science

Although there are many potential strategies to recruit and sustain public participation in monitoring programs, information on the relative success of different approaches is sparse. We explored the impact of three approaches in terms of increasing participant engagement in NestWatch, a continent-wide program that enlists the public to monitor and record reproduction in birds. Recruitment approaches included 1) manipulating web site content to direct participant effort, 2) specific, hypothesis-driven calls-to-action, and 3) fun-based campaigns designed to introduce potential participants to the project. Website manipulations included featuring 18 under-reported species in an ongoing "Focal Species" campaign to encourage monitoring of these species. Specific calls-to-action featured three campaigns with clear scientific underpinnings. The fun-based campaign featured an online tool for sharing and displaying photos of nesting birds. Website changes resulted in a 22% relative increase in submissions of the nests of the 18 new focal species. Responses to specific calls-to-action were mixed, with one initiative leading to a twofold increase in data submissions while another resulted in only a marginal increase. The fun-based campaign succeeded in reaching new audiences, with 32% of newly-engaged users also submitting biological data. We show that participants can be recruited to find and monitor additional nests when requested to do so, and are most responsive to specific, hypothesis-driven requests.

9:55-11:15am
Session 1F   230B
Talks: Making Education and Lifelong Learning Connections

YOUNG CITIZEN SCIENTISTS TRACK EASTERN BOX TURTLES AT THE LAKE RALEIGH AREA

Juliana Thomas, Exploris Middle School

As a 6th grade teacher, I wanted students to be involved in "real science", collecting "real data," and being part of a scientific research project; that is what we have been doing at Exploris Middle School in downtown Raleigh, NC, for 8 years now. In collaboration with the Centennial Campus Center for Wildlife Education-NC Wildlife Resources Commission, sixth graders have been tracking Eastern Box Turtles, collecting data of their movements, using tracking devices, and analyzing data by creating Arc GIS maps-The Where is Waldo Project. This project started by tracking an introduced turtle (Waldo) to the Lake Raleigh area after he had been hit by a car, and taken to recover at NCSU Veterinary Department. Since then, every year, sixth graders go through the complete scientific process, asking questions and finding

answers, as they track Waldo and native turtles in that area. They have found very interesting information; students have been able to determine home range area, effects of moving turtles to other areas, and turtle mortality. When finding a turtle on the road, moving it to "a better, nicer place" is not the best thing to do, and the students have found out why. Another concern has been an increased in turtle mortality, due to humans activity.

This year, we continue with the process of asking more questions related to home range and mortality, and want to move on, by increasing our audience in data collection. We are about to add a project in the iNaturalist website, so that anyone can put in information about Eastern Box turtles, such as pictures and locations of the turtles found, sizes, and turtle mortality. This can add a new perspective of data collection to our students, as we continue "being scientists in the classroom."

CITIZEN SCIENCE IN SCHOOLS: ADDRESSING CHALLENGES AND MAXIMISING IMPACT
Lucy Robinson, John Tweddle, Anne Jungblut, and Jade-Lauren Cawthray, Natural History Museum London
Citizen science is increasingly being incorporated into formal education settings, and this brings with it a range of opportunities and challenges for project developers, teachers and students alike.

This presentation introduces The Microverse, a citizen science project which engages high school students with biodiversity research using cutting edge genetic sequencing technologies. The Microverse investigates the communities of micro-organisms living on buildings, to understand how the increased use of modern building materials is affecting microbial community composition. Students aged 16-18 use sterile sampling protocols to gather micro-organisms for 'next generation' genetic sequencing, generating new knowledge of this understudied urban ecosystem.

Using our experiences with The Microverse and a range of other museum-led case studies, we will explore the opportunities and challenges of implementing citizen science in a formal education setting, from the perspective of both project developers and teachers. Citizen science provides exciting opportunities for school teachers to implement key areas of the National Curriculum including taxonomy, genetics, evolution, the scientific method, peer review process and citizenship. However, potential educational outcomes stretch far beyond meeting curriculum guidelines. We will discuss recent museum-based research into the impacts of interacting with practising scientists, including changing perceptions of 'who scientists are', an increased identification with scientists on a personal level, and a greater appreciation of the relevance of their work and the career options available. We will explore how the findings of this research may be applied to the field of citizen science to increase the impact of this approach in formal education. Finally, we will discuss the challenges of implementing citizen science in a school setting, taking into account the time and curriculum constraints on teachers, and sharing lessons learned from these case study projects.

STUDENTS DISCOVER: WHAT EMERGES WHEN SCIENTISTS AND TEACHERS CO-CREATE CITIZEN SCIENCE?
Julie Urban and Holly Menninger, North Carolina Museum of Natural Sciences (NCSU); Susan Parry, Kenan Fellows Institute, NCSU; Jeni Corn, Friday Institute for Educational Innovation, NCSU; Liz Baird and Rob Dunn, NCSU
Students Discover is an NSF-sponsored Math-Science Partnership project that brings authentic research into middle school classrooms through citizen science (education.yourwildlife.org). In July 2014, the NC Museum of Natural Sciences hosted its first cohort of middle-school teachers who worked in teams with post-doctoral scientists to co-create four original citizen science projects and associated lesson plans: 1) studying ancient shark diversity using 10 million year old fossils, 2) understanding urban mammal movement as revealed by camera traps, 3) investigating the role of beneficial microbes on dandelion survival, and 4) studying human evolution through the mites that live in the pores of our faces.

We will share the outcomes of Students Discover in its first project year. Based on observations and evaluations made by our partner research team, NCSU's Friday Institute for Educational Innovation, we will discuss the effectiveness of these projects as they contribute to the formal classroom learning of students in participating classrooms, as well as our efforts to scale projects to engage students throughout the US and the world. Our initial observations have revealed an unexpected synergy between the

postdoctoral scientists and their teachers that was transformative for both parties, in terms of learning how research is performed and more broadly understood. We will therefore discuss our assessment of how central the experience of scientist-teacher co-creation is to the success of citizen science intended for implementation in the classroom.

BRINGING CITIZEN SCIENCE INTO THE CLASSROOM WITH NOVA LABS
Ralph Bouquet, NOVA (WGBH)
NOVA Labs is a free digital platform that engages teens and lifelong learners in activities and games that foster authentic scientific exploration. From building RNA molecules and designing renewable energy systems to tracking cloud movements and learning cybersecurity strategies, NOVA Labs participants can take part in real-world investigations by visualizing, analyzing, and playing with the same data that scientists use. In this talk, NOVA Labs Outreach Coordinator Ralph Bouquet will discuss how NOVA Labs uses access to real data and realistic scenarios, learning through games and problem solving, and engaging media-based narratives to create a platform that connects students with real science.
NOVA Labs is produced by NOVA at WGBH in Boston. For more than 40 years, NOVA has reigned as the undisputed leader in science television, winning dozens of awards and drawing an average of 4.5 million curious viewers every week. WGBH Boston is America's preeminent public broadcasting producer, the source of one-third of PBS's prime-time lineup along with some of public television's best-known documentary and lifestyle shows, many public radio favorites, and a roster of children's programs. Visit http://www.pbs.org/wgbh/nova/labs/ for more information.

MOSQUITO PROJECTS ENABLE STUDENTS TO CONDUCT RESEARCH INVESTIGATIONS AND POSITIVELY IMPACT COMMUNITIES
Elena Sparrow, University of Alaska Fairbanks; Rebecca Boger, Brooklyn College, City University of New York; Mullica Jaroensutasinee and Krisanadej Jaroensutasinee, Walailak University, Thailand; Siriwan Wongkoon, Prince of Songkla University, Surat Thani Campus, Thailand
There is increased concern about impacts of climate change on vector-borne and other infectious diseases especially in developing countries such as those in Asia and Africa. Two mosquito citizen science projects were developed in the GLOBE (Global learning and Observations to Benefit the Environment) Seasons and Biomes project, one for monitoring larval abundance for mosquitoes that are vectors for malaria and another for determining larval abundance for mosquitoes that are vectors for dengue fever. Professional development workshops were conducted for primary and secondary teachers from Tanzania, Kenya, Nigeria, Madagascar and Thailand. These workshops focused not only on learning science content and process skills but also science measurement protocols and best teaching practices to engage students in scientific inquiry about real world problems relevant to their locale. The mosquito protocol and learning activities for dengue fever were developed and used in Thailand, while the materials for the mosquito investigation for malaria were used by teachers from the African countries. A Mosquito Online Analytic Service tool for querying, analyzing and visualizing patterns of mosquito larval distribution was developed in Thailand, that can help identify dengue risk areas and design effective dengue control strategies. Students have also conducted their own research projects and presented them in their own classes and schools but also in national and international conferences. Research investigation involvement and visualization of results empowered students to help clean up and cover water containers in their households and neighborhoods, one of the effective ways to eliminate mosquito breeding sites. We are working on the development of a mosquito protocol that can monitor larval abundance of mosquito vectors for malaria, dengue and West Nile fever that can be used in the U.S. and other parts of the world to engage more students and perhaps community members as citizen scientists in mosquito research.

9:55-11:15am
Session 1G   230C
Talks: Tackling Grand Challenges and Everyday Problems with Citizen Science

DIGITIZING LANDSCAPES: SENSORS, SATELLITES, & YOU!

Julia Kumari Drapkin, iSeeChange; and Lily Bui, Massachusetts Institute of Technology

iSeeChange is a crowd-sourced climate change documentation effort that seeks to bring ground truth and human perspective to the daily reality of the shifting climate. First developed in Western Colorado with KVNF Mountain Public Radio and the Association for Independents in Radio, the project is creating an engaging community almanac of the new climate era, from written posts of heat waves, to audio recordings of the water shortages to photography of the first frost.

This year, iSeeChange is partnering with NASA's Orbiting Carbon Observatory-2 (OCO-2) to develop a pilot project tentatively called "NASA Citizen Science Corps" that will help monitor the Earth's vital statistics, both on the ground and from space. The goal of this Citizen Science Corps is to engage science-interested citizens by inviting them to participate in NASA's OCO-2 mission and expand the pool of both iSeeChange participants and earth observation data users. Additionally, iSeeChange will also partner with the BEACON project, a system of approximately two dozen air quality monitoring "nodes" spaced on a 2-km grid around the city of Oakland, CA. This spatially dense network rapidly samples CO_2 concentrations and uploads them to a website in near real time, giving collaborating researchers and members of the Oakland community unique access to high-resolution pictures of how the urban landscape and lifestyle affects CO_2 levels in the area.

Using iSeeChange's digital platform, its network of contributors, and public media partners, local communities will be called to action on a regular basis to collect measurements, take photographs, post observations and ask questions online. By combining local community stories, data, and satellite data, iSeeChange aims to connect the dots between where we live, how we live, and the impacts that climate change has on the world around us.

CO2 MONITORING IN HIGH-DEFINITION

Alexis Shusterman and Virginia Teige, University of California, Berkeley; David Holstius, Bay Area Air Quality Management District; Catherine Newman, catkaynew.com; Alex Turner, Harvard University; Ronald Cohen, UC Berkeley

The Berkeley Atmospheric CO_2 Observation Network (BEACO2N) was founded in 2012 as a web of 25 air-quality monitoring "nodes" stationed atop schools and museums around the Oakland metropolitan area. While most other CO_2 monitoring efforts report a single, average value for entire cities or regions, BEACO2N paints a higher-resolution CO_2 picture by employing more nodes, spaced only one mile apart. To achieve its unique spatial coverage, BEACO2N uses a suite of low-cost, commercially available materials and relies on a network of volunteers (mostly educators and regulators) to provide roof, power, and internet access for the nodes. In this way, BEACO2N seeks to bridge the gap between citizen science and traditional science by gathering quality-controlled, usable observations in an inclusive neighborhood-level space and making them available to the public in near real time (http://beacon.berkeley.edu).

The BEACO2N philosophy insists that the same data that informs and inspires communities can also feature in meaningful academic work. Indeed, the first two years of results have provided convincing evidence that this low-cost, volunteer-corps network nonetheless captures significant local CO_2 events with sufficient sensitivity to inform pollution models and regulations. This validation of the BEACO2N approach offers insight into questions common to all citizen science projects, such as: How good is 'good enough' when it comes to data? What swift, efficient quality-control strategies still allow for surprising results? And where is the trade-off between the shelf price of materials and the cost of their repair and/or maintenance? Initial thoughts and lessons from BEACO2N's recently forged collaboration with community climate change almanac iSeeChange will also be presented, as well as potential future applications of the BEACO2N data set.

THE AIR SENSOR CITIZEN SCIENCE TOOLBOX: A COLLABORATION IN COMMUNITY AIR QUALITY MONITORING AND MAPPING

Amanda Kaufman, ORISE Fellow hosted by US EPA Air, Climate, and Energy (ACE) Research Program; Ron Williams and Timothy Barzyk, US EPA National Exposure Research Laboratory (NERL), Research Triangle

Park, North Carolina; Marie O'Shea, Anhthu Hoang, and Patricia Sheridan, US EPA Region 2, New York, NY; Molly Greenberg, Ironbound Community Corporation, Newark, NJ

The use of small sensor technology is rapidly growing, especially in communities. EPA is actively supporting citizen science projects and responding to community requests for information and guidance on air sensor use. The Air Sensor Citizen Science Toolbox is being developed by the US EPA with resources and other tools that can be used by citizens to learn more about air sensor technology. The toolbox has an overarching goal of providing guidance and instructions to citizens to allow them to effectively collect, analyze, interpret, and communicate air quality data (http://www.epa.gov/heasd/airsensortoolbox). EPA's Office of Research and Development is collaborating with EPA Region 2 and the Ironbound Community Corporation (ICC) in Newark, New Jersey, to develop a sensor package for use in the community. The Ironbound community is an environmental justice community made up of around 50,000 residents; the majority of whom are foreign born. The community is bordered by highways, rail yards, major seaports, an international airport, and hundreds of industrial facilities. It is believed that residents might be exposed to a variety of airborne pollutants from these sources. To raise awareness of local air pollution levels through citizen science-based monitoring, scientists involved in the Ironbound Community Pilot Project are:

•Working with community members to develop a study design for monitoring air quality in the Ironbound Community;
•Assisting the community in selecting appropriate pollutants for citizen scientists to monitor;
•Providing necessary environmental sensors, one-on-one training, and developing written directions for sensor use;
•Guiding community members on data analysis, data viewing options, and communication.

A future goal of this project is to translate these methods across other EPA regional and tribal offices so they can collaborate with their local community action groups and address similar issues. The Citizen Science Toolbox has the potential to be a valuable resource for such collaborations.

THE NORTH FORK VALLEY AIR MONITORING PROJECT: CITIZEN SCIENCE MEETS PROJECT-BASED LEARNING USING NEXT-GENERATION AIR QUALITY MONITORS IN COLORADO

Katya Hafich, Ashley Collier, and Michael Hannigan, University of Colorado, Boulder (UCB); Sarah Sauter, Western Slope Conservation Center; Ben Graves, Delta High School; Joanna Gordon, UCB

Using low-cost, next-generation air quality monitoring pods, this innovative citizen science project incorporates project-based learning with high school curriculum on air quality, energy development, and methods for gathering data. The project is a collaboration between the University of Colorado at Boulder, the Western Slope Conservation Center, and Delta County schools, and brings cutting edge tools to a rural area in Colorado that faces potential impacts to air quality as a result of current and future energy development. Rural communities typically lack historical air quality data, tools to monitor air quality, and connections to higher learning and university resources. In the North Fork Valley, CU grad students teach high school students how to deploy and use these monitors to measure NO_2, O_3, CO_2, and total VOC's. Currently, a database is being developed for air quality data in Colorado, where data collected by citizens will be accessed and stored. In the meantime, North Fork Valley air quality results will be shared with the community through outreach events and a written report. This project provides our group with one of our first opportunities for long-term data collection providing valuable information on monitor performance, sensor reliability, calibration frequency, and the feasibility of providing a community with quality data using next-generation technologies. We present lessons learned about working with high frequency continuous data in the classroom, building partnerships and awareness to support citizen science in rural communities, and working with the energy development industry.

CITIZEN SENSING, MONITORING AIR POLLUTION AND BUILDING THE FRACKBOX

Helen Pritchard, Jennifer Gabrys, Helen Pritchard, Tom Keene, and Nerea Calvillo, Goldsmiths, University of London, UK

A number of environmental sensing technologies and practices are emerging that seek to enable citizens to use DIY and low-tech monitoring tools to understand and act upon environmental problems. Such "citizen sensing" projects intend to democratize the collection and use of environmental sensor data in order to facilitate expanded citizen engagement in environmental issues. But how effective are these practices of citizen sensing in not just providing "crowd-sourced" data sets, but also in giving rise to new modes of environmental awareness and practice? The Citizen Sense project investigates these questions by attending to the relationship between technologies and practices of environmental sensing with citizen engagement. This presentation will discuss Citizen Sense project work on participatory engagements with "pollution sensing" in relation to monitoring air quality near infrastructure of unconventional natural gas extraction in the form of hydraulic fracturing (or fracking) in northeastern Pennsylvania, USA. This presentation will outline citizen-sensing practices that monitor fracking-related pollution that are already underway, and it will discuss our attempts to contribute to monitoring processes through further participatory and practice-based citizen-sensing initiatives, including the developing of a monitoring device, the "frackbox."

11:15-11:45am
Coffee Break

11:50am-1:10pm
Session 2A   Lower Level 20A
Symposium – Research and Evaluation on the Citizen Science Experience

MODELING WITH CITIZEN SCIENTISTS: USING COMMUNITY-BASED MODELING TOOLS TO DEVELOP CITIZEN-SCIENCE PROJECTS RESULTING IN RESOURCE MANAGEMENT OUTCOMES
Daniel Betz and **Rebecca Jordan** (Session Chair), Rutgers University; **Steven Gray**, University of Massachusetts; **David Mellor** and **Alycia Crall**, Virginia Tech; **Greg Newman**, Colorado State University
Submitted for symposium: Improving the Influence of Citizen Science on Environmental decision-making. Although model-based reasoning is often at the center of scientific investigation, the process of constructing, refining and empirically validating scientific models is not often made explicit to participants in many citizen science programs. The lack of attention that modeling receives in citizen science programs is likely attributable to resource constraints, given that scientific modeling often requires considerable training and the software tools that scientists use are not easily accessible to members of the general public. This limitation can also present difficulties in communicating ideas in the decision-making process. To address these issues, we present the development and use of a fuzzy-logic cognitive mapping software called Mental Modeler (http://www.mentalmodeler.org/), embedded within a citizen science web portal that allows scientists, environmental managers and citizen scientists to collaboratively develop semi-quantitative conceptual models of environmental problems that are then used as a basis to structure citizen science projects. We suggest that highlighting the role that model-based reasoning plays in scientific investigation and engaging citizens in iterative computer-based modeling and scenario activities: (1) allows citizen groups to collaboratively design their own community-based projects that are of local interest and concern; (2) fosters model-based reasoning in citizen science project participants and (3) serves as a novel measurement tool for citizen science researchers to understand conceptual change as participants engage in these projects. Using data collected from four community groups that worked with professional scientists and land managers to develop local projects in Virginia, we first outline architecture of the modeling software and web portal. We then describe participant interaction with the modeling tool and review the data and projects that were generated. Finally, we discuss the benefits and limitations of incorporating model-based reasoning and modeling tools into the development of resource management projects.

11:50am-1:10pm
Session 2B   Lower Level 20B

A QUEST TO BUILD CAPACITY FOR SCIENCE-BASED RESTORATION WITHIN A TRIBAL COMMUNITY
Jonathan Long, USDA Forest Service PSW Research Station
My story will recount a twenty-year journey to build capacity in a tribal community to heal lands and waters using science and traditional knowledge. This long-term perspective will help to consider community-level outcomes and the advantages of investing in institutions or individuals. Over twenty years ago, the White Mountain Apache Tribe hired me as a planner to help restore culturally and ecologically important waters that had been damaged. Ten years ago, a School Board President and I launched a summer program for high school and college students to engage in this work in her community that had been hit hard by a major wildfire. In addition to working with the Tribal government and the school, I have worked through university programs and with many individual community members as students or staff. The presentation will include photos, video clips, and quotations that reveal how the people and places involved have evolved over this period and been influenced by our efforts. The elements of fire and water maintain a dynamic social-ecological landscape marked by dramatic periods of loss and recovery. The story will reflect on our outcomes and which strategies have appeared particularly helpful. Our successes include on-the-ground restoration, graduations and jobs for participants, a wealth of data, and publications. Our struggles include students who did not complete academic programs and the need to develop robust data management systems so that future generations can more easily build upon our work. In addition, it has been a personal challenge to keep these interactions going while living far from the community. After revealing some new strategies that we have planned, I will close by inviting discussion among others who have engaged in similar quests.

STORIES OF INTERCULTURAL COLLABORATIONS: TRIBAL NATIONS AND THE LOST LADYBUG PROJECT
Leslie Allee, Rebecca Smyth, and John Losey, Lost Ladybug Project, Cornell University
Over the last eight years, the Lost Ladybug Project has worked to develop collaborations with members of Native communities in order to increase access to and offer benefits of the project. Working to increase the diversity of participants and include under-represented communities introduced other, sometimes unforeseen, factors into the equation. Our invitations to participate also meant we were asking for assistance and required us to be changed by, to listen to, and respond to the varied needs of individual communities.
Collaboration means both to "work with another person or group in order to achieve or do something" and to "give help to an enemy who has invaded your country during a war...especially an occupying force." I will tell stories and invite discussion about how the reality of multiple perspectives has helped forge some wonderful intercultural collaborations based on parallel respect and shared environmental stewardship and has helped explain why others failed to blossom and grow. All our intercultural collaborations have contributed to the development and success of both the educational and scientific aspirations of the Lost Ladybug Project.

THE ROLE OF YOUTH-BASED CITIZEN SCIENCE IN IMPROVING OVERALL COMMUNITY HEALTH:
INDIVIDUAL AND FAMILY RELATIONSHIPS WITH CITIZEN SCIENCE
Kevin Cuff, Humberto Bracho, and Tony Marks-Block, East Bay Academy for Young Scientists, and Lawrence Hall of Science, University of California, Berkeley; Allan Ahumada and Shiela Ahumada, East Bay Academy for Young Scientists; Eliot Ahumada, University of California, Berkeley
The East Bay Academy for Young Scientists (EBAYS) aims to support members of non-dominant communities in their struggles to improve and maintain overall community health. One of the essential strategies employed by EBAYS entails presenting programs at middle and high schools that enable young people to develop deeper understanding of relevant science content, as well as key scientific practice skills necessary for effective participation in collaborative research projects. Once they have engaged in EBAYS activities, participants are provided with opportunities to engage in research projects that generate

information useful in addressing critical environmental issues. In addition, participants receive opportunities to present results of their research to other members of their communities and the scientific community at large. These combined activities have proven to be effective as a means of: a) increasing appreciation for the value of scientific practices as a tool for addressing important community-based issues; b) helping raise community awareness of important issues; c) sparking interest in other forms of community activism; and d) generating valuable environmental quality data.

Three stories will be presented that illustrate the impact that EBAYS programming has had on youth participants and their families. We will outline the programmatic and personal steps taken to achieve this impact, and describe the planned and unexpected changes that have happened at individual, organizational and community levels. Speakers will include EBAYS educators, a mother, and her two sons—one a UC Berkeley freshman who began work with EBAYS in 6th grade, and the other a high school student and current EBAYS scientist. We will share the successes and challenges of supporting positive scientific, educational and community outcomes in non-dominant communities, as well as the motives that have sustained our participation in citizen science.

11:50am-1:10pm
Session 2C   Lower Level 20C
Talks: Making Education and Lifelong Learning Connections

SENSING THE ENVIRONMENT: ENVIRONMENTAL SENSOR OUTREACH IN THE CLASSROOM
Rachel McIntosh-Kastrinsky, Association of Schools and Programs of Public Health (ASPPH)/US Environmental Protection Agency
As the desire for data and information increases, so has the technology to obtain information. More and more companies, organizations and academics are creating low cost environmental sensors for use by anyone. These personal environmental monitors (PEMs) allow citizens to be scientists by learning about and sharing their environmental data. Citizen science is an emerging field aided by sensors such as PEMs and the prevalence and availability of smartphones and tablets, since many of these sensors are used in conjunction with a tablet or smartphone (iOS or Android compatible). PEMs and citizen science can help individuals learn more about their environment and help improve availability of data and information about their surrounding environment. However, it is important to provide education and outreach to citizens on how to use the devices and their quality. This outreach and education project teaches and works through the after school program Citizen Schools at Neal Middle School in Durham, NC to improve understanding and use of PEMs, specifically the Sensordrone (Sensorcon), Air Quality Egg (Wicked Devices), Anemometer (Vaavud), and Osorb (ABS Materials). Through this Citizen Schools 10-week program, students learn to utilize new technology, how the environment can affect their health and how PEMs can assist in improving their health and the environment. By being citizen scientists and using different PEMs, students learn the different information quality of devices and how to interpret the different types of information instruments provide. With this knowledge, students are able to appropriately use a PEM to help them understand their personal environment, improve their health and help others understand PEMs and the environment.

PEPPERWOOD'S TEENNAT - DIVERSE YOUTH CONTRIBUTING TO CONSERVATION SCIENCE
Sandi Funke, Michelle Halbur, Nicole Barden, Celeste Dodge, Jesse Robinson, and Lisa Micheli, Pepperwood Preserve
Pepperwood's TeenNat project empowers diverse youth to expand their scientific knowledge base, broaden their career horizons, and develop their outdoor exploration skill sets while they collect and manage critical biodiversity data. Building on the successful 2013 pilot, the project ran three days a week for five weeks in July, 2014. Using digital cameras and GPS units, 28 teen interns worked with Pepperwood educators and researchers to record and share species observations on iNaturalist.org. iNaturalist.org is a social network that enhances awareness of biodiversity and collects data for conservation planning. Field

expeditions were complemented with direct instruction as well as a gallery exhibit displaying photographs from the field.

TeenNat participants uploaded 1,043 biodiversity observations to iNaturalist.org. The observations included photos, GPS coordinates, and written notes. Of these observations 376 were vegetation, 478 were animals, and 87 were fungi. On iNaturalist.org experts are invited to clarify or confirm observations. Interns classifications ranged from the level of kingdom to species. Sixty percent of the classifications were confirmed by over twenty members of the scientific community and forwarded to the Global Biodiversity Information Facility. Interns also set up 10 long-term monitoring plots enacting the Save The Redwoods League Fernwatch protocol.

Educational outcomes were measured in a mixed-methods evaluation. Interns showed significant gains in their knowledge of native species and natural science careers. They significantly expanded their ability to name and characterize dangers found in the field while their attitudes about being in nature also significantly improved. They were also able to demonstrate skills in utilizing scientific equipment. TeenNat interns ranged in age from 13 to 18 and hailed from Sonoma, Napa, and Solano counties. 64% of the interns were Caucasian and 36% were students of color. They were recruited through multiple means including creation, translation and distribution of bilingual marketing fliers and school visits.

CITIZEN SCIENCE HACKLABS: A TEEN PROGRAMMING COLLABORATION BETWEEN THE ADLER PLANETARIUM AND SHEDD AQUARIUM
Kelly Sutphin-Borden, Adler Planetarium; Wade Berger, Shedd Aquarium; Laura Whyte, Jennifer Bundy, and Nathalie Rayter, Adler Planetarium

Advances in technology and communication have enabled scientists to utilize the power of individuals to increase knowledge of the natural world through the power of citizen science. These decreasing barriers for access mean young people have the opportunity to directly contribute to scientific research. From October 2014-February 2015 the Adler Planetarium and Shedd Aquarium, two of Chicago's foremost cultural institutions, are partnering to offer Citizen Science HackLabs: Data in Difficult Places to directly engage youth in the processes of citizen science.

This program, comprised of four workshops and a culminating hackathon, centers on engaging teens around the impact of citizen science on current scientific advances and research potential. Workshops will combine experiment design with data collection, analysis, interpretation, and visualization. Participants will use digital and physical tools for data collection and analysis while collaborating with peers to analyze and interpret data. The workshop series will culminate in a hack day—a daylong competition where teams of participants utilize skills gained from the workshops to solve a real-world problem of how to get "Data from Difficult Places: Dark, Deep, and Dangerous."

The Shedd and Adler each bring their unique scientific content expertise to this program. Shedd-hosted workshops will focus on aquatic science with Shedd Conservation and Research scientists present to act as science mentors. The Adler, home to Zooniverse citizen science project development staff and an active astronomy department, will leverage web development and space science content expertise. In addition to these institutional staff, STEM mentors who are professionals in technology and science industries will be available at Adler-hosted workshops to work with young people.

This talk will overview the collaboration between the Adler and Shedd, including workshop design models, lessons learned from the first iteration of the program, and program outcomes.

DRIVEN TO DISCOVER: USING CITIZEN SCIENCE AS A SPRINGBOARD INTO SCIENCE INVESTIGATIONS
Andrea Lorek Strauss, University of Minnesota Extension; Rob Blair and Katie-Lyn Bunney, University of Minnesota

Citizen science programs invite the public to participate in scientific research. Through these experiences, participants learn scientific data collection protocols and have opportunities to observe nature, which naturally leads to asking questions about the natural world. The structured observations that are part of many citizen science projects can thus provide a springboard for full engagement in the process of science. However, participants often lack the skills and experience to conduct research that will address their

questions. The Driven to Discover project, funded by the National Science Foundation, is training leaders of youth groups to use citizen science experiences to stimulate curiosity and inspire motivation to design and carry out scientific research projects. We will describe the program model and methods used to foster authentic inquiry in youth age 10-14 outside the traditional school setting, such as 4-H clubs, scout groups, or community youth programs and preliminary evaluation results related to youth and adult knowledge and attitude changes.

While our most successful group leaders combined a strong science background with experience working with youth, leaders who had either a science background or experience with youth were also successful. Training methods were developed to strengthen adult leader science knowledge and skills as well as understanding of critical concepts for effectively working with youth. The Driven to Discover program has thus bridged the scientific and educational goals of citizen science. By designing and carrying out their own projects, youth and adults alike gained a greater understanding and appreciation for science, and see themselves as scientists.

CITIZEN SCIENCE CAMERA TRAPPING AS A GATEWAY TO MAMMAL ECOLOGY AND STEM CAREERS
Stephanie Schuttler, North Carolina Museum of Natural Sciences; Kelsie Armentrout, Hilburn Academy; David Glenn, Burgaw Middle School; Dayson Pasion, Graham Middle School
Traditionally, K-12 science classrooms have largely used cookbook-type lesson plans where students conduct experiments with an expected outcome. Our goal as scientists and educators was to develop lesson plans that incorporate real research on local mammal communities as part of the Students Discover program. Students collect data with camera traps, archiving raw results with eMammal, a citizen science camera trapping research project. By working with citizen scientists, eMammal has collected a large range of data, providing a rich set of comparisons with school groups. Camera traps are ideal for student science classrooms because the species recorded by these cameras can be verified by eMammal experts. Through the Students Discover program, the citizen science process is taken even further, by allowing students to ask original and authentic scientific research questions. Three teachers from North Carolina public schools participated in a three-week externship with scientists to learn the scientific research process of eMammal and developed four lesson plans integrating the latest national and state science standards. The implementation of these lessons will result in peer-review quality scientific research, while also providing structure for teachers to allow for scaling across the state and soon nation. Finally, we are extending two of the lesson plans for use in cross-cultural classroom learning between schools in North Carolina, Mexico, and India. All lesson plans will be available for other schools, and accompanied by instructional videos. The data collected by students, and research questions addressed in lesson plans ,will be used by scientific publications extending to our knowledge of mammal ecology. We hope that the excitement of studying charismatic animals through camera trapping will not only motivate students to expand our knowledge of mammal ecology, but also engage them in the scientific process and encourage more to pursue a STEM career.

11:50am-1:10pm
Session 2D　　Lower Level 220D
Panel: Tackling Grand Challenges and Everyday Problems with Citizen Science

THE CROWD & THE CLOUD—USING BROADCAST AND SOCIAL MEDIA TO ADVANCE AND SUPPORT CITIZEN SCIENCE
Geoff Haines-Stiles (Session Chair), PI, THE CROWD & THE CLOUD; **Waleed Abdalati**, CIRES, University of Colorado Boulder, and Host, CROWD & CLOUD; **Erna Akuginow**, Passport to Knowledge/GHSPi; **Darlene Cavalier**, SciStarter, Science Cheerleader, Arizona State University, *Discover* Magazine; **Rajul Pandya**, Thriving Earth Exchange, American Geophysical Union (AGU); **Alexis de Belloy**, Skoll Global Threats Fund
A November 2013 workshop on "New Visions in Citizen Science" at the Wilson Center concluded with a series of recommendations as to next steps, including (1) raising the visibility and impact of citizen science (CS); (2) broadening participation and lowering barriers to entry; and (3) developing and deploying training

materials, including "success stories." THE CROWD & THE CLOUD project (C&C), supported by NSF, is an ambitious transmedia initiative addressing each of those challenges. C&C includes 4 hour-long public television programs to air in Fall 2016, innovative social media resources, including a custom-designed 2nd screen app to help turn "viewers into do-ers," and external evaluation to address the questions, "How, where, when, why and with whom can media, both broadcast and online, generate greater and deeper involvement in citizen science?" This session addresses conference Themes 1, 2 and 4 and invites creative collaboration by attendees in C&C's work relatively early in project development.

Panelists will include C&C Principal Investigator, Geoff Haines-Stiles; former NASA Chief Scientist, Waleed Abdalati, now director of CIRES, UC Boulder and host of the TV specials (on Big Science and the democratization of research); Darlene Cavalier, founder, Science Cheerleader and SciStarter (on maximizing awareness of innovative CS projects); Rajul Pandya, Program Director of AGU's Thriving Earth Exchange (on engaging underserved communities in CS); and Alexis de Belloy, Entrepreneur in Residence, Skoll Global Threats Fund, on SGTF's support of participatory surveillance and "crowd-sourcing" for public health initiatives such as "Flu Near You." This diverse panel will discuss C&C's assumptions about how media—old and new—can mobilize broader awareness of, and greater participation in, CS by the public, and acceptance by professional researchers. It will present planned program content and invite feedback and new ideas, and the audience will even have a chance to boo or cheer episode working titles!

11:50am-1:10pm
Session 2E   230A
Talks: Best Practices for Designing, Implementing, and Managing Citizen Science Projects and Programs

EVALUATING THE USE OF CITIZEN SCIENCE DATA FOR DETECTING TRENDS IN CLIMATE-SENSITIVE WILDLIFE
Jami Belt, Glacier National Park, Crown of the Continent Research Learning Center
Wildlife in alpine and subalpine landscapes are expected to feel the pressure of climate change sooner than their low elevation counterparts. Each year since 2008, citizen scientists have hiked hundreds of miles into Glacier National Park's high country to look for mountain goats (*Oreamnos americanus*) and American pikas (*Ochotona princeps*), two species that may serve as sentinels for changes in these mountain climes. American pikas are sensitive to temperature increases and may be pushed out of their historic range. Counts of mountain goats, a notoriously difficult to study species due to the rugged terrain they inhabit, are declining throughout their range, but little is known about how resilient the species may be to climate change. Our small army of over 150 volunteers each year has provided a large amount of baseline information about mountain goats and pikas, a much-needed starting point for tracking future changes. To understand how well these population and distribution estimates can serve as an early warning signal, we needed to compare them citizen science estimates to data gathered by more traditional methods (surveys by biologist and aerial surveys). In mountain goats, although detection by biologists was significantly higher and less variable than that of volunteers, the two population density estimates overlapped and population estimates by volunteers were more similar to those from aerial surveys. For pikas, biologists were more consistent at identifying and finding pika signs than volunteers, but volunteers could reliably detect pika site occupancy. Our findings have informed changes to our mountain goat trend monitoring in Glacier and changes to pika monitoring protocols across a network of western national parks. These evaluations underscore the value of testing data quality and adapting protocols before embarking on a decade or more of monitoring to detect population level changes in wildlife.

SUPPORTING QUALITY ASSURANCE FOR CITIZEN SCIENCE OBSERVATIONS OF PLANTS AND ANIMALS
Clemens Jacobs and Alexander Zipf, Heidelberg University, Germany
For citizen science observations of plants and animals, quality assurance is a vital issue. In many cases, experts check reports, judging the plausibility of observations based on their own expert knowledge, but also using spatial and temporal context information. In fact, earlier observations that were reported to the

same project or to other projects are a valuable source of context. Was the species observed at or near the same place before? What other species were reported at that place? Are there reports from the same time of year? Questions like these can be answered not only by humans, but also by computers that have the necessary data and analysis methods available. We followed exactly this path to build a decision support system designed to help experts make sound decisions about acceptance or rejection of species observations reported by volunteers to online portals. When triggered by an expert for a certain new observation, the application analyzes existing, certified reports, using as parameters the new observation's properties (species, date, place and reporter). The application then produces a dossier of information for that observation, including an estimation of the observer's degree of expertise, a visualization of the observation's date, and results of spatial analyses (looking at the species reported close to the observation). This talk will present important lessons learned from the use of this tool for checking species observations in a German citizen science portal, which are subsequently employed for administration and planning purposes. An outlook is given on advanced methods for (semi)automatic estimation of plausibility for citizen science species observations that are currently being developed and examined in depth in a research project at Heidelberg University (GIScience Group, Department of Geography).

THE IMPACT OF INTELLECTUAL PROPERTY LAW ON ACCESS TO, DISSEMINATION AND USE OF CITIZEN SCIENCE RESEARCH

Teresa Scassa and Haewon Chung, University of Ottawa, Canada

The term "citizen science" can be used to describe a very broad range of activities in support of scientific research. Bowser and Shanley have defined it as "a form of collaboration where members of the public participate in scientific research to meet real world goals" (Bowser & Shanley, 2013, 45). As with many other definitions of citizen science, the primary relationship appears to be that between the members of the public who participate, on the one hand, and the researchers on the other. Yet the relationships are infinitely more complex, particularly when they are considered in terms of rights to access, disseminate and use the research output. The web of relationships common to science research include (but are not limited to) those between researchers and their institutions; researchers and their funders; researchers and participants; researchers/participants and the technological platform used to carry out the project; and researchers and the journals that publish research results.

The rights to access, disseminate and use the output of scientific research are intrinsically tied to the law regarding ownership of intangible intellectual property (IP). Ownership of IP rights is, in turn, affected by different relationships and how they are structured. In this presentation we explore 1) how ownership of all or parts of citizen science research projects may be determined by IP law; 2) where ownership rights are located; 3) how ownership is negotiated at different stages of the development and execution of citizen science projects; and 4) what the consequences of IP rights, their location, and their negotiation, have on rights to use, share or access research results.

KEEPING IT REAL: MANAGING CITIZEN MONITORING PROGRAMS FOR THE COLLECTION OF ACTIONABLE DATA CONCERNING WATER QUALITY AND WATERSHED MANAGEMENT

Erick Burres, Clean Water Team

Citizen science offers communities the chance to "share the economy" when it comes to water quality watershed management. Through citizen science projects, crowdsourcing and strategic partnerships, large useful datasets can be created through the efforts of many. Ensuring data collected has value towards understanding real environmental conditions, pollution source identification, will empower informed management decisions and is scientifically objective should be of primary importance for monitoring programs interested in producing actionable data. The Clean Water Team has assisted hundreds of programs to ensure that the data they collect is of known value and relates directly to answering their questions of interest. The Clean Water Team's approach to "Keeping it Real" relies on question formulation, data needed to answer that question (regulatory and/or environmental), data quality requirements and program costs (including volunteer skill levels) required to obtain the data needed, re-evaluation and adaptive alignment of program support and data, and the consideration of adding value so

data may be used beyond the program's primary question of interest. Our approach supports the formation of monitoring plans, Quality Assurance Project Plans (QAPP), training manuals, health & safety communication, information management & sharing, and project reporting. Data collected by citizen scientists through this approach have been successfully used by communities, scientists, and agencies for environmental and regulatory applications, to improve and protect water quality and environmental conditions.

IDENTIFYING SEVENGILL SHARKS IN SAN DIEGO WITH WILDBOOK
Barbara Lloyd and Michael Bear, Ocean Sanctuaries.org; Jason Holmberg, http://www.wildme.org/wordpress/
Our goal is to attempt the identification of Sevengill sharks (*Notorynchus cepedianus*) that may be returning to San Diego from year-to-year, using the pattern recognition algorithm provided in "Wildbook," a web-based application for wildlife data management, designed by Jason Holmberg. "Wildbook" has been successfully used to ID Whale Sharks (*Rhincodon typus*) by their spotting patterns.[1, 2]
Sevengill sharks (*Notorynchus cepedianus*), are currently listed as Data deficient (DD) on the IUCN Red List: This assessment is based on the information published in the 2005 shark status survey (Fowler et al. 2005).[3]
The genesis of this project was the *apparent* increase of encounters and sightings reported by divers with this species in the San Diego area, from 2009 to the present, to provide a long-term population dynamics study to examine the possible reason for this, as well as to provide a baseline study for future researchers. For specifics on our methodology, please see here: http://sevengillsharksightings.org/our-methodology-introduction/
[1] http://www.whaleshark.org/
[2] http://www.wildme.org/wildbook/doku.php
[3] http://marinebio.org/species.asp?id=1521

11:50am-1:10pm
Session 2F   230B
Talks: Broadening Engagement to Foster Diversity and Inclusion

BIODIVERSITY PEEK: FOR GLOBAL CITIZEN SCIENTISTS
Stephanie "Jo"Bowman and Paul Hamilton, The Biodiversity Group
Biodiversity PEEK (Photography Educating & Empowering Kids and their Communities) is the international citizen science program of The Biodiversity Group. We provide equipment and train local adult mentors to work with youth to use digital cameras as a means to explore and digitally document the overlooked, threatened flora and fauna around them. Biodiversity PEEK strives to increase the rate of literacy of both computers and the written word, as well as feelings of empowerment, and regenerative lifestyles, all while raising awareness and appreciation of local conservation concerns in the often impoverished communities where we work; from Ecuador to Vietnam to Mexico. And, Biodiversity PEEK is scalable and adaptable to other communities and organizations around the globe. Biodiversity PEEK is a hands-on, place-based program that satisfies these outreach objectives:
• To collect data in the field at our research sites year-round, as opposed to just interval research trips.
• To give real, concrete assistance to the educationally, economically, and technologically impoverished communities at our study sites; knowing that people can only afford to take care of their wild places if their own human needs are met first.
• To help develop a relationship between local people and their neighboring ecological reserves; run by organizations with whom we partner in the field.
• To be both place-based and international in function; something carried out on a local level around the world, extending to places where we do not have a physical presence.
Our talk will give you the basics of how Biodiversity PEEK works for us, show you how it can work for you, and "wow" you with some of the incredible photographs from our international, local participants!

BLENDED ENGAGEMENT WITH NATURAL HISTORY: BUILDING iSPOT'S CITIZEN SCIENCE COMMUNITY

Janice Ansine, The Open University, UK

http://www.iSpotnature.org is an Open University (OU) award-winning citizen science initiative. Since its launch in 2009 millions of people have been engaged through their interest in wildlife, helping them identify species using a system that connects novices to experts. Co-created, iSpot enables the public to participate in scientific research through crowdsourcing species names and uses a combination of communication, engagement and learning opportunities, both formal and informal, to reach a wide and diverse audience taking them on a unique learning journey around biodiversity.

Up to end of 2013, iSpot Biodiversity Mentors helped the public, many considered 'hard to reach', to engage with the natural world through events and activities across the UK reaching over 80,000 people leading hands-on activities such as bug hunts, bat walks, pond dipping, rock pooling etc. creating links with community groups and organisations many who now use iSpot to facilitate their own engagement activities. iSpot also contributes to learning opportunities and the OU's Futurelearn Introduction to Ecosystem MOOC (Massive Open Online Course) uses the website as part of the students learning activities and in the first presentation over a fifth of those on the course were also registered and using the site. OU / BBC radio and TV co-productions also take iSpot into millions of households; while media stories about interesting finds such as the story of 6 year old Katie finding a rare moth not seen in Europe before, reached an estimated audience of over 3.5 million resulting in 7,000 visits to iSpot during October 2009 alone.

This presentation will share the blended engagement model that has been used in the development of iSpot to date, and the contribution this has made to its success.

SCIENCE OF THE CITY: FROM THE STREET TO THE LAB

Ramon Sangüesa (Director of Research), and Irene Lapuente (Director), La Mandarina de Newton SL, Barcelona, Spain

Science of the City (scienceoftheciyt.net) is a four-year project organized by La Mandarina de Newton with the support of the Spanish Foundation for Science and Technology. It engages citizens in finding the science in their cities and to become actual scientists by proposing research questions, hypothesis, gathering evidence and performing experiments. It also invites them to use the web and audiovisual forms of expressions to communicate their interests and findings. We describe how the project has evolved from a participatory approach to a Responsible Research and Innovation project that eventually put into contact individual citizens with research groups. In this way, the research groups started new lines of research that were of interest to citizens. Conversely, citizens actually collaborated tightly with researchers and got a first hand experience in the process of research and science in general. We will show how the design approach we used in the preparation of the whole process has been the key to go beyond crowdsourding and into actual "communication by doing together" in the true spirit of citizen science.

COLLABORATIVE SUSTAINABILITY SCIENCE: AN EXAMPLE FROM BARBUDA

Rebecca Boger and Sophia Perdikaris, Brooklyn College, CUNY; Jen-I Costosa, CUNY Graduate Center; John Mussington, Barbuda Research Complex, Antigua and Barbuda

Barbuda, West Indies is a semi-arid, small island developing state that has rich history of resilience and sustainability despite the socio-economic and environmental challenges people living there have faced. However, now Barbudans are largely reliant on food, water and other necessities while archaeological remains are degrading and the environment is being impacted by climate change (e.g., sea level rise, changing hurricane and drought patterns, coastal erosion). To overcome the lack of government sponsored environmental monitoring and cultural preservation efforts, an interdisciplinary team of archaeologists, anthropologists, and geoscientists are working closely with US undergraduate and graduate students, along with Barbudan experts and high school students to document cultural remains and assess the state of environmental resources on the island. This collaboration is made possible through

an NGO, the Barbuda Research Complex. Our research approach integrates traditional ecological knowledge (TEK) with western science to take a long-term perspective and assessment of the present situation. Methods used for data collection are varied and include kite and unmanned flight air photography, GPS mapping, water and soil testing, surveys and focus group discussions. Of particular interest is the involvement of and impacts on youth who comprise about half of the population. Barbudan youth work closely with university faculty, US undergraduate and graduate students, and Barbudan experts. Citizen science is being incorporated into the high school curricula; this makes learning more relevant, fosters intergenerational learning, empowers youth with valuable technical and critical thinking skills, and promotes cultural identity. Together, this collaboration is building a robust dataset while enhancing the capacity of people to address the challenges being brought about by climate change.

BIRDS HITTING BUILDINGS: HERDING SCIENTISTS, ARCHITECTS, AND BIRDWATCHERS TOWARDS THE SAME GOAL

Sami Nichols and Rob Blair, University of Minnesota

Project BirdSafe is a joint effort of multiple organizations to reduce the number of birds killed or injured when they collide with structures in the Twin Cities of Saint Paul and Minneapolis. A major component of this effort is a citizen-science based research project to determine what species of birds are most adversely affected by bird-building collisions, what features of buildings lead to increased bird mortality, and during what times of year the birds are most at risk. To answer these questions requires the interaction and cooperation of three different groups of people who are motivated by the same goal (Save the birds!) but come from very different disciplines and backgrounds: scientists, architects, and birdwatchers. In this presentation, we explore the ways that these three groups approach the issue, their proposed solutions, the reasons for their involvement, and the barriers that had to be overcome to craft a single, citizen-science project. We, as the scientists on the project, will describe our efforts and offer suggestions on how to work with these multiple constituencies in a manor that results in good science, good design, and good conservation.

11:50am-1:10pm
Session 2G   230C
Talks: Tackling Grand Challenges and Everyday Problems with Citizen Science

ENGAGING CITIZENS FOR BIODIVERSITY EXPLORATION: A CASE STUDY IN THE BAY OF BISCAY BASED ON FAMILY PHOTOGRAPHS

Eduardo Dopico and Eva Garcia-Vazquez, University of Oviedo, Spain; Ricardo Fernandez, Consejeria de Educacion, Asturias, Spain

Scientists report accelerated changes in marine biodiversity on the last decades. However, the real extent of such changes cannot be properly estimated due to the lack of a reliable baseline covering the last century. In the coast of Asturias (North of Spain, Bay of Biscay) documented information about biodiversity prior to 1980 is very scarce and fragmented, in absence of systematic monitoring. However most families conserve old photographs taken from a short distance that document children playing amid seabirds, grabbing small animals from the rock pools, and other moments when not only the persons but also the environment is protagonist. Here we present an experience where volunteers have found old family photographs and returned to the same places on the coast for taking new photographs again from the same perspective. They were involved in image analysis and biodiversity measurements, as well as in the process of statistical analysis between past and present biodiversity indices. This activity allowed to quantifying coastal diversity changes occurred in the region during the last century and to starting an archive of photographic materials for purposes of biodiversity studies. More importantly, it was the seed for creating a very motivated group of volunteers engaged in marine environmental monitoring and conservation.

USING CITIZEN SCIENCE TO EVALUATE THE CULTURAL VALUE OF BIODIVERSITY

Gianfranco Gliozzo, Extreme Citizen Science (ExCiteS) Research Group, University College London (UCL), UK; Elizabeth Boakes, Faculty of Life Sciences, UCL; David Roy, CEH, Centre for Ecology and Hydrology, Oxford; Muki Haklay, ExCiteS, UCL; Chloe Smith, Greenspace Information for Greater London, UK
Biodiversity provides a cultural ecosystem service by enhancing people's lives both actively and passively, for example, via bird-watching or walking through a park. Recreational benefits of biodiversity are now recognised to be both significant and undervalued. Access to greenspace has been shown to have many positive impacts on human health and well-being but more research is needed to understand the specific components of natural environments that are responsible. Identifying the aspects of biodiversity perceived by the public as most valuable would allow us to track their changing status and incorporate their stocks into decision-making thus ensuring their contribution to human wellbeing is not lost. Biodiversity's value to people is difficult to assess because the beneficiaries are acting as individuals, differently motivated and scattered across the country. Citizen science approaches offer an ideal means to gather data, not only on biodiversity itself, but also on people's motivations for encountering it. We use citizen science records as metrics for evaluating the cultural value of biodiversity. We assume that the effort to record an observation reflects the value of the recorded species and that volunteering is a contribution to wellbeing. We use the composition of citizen science data collected across the London boroughs of Camden and Westminster as a case-study to explore which components of biodiversity have the most value to people (e.g. colourful, rare, native, easy to spot/birds, butterflies, flowering plants etc.), where biodiversity provides the most value (e.g. garden, park, urban street) and when (e.g. season, weekend).

An understanding of how the cultural value of biodiversity varies with taxon and environmental setting has high relevance for urban planning and natural capital accounting. It will also allow us to build models of volunteer behaviour, hence facilitating the most appropriate use of citizen science in biodiversity monitoring.

COMBINING CITIZEN SCIENCE AND DNA-ASSISTED SPECIES IDENTIFICATION TO ENABLE "A NEW KIND OF ECOLOGY"

Karen James, MDI Biological Laboratory

Climate change is shifting species' geographic ranges, patterns, abundances, seasonal activities, and interactions with other species. Understanding, predicting, and managing how species respond to climate change and other environmental changes is a critical challenge in environmental biology, which will require what Georgina Mace called "a new kind of ecology…predicated on scaling up efforts, data sharing and collaboration." Collection of these kinds of data typically requires the identification of biological specimens; yet, that task is difficult and labor-intensive, and is compounded by a dearth of taxonomic expertise—the "taxonomic impediment." Citizen science is proposed—and has in some cases been successfully implemented—as a mechanism for expanding the scientific workforce to address difficult, large-scale or computationally intensive ecological research questions. Unfortunately, training citizen scientists to accurately identify most organisms is, like the task of identification itself, prohibitively time-consuming. Thus projects that engage the public in identifying biological specimens, including "bioblitzes," still rely heavily on professional taxonomists to identify collected specimens, and the taxonomic impediment remains in place. Automated identification tools that use morphology (e.g. Leafsnap), sound (e.g. Song Scope) and other characteristics, and online crowd-sourced photo identification services (e.g. iNaturalist, iSpot), are already being used to help citizen scientists identify unknown specimens. DNA-assisted species identification ("DNA barcoding" and related techniques) can complement these tools to empower researchers and citizen scientists alike to accurately identify organisms and enable transformative increases in the scope and scale at which ecology and biodiversity science are done. In this talk, I will introduce, explain, and demonstrate DNA barcoding for specimen identification, and discuss its potential and implications for citizen science and environmental science.

BEYOND TRANSCRIPTION: REALISING THE RESEARCH POTENTIAL OF MUSEUM SPECIMENS THROUGH CITIZEN SCIENCE

John Tweddle, Mark Spencer, and Lucy Robinson, Natural History Museum, London, UK
Technological advances are making a new generation of natural history museum—the digital museum—increasingly possible. Digital technology offers the exciting prospect of making the information contained within the world's vast natural history collections freely available online, to a truly global audience. This has the promise to revolutionise how museum collections—and the long time-series biodiversity archive that they contain - can be used to generate new understanding of the natural world and address some of the key questions facing the future of biodiversity, including the impacts of environmental change.

To support this enormous endeavour, museums are increasingly utilising a citizen science approach to help digitize specimen information, for example by asking volunteers to help transcribe collecting data from specimen labels and registers. This typically takes the form of online crowdsourcing via a web platform, with the organisation concerned choosing and uploading the dataset to be worked on. A growing number of innovative transcription-based projects are available and whilst knowledge gaps remain, the benefits of this form of citizen science to the organisations and citizen scientists involved are increasingly understood.

But can museums move beyond employing such citizen science approaches primarily as means to support the digitisation of specimens for future research use, to models through which participating volunteers are able to directly contribute to this research activity? Could this provide a richer experience for scientists and volunteer participants alike?

In this presentation we explore potential future directions for natural history specimen-based citizen science. We illustrate the talk with examples from the UK, including a new co-created project through which museum scientists and volunteers, amateur naturalists and the online community are working together to investigate the impact of climate change on the UK's charismatic and botanically important orchid populations.

ACTING LOCALLY AND THINKING GLOBALLY: BUILDING REGIONAL COMMUNITY AROUND CITIZEN SCIENCE TO BROADEN IMPACTS AND TO CREATE A SCALABLE MODEL
Alison Young and Rebecca Johnson, California Academy of Sciences
The mission of the California Academy of Sciences is to explore, explain, and sustain life. Our museum inspires visitors about the natural world, while our scientists document biodiversity and discover new species in hotspots around the globe. Our citizen science program combines science learning with research, empowering the public to do the same type of work as our scientists, while engaging communities to answer real research questions and connecting people to biodiversity all around them.

To broaden the impacts of our citizen science work, the Academy has actively tried to build and cultivate local community and partnerships around citizen science, striving to create a model of networked biodiversity citizen science and research in San Francisco and the Bay Area that can be scaled globally. Through face-to-face citizen science programs, we are connecting with the public, building understanding of local biodiversity as well as connection to place that can lead to stewardship. With iNaturalist.org, we are fostering both a local and a global network of volunteers and professionals working together to tackle pressing biodiversity and conservation challenges. Through our local efforts and via global outreach, we are encouraging people to document the organisms they see in their everyday life, to help answer research questions, and to come together in "bioblitzes" of parks and open spaces – all with iNaturalist and their smartphones. Strong partnerships with management organizations and local government ensure data collected through our citizen science efforts support both research and conservation outcomes. We have also organized a coalition of citizen science practitioners in the Bay Area to further best practices and research in the region. It is our goal that the collective impact of these efforts will advance biodiversity understanding and conservation locally, and provide a scalable model that can be enacted in other regions around the globe.

1:10-2:30pm
Ballrooms 220B and 220C
Networking Lunch

2:40-4:00pm
Session 3A   Lower Level 20A
Speed Talks: Across Conference Themes

INDIGENOUS PEOPLES AS CITIZEN SCIENTISTS
Simon Lambert, Lincoln University, New Zealand
Indigenous Peoples hold important knowledge of their environments. This ancient knowledge is increasingly sought as data for a variety of scientific disciplines and practices including environmental management, ecology, ethnobotany, fisheries, forestry, and disaster risk reduction. Many Indigenous communities are not opposed to working with scientists and various international conventions have articulated a role for Indigenous knowledge, particularly traditional ecological knowledge. However, the history of much 'collaboration' has created significant barriers to progressing truly inclusive Citizen Science in many countries. Examples from Aotearoa New Zealand will be discussed to show that empowering Indigenous individuals and collectives as Citizen Scientists will require an acceptance of possibly radically different worldviews as well as the acknowledgement of broader issues of justice and ethics.

PARK USER CHARACTERIZATION FOR INCREASING AND INSIGHT INTO CITIZEN ENGAGEMENT
Daniel Clark, Rutgers University
A number of environmental and health issues can be better resolved through partnerships between citizens and scientists. A key factor in obtaining shared citizen science outcomes is engagement with the public and bringing together citizens, stakeholders, researchers, and policy-makers. We carried out surveys judging attitudes about the environment as well as gauging the knowledge and literacy toward the environment with a focus on park and greenspace use.
These data have allowed us to broadly characterize different types of park and greenspace users. Not surprisingly we found a strong correlation between education and financial status. However, factors such as pet ownership and parenthood also have a substantial impact on responses. Using multiple correspondence analysis, we were able to link these characteristics with distinct preferences for certain park features and motivations for use. This means that different people from similar locations would be more or less likely to engage in projects depending on the type of project, and may be engaged different ways. Our data provide insight into how groups and stakeholders may engage in environmental education or citizen science. Furthermore, spatial analysis indicates park exposure and distance are important variables.
Our characterizations have implications for how to engage the public in citizen science projects involving climate change, public health issues such as obesity, and through what means to engage citizens. Persons living the same distance from the same park may have different conceptions of citizen generated data based on a number of these factors and can therefore play an important role in data quality and data gathering.

CITIZEN SCIENCE: POTENTIAL TO BREATHE NEW LIFE INTO A COSTA RICAN NATIONAL PARK
Tera Dornfeld, University of California, Irvine
In Playa Grande, Costa Rica citizen scientists have collected ecological monitoring data for decades. Data inform conservation strategies for leatherback sea turtles (*Dermochelys coriacea*). These data have proven important because they have demonstrated that Playa Grande holds the largest nesting population of leatherback turtles in the Eastern Pacific Ocean. Data also revealed that factors including poaching and coastal development decreased the turtles' population size. To protect the turtles, the Las Baulas Marine Park (PNMB) was formed and poaching was prohibited. Capitalizing on Costa Rica's eco-tourism success, former poachers were trained as turtle tour guides. Turtle tourism and the protected beach facilitated employment and concurrent immigration of Nicaraguans and North Americans. However, this immigration has placed development pressure on PNMB, including legislative action to downgrade its protective status. Currently, beyond the threats to turtles, PNMB may also be undervalued by local residents. To increase PNMB's perceived importance, scientists proposed increasing local peoples' interaction with

PNMB. One option was participation in turtle monitoring. However, few local residents assist in monitoring as these efforts are conducted almost exclusively by foreign volunteers though the Earthwatch Institute. My doctoral research thus focuses on how to engage local residents in expanded PNMB monitoring efforts. Specifically, I aim to use Participatory Rural Appraisal (PRA) as the first step towards co-management of PNMB. By conducting park surveys local residents could identify their unique park usage, discover potential for improved use of PNMB, and reveal any similarities and differences of usage among diverse residents. Through these efforts PNMB could be better suited to local needs and residents might place a greater value on the park. Therefore, PNMB would be safeguarded against future attacks on its park status and would remain a refuge for turtles. I seek insights from the citizen science community to understand PRA's potential in PNMB.

THE DORNSIFE CENTER FOR NEIGHBORHOOD PARTNERSHIPS: BUILDING A FRAMEWORK FOR COLLABORATIVE INQUIRY
Jennifer Britton, Drexel University
Drexel University's Dornsife Center for Neighborhood Partnerships is a newly established urban extension center designed to foster creative and collaborative relationships between Drexel University's students and faculty and residents of the two neighboring communities of Mantua and Powelton Village. The Dornsife Center offers an infrastructure - space, promotion, local networking - for researchers at the university to connect with neighborhood residents in a number of ways, including as research partners. Part of the Dornsife Center's mission is to share the university's knowledge resources with surrounding communities, and to create more coherent platform from which faculty can conduct participatory and community-facing research projects. Where academic integration is concerned we are creating organizational structures to support radically participatory work that engages residents of these two diverse neighborhoods that have been long estranged due to barriers of race and class. Projects like the multidisciplinary CORE Lab and the Community Lawyering Clinic are meant to invite the university's neighbors as thought partners, not just focus group subjects, in the process of research and inquiry. This talk gives an overview of the Dornsife Center's work, successes, and challenges.

ENGAGING A DIVERSITY OF CITIZEN SCIENTISTS AROUND URBAN TREES IN GREATER LOS ANGELES
Mark Chandler and Gitte Venicx, Earthwatch Institute; Darrel Jenerette and Sheri Shiflett, University of California Riverside
Cities are growing and changing with climate change, increasing human population density, emerging diseases, pests, and health concerns. How can we engage a diversity of people to study how designing nature back into cities can create a more livable urban environment for all?
Within a large urbanized region such as Los Angeles, the impact of climate change and the urban heat island can vary substantially and underserved communities are often the hardest hit. Trees reduce temperature by shading the ground and buildings beneath them and via evapotranspiration from leaves. One promising area of research is to understand the link between urban cooling benefits to tree patterns including tree growth and diversity of leaf traits including nitrogen content and the ratio between size and weight. Aerial imagery collected by NASA is providing information about ground temperature and vegetation cover, but on the ground collection of tree species, size and leaf chemistry is essential to ground truthing the models and developing guidelines about which trees to plant to optimize ecosystem services provided to neighboring communities.
To understand the variability across greater Los Angeles in tree cover, a coalition of willing partners worked together to engage a diversity of citizen scientists to collect the data within a narrow time frame. This network of diverse partners successfully leveraged their membership base of diverse individuals to collect information from Reseda to the San Gabriel Valley. Participants included high school students, boy scouts, and corporate employees in disadvantaged towns in the San Gabriel Valley led by AMigos de los Rios. The Natural History Museum of Los Angeles and TreePeople reached out to the respective member bases to recruit participants in parks in LA, and their families from Heschel Day School collected data in Reseda. Networks of citizen science can be mobilized to great effect.

MAD EVALUATION: STRATEGIES AND LESSONS LEARNED IN THE DAUNTING WORLD OF EVALUATION FOR YOUTH-BASED PROGRAMS
Amy Dean, Farallones Marine Sanctuary Association
Because of the diverse nature of the field, there is no "correct" or "standard" approach to citizen science evaluation. However, the recent development of evaluation toolkits are helping practitioners get a handle on how best to design, implement, collect and assess data. These toolkits may help to advance the field considerably, making possible the collection of large volumes of quantitative data and ultimately increasing our understanding of long-term impacts to participants.
However, a challenge for many citizen science practitioners, many of whom are often working in the non-profit realm, still remains. Organizations with very few resources often find evaluation operationally challenging and daunting. Our goal is to share both the absurd and rational perspectives of one youth-based citizen science program, LiMPETS, in overcoming the challenges of conducting evaluation in a resource-limited environment. We will provide information on what challenges we've experienced in developing goals and an evaluation framework for our citizen science work, what operational approaches work best for a small budget and few staff, and what we think can be done to help make evaluation more effective for the LiMPETS program and the broader field.

WHO GENERATES BETTER DATA: GROUP MEMBERS, OR INDIVIDUAL PARTICIPANTS?
Theresa Crimmins, Alyssa Rosemartin, and Lorianne Barnett, USA National Phenology Network
The primary goal of many citizen science programs is to collect data of sufficient quality and quantity to support scientific research. As such, it is critical to understand the most effective means of engaging volunteers. Using six years of data from a national-scale biodiversity monitoring program, we compared the efficacy of two ongoing models of participation -- Independent Participation and Local Project Participation – on several metrics: number of volunteers engaged, data quantity per participant, within-season activity level, and long-term participant retention.
The USA National Phenology Network (USA-NPN) fosters two models for engaging observers in the citizen science program, Nature's Notebook. The standard model is Independent Participation (IP), wherein individuals learn about and participate in Nature's Notebook independent of any other group. An alternative model, Local Project Participation (LPP), represents a rapidly growing segment of Nature's Notebook wherein observers participate as part of a locally or regionally organized group. Organizations including nature centers, arboreta, colleges, Master Gardener chapters, and land trusts have established such local phenology projects. All IP and LPP participants receive regular support and communication from USA-NPN staff. LPP participants typically receive additional communication and support from their local project coordinator.
The LPP model results in more observations per participant and greater retention into the second year than the IP model. However, the IP model yields more participants overall; within-season activity level does not differ between the two models. We hypothesize that the LPP model boasts higher numbers for some metrics because it involves more face-to-face interaction and is more locally relevant to participants. However, the IP model also represents a good opportunity to grow our data resource. Results from this formative assessment will be used to allocate resources for Nature's Notebook, and could be considered by other citizen science programs operating primarily via the Internet.

2:40-4:00pm
Session 3B   LL20B
Story Presentations across Conference Themes
   Session Chair: **Linda Silka**, Director, Margaret Chase Policy Center, University of Maine

MONARCH CITIZEN SCIENCE WITH MIDDLE SCHOOLERS: A GRADUATE STUDENT PERSPECTIVE
Kelly Nail, University of Minnesota Conservation Biology Graduate Program
For the past five years, the presenting author has engaged with a diverse group of middle school students

participating in citizen science through both an NSF-funded project, Driven to Discover, and the national Monarch Larva Monitoring Project (MLMP). As a graduate student, I have found ways to combine my biological research with the interests of these student participants. I will discuss the partnerships that resulted from this work, including microclimate research with a young MLMP volunteer and work with citizen science outreach through the national television show SciGirls.

The first partnership involved a seventh grader who became interested in the microclimate of monarch larvae and how temperature varied on different parts of a milkweed plant. While I had been working with this student through her Driven to Discover group, our overlapping research interests led to a microclimate side project. I will describe the details of our experiment, which formed the basis of a science fair project for her and provided me with valuable data for my research.

My second collaboration involved the PBS show, SciGirls. I became involved as a mentor for three diverse middle school girls. I will discuss the process of working together on the MLMP, as well as my involvement in the girls' individual science projects. My experience can serve as a model for involvement of graduate students with both youth and citizen science by focusing on these experiences as a compliment to my graduate research, rather than merely an unrelated duty.

DECODING NATURE: BALANCING STUDENT PARTICIPATION AND CUTTING-EDGE RESEARCH
Della Hopkins, Natural History Museum, London, UK
The Decoding NAture project is a unique citizen science partnership between the Natural History Museum (NHM, London) and UK schools, established in 2009. It is designed to immerse children into the life of a real scientist whilst gathering high quality publishable data. Initially, the project (then called 'Tree School') focused on investigating the floral diversity of native trees using DNA barcoding. By design, the project provided an opportunity to be involved in the entire process of data generation during week-long residential courses held at a purpose-designed science education centre.

The project has been successful in many ways, particularly the deep level of involvement for the children and the quality of data produced. However, the time frame required for this approach meant that the rate of data production sufficient for publication conflicted with the rapid progression of DNA barcoding developments.

In this session I will share our lessons learned and show how the evolution of the project over the past six years has overcome these challenges. Utilising the feedback gathered from all involved parties we have been able to achieve the ideal balance between inclusivity and the production of high quality scientific data. We have had successful results, with extensive benefits for students and scientists alike. Engaging the students in all aspects of the process enables them to become real scientists and see the relevance of their work for the environment and current research. The data collected has led to new findings with implications for taxonomy and conservation in the UK.

It is hoped that this approach will be applicable to other citizen science projects, and will encourage discussion about the merits of this concept, especially how to maximise the balance between participant learning and the volume of data generated.

DETERMINING THE WILLINGNESS TO PAY FOR ECOSYSTEM SERVICE RESTORATION: A HIGH SCHOOL CITIZEN SCIENCE PROJECT
Kristina Nicosia, West-Windsor Plainsboro School District
In this story, I will discuss a project where a high school biology teacher and her students engaged in a citizen science partnership with a local watershed group. In this collaborative citizen science project, students collected data to determine willingness to pay for ecosystem service restoration. The teacher and students maintained control of the research while scientists from a local state university and members of the watershed group served as consultants. Students, who were enrolled in an honors course, took on this project with a goal of generating useable information regarding a local environmental issue. The teacher made possible this research with the goal of integrating quantitative social and natural science data into a real life environmental problem and issue.

The result of this collaboration was a peer-reviewed manuscript and a series of presentations making data available to decision-makers involved in the restoration project. In this discussion, I will share the classroom products and discuss how this type of data collection can be balanced with a formal science curriculum to both educate and motivate students. Furthermore, I will reflect on student, scientist, and partner comments framed around opportunities and barriers to conduction authentic research in a formal high school classroom.

2:40-4:00pm
Session 3C   Lower Level 20C
Talks: Tackling Grand Challenges and Everyday Problems with Citizen Science

DEMOGRAPHIC MODELING OF CITIZEN SCIENCE DATA INFORMS HABITAT PREFERENCES AND POPULATION DYNAMICS OF RECOVERING FISHES
James Thorson, Fisheries Resource and Monitoring Division, NWFSC, NMFS, NOAA; Mark Scheuerell, Fish Ecology, NWFSC, NMFS, NOAA; Brice Semmens, University of California, San Diego; Christy Pattengill-Semmens, Reef Environmental Education Foundation (REEF)
Managing natural populations and communities requires detailed information regarding demographic processes at large spatial and temporal scales. This combination is challenging for both traditional scientific surveys, which often operate at localized scales, and recent citizen science designs, which often provide data with few auxiliary information (i.e. no information about individual age or condition). We therefore combine citizen science data at large scales with the demographic resolution afforded by recently developed, site-structured demographic models. We apply this approach to categorical data generated by the citizen-science Reef Environmental Education Foundation (REEF) Fish Survey Project, representing species density of two managed reef fishes in the Gulf of Mexico. We then use a site-structured demographic model to estimate abundance trends, habitat associations, and interannual variability in recruitment for each species. This approach identifies strong preferences for artificial structure for the recovering Goliath grouper, while revealing little evidence of either habitat associations or trends in abundance for mutton snapper. Results are also contrasted with a typical generalized linear mixed-model (GLMM) approach, using real-world and simulated data, to demonstrate the importance of accounting for the statistical complexities implied by spatially structured citizen science data. We conclude by discussing the increasing potential for synthesizing demographic models and citizen science data, and the management benefits that can be accrued.

COMMERCIAL FISHERMEN ARE CITIZEN SCIENTISTS: SOUTHEAST ALASKA SPERM WHALE AVOIDANCE PROJECT (SEASWAP): SUCCESSFUL LONG-TERM SCIENCE COLLABORATION TO STUDY SPERM WHALE AND FISHING INTERACTIONS IN ALASKAN WATERS
Victoria O'Connell, Sitka Sound Science Center; **Jan Straley**, University of Alaska Southeast; Aaron Thode, Scripps Institution of Oceanography; Linda Behnken and Dan Falvey, Alaska Longline Fishermen's Association; Lauren Wild, lwild@sitkascience.org; Joe Liddle, University of Alaska
Since 2003, the Southeast Alaska Sperm Whale Avoidance Project (SEASWAP), a collaboration among commercial fishermen (ALFA, CBSFA), academic scientists (UAS, SIO, SSSC) and fishery managers (NOAA, ADFG), has undertaken research in the Gulf of Alaska to reduce interactions between sperm whales and longline gear. The problem is the removal of fish from commercial fishing gear by sperm whales, a behaviour called depredation. This behaviour increases harvesting costs, creates risks of whale entanglement, and confounds fish stock status. Fishermen are involved in SEASWAP as citizen scientists by defining study questions, setting objectives, designing and testing equipment and representing SEASWAP at conferences. The partnership with fishermen collecting data has greatly enhanced our ability to understand the magnitude of the problem. Very little was known about the current status of the sperm whale population in Alaska and the involvement of the commercial fishing fleet greatly expanded our eyes on the ocean. SEASWAP provided logbooks and cameras to fishermen who documented interactions. Photographs aided in identification of individual whales, defining local populations of sperm whales,

providing critical new information. In 2004 SEASWAP added acoustic research when it became evident whales were using biosonar around the vessels. Fishermen were instrumental in modification of scientific equipment to make deployment of equipment practical on commercial vessels. This helped tremendously in increasing the study sample size to statistically testable levels in testing the efficacy of potential deterrents. The perspective of fishermen on whale behaviour, fishing gear mechanics, and possible solutions has been invaluable in understanding the behaviour and foraging ecology of sperm whales involved in depredation. SEASWAP is internationally regarded as having gained insights into a difficult to study problem through the engagement of fishermen as citizen scientists and we continue to pursue this partner research housed at the bioacoustics lab at the Sitka Sound Science Center.

CITIZEN SCIENTISTS AND OCEAN CONSERVATION—COLLABORATION FOR SUCCESS
Nicole Crane, Cabrillo College; Giacomo Bernardi, University of California Santa Cruz; Kristin Precoda, Oceanic Society; John Rulmal, Ulithi Falalop Community Action Program; Michelle Paddack, Santa Barbara City College
We present results from our work with autonomously governed outer island communities of Yap state, Federated States of Micronesia. These communities are on the front lines of ecological and cultural changes, and are facing declines in critical reef resources. The project is made possible through the active collaboration and involvement of citizen scientists. Participants join our team of ecologists and help collect data for the work. Each participant is evaluated for their skills and interests, and trained to collect appropriate data. The amount of data we collect is large, and there are several types of data that can effectively and accurately be collected by citizen scientists. We also get support from individuals whose areas of expertise (such as in industry or management) can help support the Project. We will present project approaches, results, and sampling designs. The sampling designs are also modified into data collection protocols for the communities in which we work, since they are essentially citizen scientists too. This has been a very successful approach for our work, and has enabled us to accomplish far more than we could have otherwise. Our work focuses on the inhabited islands of Ulithi Atoll, the fourth largest atoll in the world. Declining coral cover, problematic fishing practices, historical reef degradation and 'invasive' species are contributing to a decline in reef health and associated resources. The people of Ulithi rely on their reefs for food and protection from erosion, and the issues they face are ecological and cultural in nature. The traditional (indigenous) approaches to conservation and management were successful, and our approach is to combine traditional methods with modern scientific analysis to implement management plans. Diversity in approach, ideas, and methods is important, and citizen scientists provide ideas from different perspectives in addition to actual data collection.

REINVENTING FISHERIES MANAGEMENT IN THE WESTERN ATLANTIC: INVOLVING FISHERS IN PREDICTION, VERIFICATION, MONITORING AND PROTECTION OF SPAWNING AGGREGATIONS
William Heyman, LGL Ecological Research Associates, Inc.
Groupers and snappers comprise most of the highly desired and heavily exploited fishes in the US South Atlantic, Gulf of Mexico and the wider Caribbean. These fishes support commercial and recreational fishing, dive tourism, and coastal food security and culture. Sustainable management of these valuable resources is an important, large-scale social and scientific challenge for several reasons. Target species' ranges typically transcend the territorial boundaries of the managing states. Many species are long-lived and migrate to spawn in aggregations, where they are particularly vulnerable to fishing. Traditional management of these fishes is based on stock assessments but the data to run assessment models are difficult and expensive to collect. As a result, many snappers and grouper species are considered data-limited stocks where traditional stock assessment methods are not applicable and species have experienced significant declines.
Meanwhile, fishers that depend on these resources have had only limited involvement in data collection or management of the resources on which they depend. Yet fishers maintain intimate local ecological knowledge (LEK) of the resources and spend many hours on the water. With broad collaboration from fishermen, scientists, and managers the author lead the development of a shared protocol for monitoring

of reef fish spawning aggregations starting in 1998. Collaborative use of the system led to fisher support for legislation to protect 11 spawning sites in Belize in 2003. The system is still in use in Belize, Mexico, Honduras and the Cayman Islands and is being expanded to include the US South Atlantic and the Gulf of Mexico. The ultimate aim is the development of a network of individuals and institutions that share a protocol for monitoring and protection of spawning sites which in turn will support better stock assessments, shared regional management, and the recovery of snapper grouper stocks throughout the Western Atlantic.

YOUNG MARINE EXPLORERS: A CASE STUDY IN CAPACITY BUILDING THROUGH CONSERVATION
Nikita Shiel-Rolle, Young Marine Explorers; Kathleen Sullivan Sealey, University of Miami
The Bahamas, a Small Island Developing State, like many island nations struggles to manage their natural resources. Bahamians depend heavily on the marine environment as it drives the countries tourism based economy. Despite the dependency on the marine environment, unsustainable behaviour such as clearing of coastal plants, filling of wetlands, poor waste management, overfishing and the illegal harvesting of marine resources has resulted in the degradation of marine resources that threatens the economy, human health and wellbeing. One of the underlying problems driving this unsustainable behaviour is the poor educational output of students graduating from Government schools within The Bahamas. Over the last 20 years the graduating average in the Bahamas has been a D. Young Marine Explorers (YME) a Bahamian non-profit organization has designed a citizen science program that supports the standardized high school science curriculum and builds human capacity intended to reduce resource degradation. YME develops an appreciation for the environment within youth from underserved communities by providing environmental education, fostering emotional connections with the environment and inspiring an internal locus of control. YME is building the next generation of environmental leaders in The Bahamas, which are students from underserved communities that are prepared to take on the pressing social and environmental challenges facing The Bahamas. Over the past five years the increase in the organizations hours of impact within underserved communities shows that there is both a need and interest for such a program. This study will discuss both the accomplishments and challenges of the organization and how citizen science programs offered by YME are capable of providing valuable information on Bahamian biodiversity, filling a much-needed gap in the existing conservation efforts within the country.

2:40-4:00pm
Session 3D   Lower Level 20D
Panel: Tackling Grand Challenges and Everyday Problems with Citizen Science

BIOMEDICAL CITIZEN SCIENCE: EMERGING OPPORTUNITIES AND UNIQUE CHALLENGES
NIH Citizen Science Working Group (National Institutes of Health)
Jennifer Couch, Ph.D. (Session Chair), Chief of the Structural Biology and Molecular Applications Branch in the Division of Cancer Biology, NCI, National Institutes of Health; **Sandra Soo-Jin Lee**, Ph.D., Senior Research Scholar, Stanford Center for Biomedical Ethics, Stanford University; **Markus Covert**, Ph.D., Associate Professor of Bioengineering, Stanford University; **Benjamin M. Good**, Ph.D., Assistant Professor, Department of Molecular and Experimental Medicine, The Scripps Research Institute; **Henry Herrera**, President & CEO of the Center for Popular Research, Education & Policy
Biomedical research poses unique opportunities for citizen science to contribute to understanding the biology underlying health and disease, the impact of behavior and the environment on health, and individuals' personal and collective health. But it also poses unique challenges for citizen science. Individuals, some either already diagnosed or predisposed to a disease, are motivated both to share clinical information about themselves and to shape future research directions that will benefit others with their condition. In addition, there exists a wealth of expertise and creative problem-solving capabilities outside the realm of traditional biomedical research expertise that can be brought to bear on biomedical research questions, currently most commonly through game interfaces. The National Institutes of Health (NIH) supports all aspects of biomedical science including biological, clinical, behavioral, and

epidemiological research. We are investigating the use of citizen science methods for biomedical research. In May of 2013, our working group brought together from the non-profit, for-profit, and academic sectors who had successfully run biomedical citizen science projects for a think tank. This workshop highlighted many opportunities to bring the public's passion, time, data, and sharing of ideas to change the paradigm of biomedical research and redefine the current relationships between physicians, academic centers, and the public. Two additional workshops planned for this winter follow up on key recommendations and areas of opportunity: investigating the ethical, legal, and social implications (ELSI) of citizen science biomedical research; and the use of games for biomedical research. This panel will include reports from those workshops and the think tank, and will focus on how those issues impact citizen science biomedical research from NIH's perspective and the unique opportunities for these approaches in the biomedical space. Presenters could include leaders of these activities from the NIH as well as experts from the field.

2:40-4:00pm
Session 3E   230A
Talks: Best Practices for Designing, Implementing, and Managing Citizen Science Projects and Programs

PLANTS OF CONCERN: CITIZEN SCIENTISTS MONITORING RARE PLANTS IN THE CHICAGO REGION
Rachel Goad, Plants of Concern, Chicago Botanic Garden
Despite being highly urbanized, the greater Chicago region contains high quality natural areas that support rare plant species. Land managers need rare species data for management planning but are often unable to collect this data on the scale at which it is needed. To address these needs, Plants of Concern was founded in 2001. This citizen science-based, regional rare plant monitoring program has engaged over 700 volunteers to monitor more than 200 species across northeastern Illinois, northwestern Indiana, and southeastern Wisconsin. Partnerships with 115 federal, state, and local landowners, local volunteer groups, and NGOs have been critical to the success and scope of the program. A standardized monitoring protocol, approved by an Advisory Group of land managers, scientists and volunteers, is used consistently throughout the region and makes comparisons across property lines possible. Data collected tracks changes in plant populations in response to management over time, a critical piece of an adaptive management process. This data is stored in a centralized database that volunteers and land managers have access to through a secure, password-protected website. Results reported to land managers alert them to potential threats to populations, highlight beneficial practices, and aid in the creation of management plans. POC program structure and scope will be presented along with examples of direct benefits to rare plant populations through manager responses to POC reports, emerging trends from this long-term dataset, and results from research conducted in partnership with scientists and students. Research topics have included investigations of population genetic structure and relationships between rare plant population dynamics and land management. Finally, the presentation describes challenges encountered but emphasizes how trained citizen science involvement contributes reliable scientific data, leverages scarce agency resources and creates a constituency for conservation policy.

NEOSEC—A REGIONAL APPROACH TO CITIZEN SCIENCE IN NEW ENGLAND
Heather Deschenes and Sarah Bursky, New England Aquarium
2014 marks the 5th year of federally funded collaborative citizen science effort in New England, spearheaded by the New England Ocean Science Education Collaborative (NEOSEC). Partner institutions from throughout the region joined together to engage youth (ages 9-14) attending summer camps, in citizen science data collection. With guidance from a project science advisor and scientists selected by each partner institution, campers used data collection protocols to gather data at coastal field sites throughout the region. During the presentation we will talk about the successes, realities and challenges of such a regional approach, including; establishing a community of practice, increasing capacity of scientists and educators, increasing ocean literacy among campers and supporting peer-peer exchange of information, particularly among the youth participants.

COLLABORATIVE ECOLOGICAL OBSERVATION: ISSUES IN MOVING FROM SOCIAL MEDIA TO RESEARCH DATA

Te-En Lin, Chih-Yun Chen, and Yu-Kai Chen, Taiwan Endemic Species Research Institute; **Tyng-Ruey**, Chuang Academia Sinica; Dong-Po Deng, Academia Sinica; Cheng-Hsin, Hsu Academia Sinica; Lucien C. -H., Lin Academia Sinica; Guan-Shuo, Mai Academia Sinica; Kwang-Tsao, Shao Academia Sinica; Mei-Hsueh Wang, Academia Sinica, Taiwan

We report our experience in working with rich contents that are collaboratively produced from a citizen science project. The project Reptile Road Mortality initially started in a social media setting [1], but its produced datasets have been moved to an open platform to encourage reuse [2].

There are many issues to consider when hosting citizen science projects on the Web in particular when services provided by social media are used. Popular social media sites like Facebook and Twitter have very large user bases, and they facilitate and encourage various kinds of online user interactions. Social media makes it easier to draw people to participate in citizen science projects, but this is without drawbacks. We identify general issues in using social media for citizen science projects. We categorize these issues into five areas: Consensus, Mediation, Workflow, Reuse, and Enrichment. As we review these issues, we will elaborate some of the considerations when addressing these issues based in part by our experience in the Reptile Road Mortality project. We begin by asking some central questions in each of the five categories.

Consensus: Participants collaborate in data collection and analysis. Who can use the result?

Mediation: Participation is mediated. What are the constraints, and what to do about them?

Workflow: How does data sourced from social media fit into existing research workflow?

Reuse: How to better share citizen science datasets to the larger research community?

Enrichment: How do the above issues and considerations shape research practices?

Links:

[1] Reptile Road Mortality (Facebook Group). See https://www.facebook.com/groups/roadkilled/

[2] Taiwan Roadkill Observation Network. See http://roadkill.tw/

OPENING UP THE ZOONIVERSE : BUILDING A SCALABLE PLATFORM FOR ONLINE CITIZEN SCIENCE

Chris Lintott, University of Oxford, UK

With more than a million registered volunteers, more than thirty projects and nearly a hundred peer reviewed papers, the Zooniverse is amongst the world's most successful platforms for online citizen science. Growing from its beginnings as a single astrophysics project in 2007, it now encompassing projects in ecology, meteorology, particle physics and more.

The experienced gained in producing these projects and their subsequent success (or failure) has led to the development of a set of best practices in experiment design. A rebuild of the Zooniverse system will allow researchers to build, test and deploy citizen science projects as easily as launching a Wordpress blog. This talk, from Zooniverse PI Chris Lintott (University of Oxford), will review this progress, but then consider the problems these developments cause. What does a community engaged in 200, not 20, projects look like? What requirements should fall on the researchers, and conversely what can be expected from the volunteers? How do we avoid a tragedy of the commons in which effort is spread too thinly? Our approach to these questions is driven by a desire to maximise the scientific potential of our projects, but also by a desire for a more community-led, 'bottom-up' approach. In exploring these tensions at the meeting we hope to be able to reach conclusions informed by many of those with expertise in the field.

COSMOQUEST: USING SOCIAL MEDIA TO TIE COMMUNITY TOGETHER

Nicole Gugliucci, Pamela Gay, and Houston Southard, Southern Illinois University Edwardsville

CosmoQuest is a virtual research facility where members of the public can take part in planetary science research while also learning about astronomy and astrophysics. The citizen science takes place entirely within the website using image marking tools and data from several NASA spacecraft. The CosmoQuest team uses a variety of new and social media tools to attract new users and engage with current users, most notably Facebook, Twitter, Google Plus, and YouTube. In particular, the Hangouts on Air tool with

Google Plus and YouTube allows for weekly live broadcasts by team members and interaction with the audience through live questions and comments. Each social platform has a slightly different style of communication and method of responding to users, fans, and followers. Helpful reminders through social media are one way of keeping in contact with or reminding existing project users.

Blogging is a slightly different form of communication through the web as it focuses on long-form story-telling or informational guides that complements a citizen science project. Repositories of information can also be shared through tutorial videos made available on YouTube or other hosting platforms. Email newsletters, though hardly "new," remain an effective way of reaching a large audience with timely updates and reminders.

We will share tips and techniques for social media as used by CosmoQuest and explore web traffic results from social media. We will also discuss ways of integrating multiple methods of social and new media into a citizen science program as a way of fulfilling many of its needs.

2:40-4:00pm
Session 3F   230B
Symposium: Tackling Grand Challenges and Everyday Problems with Citizen Science

EBIRD: IDENTIFYING CHALLENGES AND FINDING SOLUTIONS FOR ENGAGING A GLOBAL PUBLIC IN CITIZEN SCIENCE
Steve Kelling (Session Chair), Cornell Lab of Ornithology, Cornell University; **Mark Reynolds**, The Nature Conservancy; **Brian Sullivan**, **Chris Wood**, and **Rick Bonney**, Cornell Lab of Ornithology
eBird: Identifying challenges and finding solutions for engaging a global public in citizen science   In September 2014 eBird received its 200 millionth bird observation and the project is now growing exponentially. Over the past 12 years eBird data have been contributed by more than 200,000 participants, and 2.5 million people currently visit the website annually to view and explore data. These data have resulted in more than 100 peer-reviewed publications that are shaping research in ornithology, ecology, human-computer interaction, computer science, and statistics. In addition, federal and state agencies, local and international NGOs, and a variety of other land managers are using eBird for conservation planning and decision-making. Also, more than 15 terabytes of eBird data have been downloaded and used in a number of educational programs both in and out of classrooms. Considering that the growth rate in each category—research, conservation, and education—ranges from 25-40% per year, this symposium will identify challenges and discuss solutions in managing a fast-growing global citizen science project. Speakers will describe the eBird program and provide an overview of its challenges, growth, and uses in scientific discovery (Kelling); describe programs in which eBird data are being used in conservation efforts, including delineation of easements for waterfowl and shorebird protection in California (Reynolds); explain procedures used to ensure eBird data quality including data management, data filters, and a network of 800 volunteer editors (Sullivan); describe how the eBird community is recruited, cultivated, and managed (Wood); and show how eBird is used to achieve outcomes for education through curricula and informal science education programs (Bonney). Emphasis in the symposium will be placed on describing lessons learned from developing and evaluating eBird that can be used in creating or improving other large-scale citizen science projects that seek to achieve wide-ranging objectives.

2:40-4:00pm
Session 3G   230C
Talks: Tackling Grand Challenges and Everyday Problems with Citizen Science

SPACE WARPS: CROWD-SOURCING THE DISCOVERY OF GRAVITATIONAL LENSES
Phil Marshall, KIPAC / SLAC / Stanford University
Gravitational lenses are rare alignments of galaxies, where the massive foreground object causes magnification, distortion and multiple imaging of the background source. They are rare, but very useful

objects: they can be used to weigh the lens galaxies, and as cosmic telescopes. Fully automated lens detection is currently out of reach: instead, tens to hundreds of thousands of targets would need to be visually classified in order to find thousands of lenses in the next generation of astronomical imaging surveys. The Zooniverse project "Space Warps" is a web-based experiment in crowd sourcing that task. I will present the system and some results from the first two projects, focusing on key features such as our agent-based online probabilistic model for interpreting the classification data, the use of simulated lenses both in this analysis and in training the volunteers, how well the system performed relevant to semi-automated methods applied to the same images, and some promising hints for the future.

ADOPT A PIXEL: SUPPORTING GEOSPATIAL CAREER DEVELOPMENT AND FEDERAL REMOTE SENSING
Jeannie Allen and Ginger Butcher, Sigma Space Corp. at NASA
Adopt a Pixel (AaP) serves both federal remote sensing science and the public by involving youth and other citizens in collecting reliable ground reference data to help improve the accuracy of Landsat scene interpretation by Landsat scientists. Participants collect photographs of the landscape and record basic information such as geographic location, cardinal direction, time of day, and land cover following a simple protocol. These data will reside inside the portal to Landsat data, Earth Explorer, at the U.S. Geological Survey (USGS), Earth Resources Observation and Data (EROS) Center, populating a new federal archive of geospatially-tagged photographs that provide a baseline record to serve multiple purposes societal benefit over the long term.
A pilot of the AaP protocol started in the Spring of 2012 by NASA's Landsat public engagement team with a variety of partners including Black Hills State University; 4-H; the New Mexico Museum of Natural History and Science with its associated Sandia Mountain Natural History Center; and Bandelier National Monument. To assess the value of these data and to engage scientists in the use of citizen science data, a pilot campaign was launched in the Fall of 2014 to collect data at specific geographic locations identified by scientists studying forest disturbance. This connection to scientists is key in the success of this project. Beyond engaging citizen scientists, AaP seeks to promote youth career awareness in fields that use geospatial technology by providing opportunities for youth to explore uploaded data, interact with scientists, and have in-depth learning experiences for building geospatial technology skills and exposure to careers in this emerging field.

HOW INNOVATIVE MOBILE AND WEB-MAPPING TECHNOLOGIES ARE EMPOWERING LOCAL COMMUNITIES AND TRANSFORMING CHIMPANZEE CONSERVATION IN AFRICA
Lilian Pintea, The Jane Goodall Institute; Tanya Birch, Google Earth Outreach; Jovin Lwehabura, The Jane Goodall Institute (Tanzania); Timothy Akugizibwe, The Jane Goodall Institute (Uganda); Yaw Anokwa, Nafundi LLC
The 30-year mission focus of the Jane Goodall Institute (JGI) is to protect with partners 85% of chimpanzees and their habitats in Africa. This is an ambitious challenge and can only be achieved through engaging in partnerships with a diversity of stakeholders, including local communities. One of the Institute's Applied Science goals is to use citizen science to empower local communities to be better stewards of their environment and custodians of chimpanzees, while enabling them to improve their own well-being. Since 2009, JGI has been developing a simple, practical and easy to use community mobile mapping and monitoring platform. The system uses open source mobile apps such as Open Data Kit (ODK), Android smartphones and tablets and Google cloud technologies to support field data collection and citizen science. Using case studies from Tanzania, Uganda, the Democratic Republic of Congo and the Republic of Congo this paper presents lessons learned, from community engagement to the actual use of citizen data to support conservation decisions. Recent developments and their potential implications for enhancing the effectiveness and use of citizen science data will be discussed including: development of a mobile app to validate near-real time deforestation alerts from Global Forest Watch; integration of citizen data with remote sensing and ecological forecasting models as part of a Decision Support System developed with the University of Maryland and NASA to monitor chimpanzee habitat health; and the use

of simple dashboards and dynamic web-maps for local decision makers and protected area managers to improve access to information derived from community data.

FROM THE GROUND TO THE CLOUD: GROUNDTRUTHING ENVIRONMENTAL CHANGE
Tanya Birch, Google Earth Outreach; **Christiaan Adams**, Google Earth Outreach; Yaw Anokwa, Nafundi LLC
Over 6 billion people in the world have mobile service. Over 70% of smartphone users worldwide and 50% of smartphone users in the US have Android phones or tablets. Numbers like that present a great opportunity for citizen science applications.
Open-source tools for collecting data from the field, like Open Data Kit, are leveraging rapid growth of the Android platform to gather local information on the ground to send it up to the cloud. Today, anyone can use their Android phone to go out in the field, in an offline environment, collect information and create a map when they're back online.
At the same time, access to cloud computing is accelerating scientists' ability to better understand our planet. Google Earth Engine is a planetary-scale platform for analyzing the world's environmental data. With over 40 years of satellite imagery from USGS on Google's cloud, anyone can see how our planet has changed over time. Scientists using Earth Engine have been able to do things never before possible, like create the world's first map of global forest change. By leveraging data from citizen scientists in the field, researchers can improve their environmental models.
We'll examine real-world applications of these technologies and reveal some of the challenges that remain. Early success stories offer optimism about how citizen scientists could contribute to groundtruth these analyses, to provide a more accurate picture on topics like global deforestation maps.

PUBLIC LAB: OPEN AND COOPERATIVE STRUCTURES FOR COMMUNITY-BASED ENVIRONMENTAL HEALTH MONITORING
Shannon Dosemagen, Public Laboratory for Open Technology and Science
At Public Laboratory for Open Technology and Science (Public Lab), we're interested in full data lifecycles and have created an open space where people come to cooperate and collaborate, bringing their own personal experiences and expertise (local or academic) to the creation of low cost, DIY, open source monitoring tools. This talk will address several of the conference themes around accessibility and inclusion by proposing and discussing models for creating engaged communities, not just tools for data collection and research projects. It will feature Public Lab as an example of organization dedicated to global community building.
Using Public Lab as a case study, I'll discuss ways in which open communities are reimagining what it means to support and create participatory project structures that are focused on leveraging a public involved and engaged in their local environments. I'll discuss methodology geared around working together in the research process through problem identification and tool development to data analysis and use. I'll additionally discuss our work around connecting online communities to geographically centralized groups through a series of gatherings (called "Barnraisings") that bring people to an area to work together, create, build, think and discuss at sites of interest. Imagine working on a water sampling device in the oil and gas pipeline riddled wetlands of south Louisiana or modifying a camera rig and then testing it out by capturing images of a contested nuclear power plant in Massachusetts. These types of scenarios are examples of delivering data using our approaches. This talk, focused on collaborative community methodologies and disruptive technology created for environmental health monitoring, will encourage people to reimagine their involvement with materials around them and begin thinking critically about aligning the concepts of "making" and "designing" to being a socially engaged member of society.

4:00pm
Coffee Available

4:10-5:30pm

Session 4A   Lower Level 20A
Symposium: Tackling Grand Challenges and Everyday Problems with Citizen Science

DIY AERIAL PHOTOGRAPHY: CIVIC SCIENCE AND SMALL DATA FOR PUBLIC PARTICIPATION AND ACTION
Shannon Dosemagen (Session Chair), Public Laboratory for Open Technology and Science; **Hagit Keysar**, Ben Gurion University, Israel; **Scott Eustis**, Gulf Restoration Network; **Lila Higgins**, Natural History Museum of Los Angeles County; **Maria Del C Lamadrid**, LA-Más and Art Center/ UNICEF's Tech4Dev in the Innovation Lab, Uganda
First used during the 2010 BP oil spill in the Gulf of Mexico, the Public Lab's DIY aerial photography toolkit—composed of balloons, kites and cheap point and shoot cameras—has gained increasing popularity. Hundreds of kits have been distributed or constructed and hundreds of maps have been created around local issues by people across the globe. In a time in which high quality aerial and satellite imagery is more accessible than ever, the question that rises is how DIY aerial photography is gaining such popularity?
In a world of Big Data, public participation is being pushed aside by increasingly data-centric and techno-centric societies. Top-down decision making processes are controlled by small groups of experts who produce, interpret and apply data in decisions that affect many. A Small Data approach is one where people collaborate to produce their own data as a means of creating packages of information that address specific problems. Locals know more about their backyards than officials do, and by rigorously patching together their detailed observations, they can gain new powerful grounds for advocacy. Easy-to-use, affordable, visually and technically engaging DIY aerial photography toolkits are helping people to leverage their knowledge with that of decision makers.
In this session we take the opportunity to examine the power of DIY aerial photography for engaging people to act on issues that matter to them and to visualize information for effective advocacy. Contributing to the theme of the conference, this symposium provides discussion on innovative methodology designed to engage communities in creating active dialogues geared towards solutions. We will present four different use cases bringing stories of engagement and change ranging from the Los Angeles River (Lila Higgins) and Gulf of Mexico (Scott Eustis), to Uganda (Maria del C Lamadrid) and Palestine-Israel (Hagit Keysar).

4:10-5:30pm
Session 4B   Lower Level 20B
Story Presentations across Conference Themes
    Session Chair: **Linda Silka**, Director, Margaret Chase Policy Center, University of Maine

OPEN SOURCE YOUR CITIZEN SCIENCE PROJECT!
Jason Holmberg, http://www.wildme.org/wordpress/; Jon Van Oast, Wild Me
The open source software and citizen science movements have strong similarities. Both attempt to achieve a goal by increasing available labor and incorporating the very best ideas through the fostering an open environment of participation. Professional information architects Jason Holmberg and Jon Van Oast present the story of Wild Me, a 501(c)(3) non-profit managing global scale citizen science projects for wildlife. Wild Me builds and freely distributes an open source software package for wildlife research called "Wildbook" to strengthen its own data management capabilities and extend the fruits of its labor and investment to other groups studying threatened animal populations. We present the benefits and challenges of combining open source software development with citizen science and discuss how our experience from our active projects for whale sharks (www.whaleshark.org) and manta rays (www.mantamatcher.org) influences our approaches to citizen science data management and engagement. As information architects, we present the need for data addressability, searchability, and accessibility to support the integration of domain specialists into citizen science, and we discuss how open software development can enforce good study design and enable broader, multi-disciplinary participation

in projects. Finally, we present our successes, failures, and ongoing experiments in developing reusable and engaging citizen science software and projects.

THE CHALLENGES WITH TRAINING OUTDOOR ENTHUSIASTS ONLINE
David Mellor, Virginia Tech; Rebecca Jordan, Rutgers University; Stephen Gray, University of Massachusetts; Greg Newman, Colorado State University; Cindy Hmelo-Silver, Indiana University
Online collaboration has the potential to foster collaborative citizen science projects across a wide geographic area. These collaborations have the potential to create rigorous projects with broad implications, while still allowing for the kinds of learning gains and other benefits found in smaller in person settings. With this in mind, we integrated a suite of online tools designed to train volunteers in creating citizen science projects. These participants are members of the Virginia Master Naturalists, a group of volunteers trained in general ecology, who work with state natural resource agencies. The online suite contains trainings on ecology, scientific modeling, and adaptive land management, and online virtual spaces to collaboratively create models and adaptive management plans. A pilot class using a hybrid teaching model with 23 volunteers in three different groups resulted in high retention (approximately 75%) and two ongoing citizen science projects related to water quality in agricultural areas and invasive plant remediation in a threatened habitat. Moving to a less facilitated and fully online model of training and project design, necessary to create regional-level projects among volunteers, however, resulted in projects with low retention (less than 10%) and no successful projects. In this story presentation, we discuss possible causes of the low retention, steps being taken to improve the situation, and open a dialogue to share ideas on best practices in training outdoor lovers in an online setting.

FUNDING CURIOSITY: KICKSTARTER, OPENEXPLORER AND THE FUTURE OF GRANT FUNDING
David Lang, OpenROV
Kickstarter doesn't have an official "Science" category, but don't let that mislead you. The Kickstarter community has changed the rules for science, exploration and conservation by creating a whole suite of new tools and technologies that allow us to ask entirely new questions and go places many of us never imagined. I could point to the ArduSat project (now launching dozens of satellites into space for monitoring purposes) or the Rainforest Connection project (planning their next 3 expeditions to use old cellphones to thwart poachers) or the OpenPCR project (which has been the catalyst for a new DIYBio toolset). The list goes on and on. More than make a list, I can attest to the effects first-hand; our story with OpenROV, an open source underwater robot, is as improbable and wonderful as I could have ever imagined.
More importantly, Kickstarter showed us the playbook: creative projects of all shapes and sizes can come to life with the support of a committed group of people and just enough money to pull it off. The same is possible for pursuits of curiosity. But the model is a little different. OpenExplorer is our community's attempt to achieve this, but there are others, and hopefully more coming.
The important part of is not which model is correct. It's that these new models don't come from the traditional rubric. Building a new funding model for science and exploration is not going to come from the NSF. It will very likely start with citizen scientists.

4:10-5:30pm
Session 4C   Lower Level 20C
Talks: Research on and Evaluation of the Citizen Science Experience

HOW THE SAUSAGE IS MADE: WHEN PUBLIC PARTICIPATION IN SCIENCE LEADS TO DECREASED TRUST OF SCIENTIFIC ASSESSMENT
Stephen Gray, University of Massachusetts
Since 2001, NOAA's Cooperative Research Program has provided federally-funded opportunities for commercial fishermen and fishery scientists to work together to conduct scientific research. In addition to generating data to improve fisheries decision-making, these projects are expected to facilitate learning

between fishermen and scientists and increase the transparency of scientific assessments. These cooperative research projects also provide an ideal opportunity to evaluate the large-scale social outcomes associated with a set of diverse PPSR projects. Based on mail-out survey responses collected from commercial fishermen (N=271) and professional fisheries scientists (N=201) from the Northeast US, this study seeks to understand: (1) the current degree and type of fishermen participation in fisheries science and (2) how the degree and type of participation in science may influence trust of scientific assessment and shared beliefs between fishermen and scientists. Survey results indicate that 53% of the fishermen and 93% of the fishery scientists sampled collaborated in cooperative research. Of those that participate, both groups report that fishermen most often participate in the data collection phase (i.e. contributory projects) with fewer respondents collaborating in terms of data analysis (i.e. collaborative projects) or more steps of the scientific process (i.e. co-created). Analysis of the social outcomes associated with different degrees of participation indicated that as scientists increase in their degree of participation with fishermen, they tend to develop increasingly similar perceptions of ecosystem change to those of fishermen. By contrast as fishermen increase participation, their trust of scientific assessments, government scientists, and academic scientists tends to increase, however fishermen on the highest end of the participation spectrum report lower trust-levels, similar to those that do not participate. We suggest that this decreasing trust is related to fishermen exposure to the "sausage making" of science, including dealing with uncertainty and socio-cultural aspects, that may negatively influence trust in science.

CITIZEN SCIENCE LEARNING AND EPISTEMOLOGY IN SOCIO-ECOLOGICALLY ORIENTED PROJECTS
Rebecca Jordan and Amanda Sorensen, Rutgers University
It is clear that citizen science programs result in a vast array of ecological and social outcomes. Positive outcomes recently reported in the literature include advancing conservation goals and increasing socio-ecological stewardship. In this talk, I will discuss learning gains and the development of epistemic practices (i.e., knowledge about the knowledge produced in citizen science) in the context of socio-ecological outcomes. Using data from two citizen science programs (MosquitoStoppers and CollaborativeScience.org) it is clear that citizen science has the potential to increase socio-ecological resilience. The latter is supported by evidence that the act of participation in data gathering in socio-ecologically framed citizen science projects can: (1) Increase individual efficacy to drive community outcomes and that this increase in perceived efficacy need not be paired with actual efficacy; (2) Help to build trust among members of similar or different communities that share goals; (3) Enable necessary communication between the public and decision-makers; and (4) Through the act of modeling, promote an increase in scientifically related epistemic practices. To develop and support such projects, however, certain issues warrant further consideration. First, projects need to be highly coordinated especially during early phases. Second, if participants are going to contribute to the decision-making process, they need to be broadly versed in the scientific enterprise. Third, project designers and participants need to consider issue framing as a means to engender support. I will conclude with a discussion about project assessment based on decision-making success.

PROMOTING RIGOROUS CITIZEN SCIENCE: EVALUATING THE LEARNING IMPACT OF THE COASTAL OBSERVATION AND SEABIRD SURVEY TEAM (COASST)
Cynthia Char, Char Associates
COASST (Coastal Observation and Seabird Survey Team) is a well-established rigorous citizen science program that has been centered on a single data type collected regionally – beached birds. Begun in 1999 with 12 participants on the southern coast of Washington, COASST has grown to over 800 active participants collecting data on more than 450 beaches in Washington, Oregon, California and Alaska. With COASST participants having discovered 45,000 carcasses of 164 species to date, COASST is the world's largest beached bird program, numerically and geographically.
In 2012, with funding from the National Science Foundation, a study was conducted to examine how effective COASST trainings are in imparting knowledge and skills to individuals new to COASST, and on the

subsequent learning for participants conducting monthly bird surveys on their beaches for one or more years. Of particular interest was participants' understanding of various scales of data, from individual bird identification to use of COASST data by the science and resource management communities. Three survey instruments were utilized, with 430 individuals responding.

Findings suggest that COASST participants successfully acquired and retained knowledge and skills across a variety of areas, including measurement and bird identification methods, and reasons underlying the need for monthly surveys and tagging of bird carcasses. Moreover, the practice of collecting COASST data appears to enable individuals to evolve mental models of their immediate environment and beyond. Relative to the pre-trained population, COASST participants demonstrated a significant increase in knowledge of the annual cycle of occurrence of common species on their beach, and of the mortality factors contributing to why beachcast birds are found. More than a third were able to describe ways that COASST data had been used in a scientific or resource management context. Program design recommendations arising from the evaluation will also be discussed.

AUDIENCE MATTERS: THE ROLE OF OUTSIDE AUDIENCES ON YOUTH EXPERIENCES IN CITIZEN SCIENCE PROJECTS

Emily Harris, Heidi Ballard, and Colin Dixon, University of California, Davis

Citizen science is rapidly being incorporated into youth development and science learning efforts, in both school and out-of-school settings, but very little research has addressed the unique ways youth-focused citizen science programs meet the multiple goals of rigorous science and quality education. Among many factors that can influence participant learning, one that makes citizen science unique is the presence of an outside audience for students' work. As part of a larger research study focused on science and environmental learning and youth development through citizen science, we present early findings on the particular role that having an "outside audience" plays in delivery and experiences of youth-focused citizen science. This may be a scientist or resource manager who uses the data, but in some sites may involve other professionals or community members. We therefore specifically ask: What affordances and constraints does an outside audience provide? What, if any, are the differences between school-based and out-of-school settings?

To answer these questions, we present in-depth observation and pre- and post- interview data from two cases that had both school- and community-based components across multiple sites around the San Francisco Bay Area (one coastal monitoring and one air and water quality monitoring). We found that the nature of the outside audiences can strongly influence how youth approach their citizen science projects and what they take away from their experiences. Educators and youth presented their findings to their audiences in creative ways, from submitting data for scientists and managers, writing blog posts, presenting at professional conferences, and sharing information with community groups, parents, friends, and passers-by.

Our findings have implications for the design and evaluation of youth-focused citizen science, specifically regarding the impacts and difficulties of having an authentic audience for youth scientific work, differences between in school and out-of-school settings, and practical suggestions for learning.

VIEWING WILDLIFE IMAGES THROUGH CITIZEN SCIENCE: IMPACT ON THE ANXIETY LEVELS OF MILITARY VETERANS WITH VARYING LEVELS OF PTSD

Scott Smedley, Nicole Evancha, and Kathryne Marinchak, Trinity College, Hartford; Lisa Nisbet, Trent University

As citizen science becomes an increasingly popular research tool, investigators must recognize potential risks to participants. In our study of the effects of residential composting on scavenger ecology, citizen scientists identify animals in wildlife camera images through crowd sourcing. To date, participants have included mainly students (secondary and college level) and high school science teachers, but we are eager to involve military veterans since they likely possess advanced observational skills and also have the potential to benefit both educationally and psychologically from involvement. However, as a precaution before engaging veterans, we are determining whether or not those with post-traumatic stress disorder

(PTSD) experience adverse reactions when viewing nocturnal, infrared-illuminated images (similar to military NightVision) or images of animals that might be considered menacing. An ongoing pilot study involves veterans with varying levels of PTSD, as measured by a standard instrument, the PTSD Checklist - Military Version (PCL-M). These participants are assessed for state anxiety levels, as measured by the State-Trait Anxiety Index (STAI-S) immediately before and after viewing a set of twenty wildlife images from our ecological research. The pilot project results to date show no adverse response to viewing the wildlife images; in fact, the veterans overall show a marginally significant decrease in anxiety after viewing. Participants with higher levels of PTSD, show the greatest anxiety reduction. In a follow-up study, psychophysiological measures of anxiety and a non-veteran control group will be added.

4:10-5:30pm
Session 4D   Lower Level 20D
Panel: Making Education and Lifelong Learning Connections

ALIGNING NEXT GENERATION SCIENCE STANDARDS TO CITIZEN SCIENCE
DarleneCavalier (Session Chair), SciStarter, Science Cheerleader, Arizona State University, *Discover* Magazine; **Andrew Collins**, School of Ants; **Leonora Shell**, North Carolina State University; **Kristian Breton**, New York Academy of Sciences; **Sandra Henderson**, Project Budburst and Citizen Science Academy; **Jennifer Fee**, Cornell Lab of Ornithology, Cornell University
The proposed session will feature several citizen science projects that have taken steps to bring their projects into the K-12 classrooms by aligning with the Next Generation Science Standards to make use of data that students can use to construct explanations and design solutions, engage in argument from evidence, and obtain, evaluate and communicate information.
Presenter/Panelists include (1) Andrew Collins with School of Ants, a citizen-scientist driven study of the ants that live in urban areas, (2) Leanora Shell with Your Wild Life and the Students Discover Project from North Carolina (NC) State University and the NC Museum of Natural Sciences, (3) Kristian Breton from the New York Academy of Sciences who is working with the Education team to design and build an online platform where youth can share and explore Citizen Science projects, (4) Sandra Henderson with NEON's Project BudBurst, a climate change focused citizen science program for educators, and (5) Jennifer Fee, from the Cornell Lab of Ornithology's BirdSleuth K-12 program, which engages students in schoolyard investigations and citizen-science projects.
After a series of short talks, the speaker/panelists will solicit input from the community on how to use citizen science data in the classroom and gather citizen science from classrooms. Questions could focus on data mining, suitable research questions, available data sets, and analysis tools, as well as how best to engage teachers and students in the research. The feedback from participants in this session could help determine the direction and emphasis for the next phase of citizen science in education with respect to NGSS, including how to scale this for the 850 projects in SciStarter's project finder.

4:10-5:30pm
Session 4E   230A
Talks: Digital Opportunities and Challenges in Citizen Science

CROWDSOURCING NAMES FOR ORGANISMS WITH iSPOTNATURE.ORG
Jonathan Silvertown, University of Edinburgh, Scotland; Martin Harvey, The Open University
Accurate species identification is fundamental to biodiversity science, but the natural history skills required for this are neglected in formal education at all levels. In this talk we describe how the web application ispotnature.org (iSpot) is helping to solve this problem by combining learning technology with crowdsourcing to connect beginners with experts. Over 94% of observations submitted to iSpot receive a determination. To date, iSpot has crowdsourced the identification of 30,000 taxa (>80% at species level) in > 390,000 observations with a global community numbering > 42,000 registered participants. More than half the observations on ispotnature.org are named within an hour of submission. iSpot uses a unique, 9-

dimensional reputation system to motivate and reward participants and to verify determinations. Taxon-specific reputation points are earned when a participant proposes an identification that achieves agreement from other participants, weighted by the agreers' own reputation scores for the taxon. This system is able to discriminate effectively between competing determinations when two or more are proposed for the same observation. In 57% of such cases the reputation system improved the accuracy of the determination, while in the remainder it either improved precision (e.g. by adding a species name to a genus) or revealed false precision, for example where a determination to species level was not supported by the available evidence. We propose that the success of iSpot arises from the structure of its social network, which efficiently connects beginners and experts, overcoming the social as well as geographic barriers that normally separate the two.

BUILDING A HISTORICAL BASELINE FOR BIODIVERSITY WITH iDIGBIO'S BIOSPEX PUBLIC PARTICIPATION MANAGEMENT SYSTEM

Austin Mast, Robert Bruhn, Jeremy Spinks, and Greg Riccardi, iDigBio/Florida State University
Many citizen science projects focus on generating present-day occurrence data on populations, species, and communities to address urgent societal challenges, such as the extinction crisis and biotic responses to climate change. Biodiversity research collections at, e.g., museums provide the opportunity to produce the important historical baseline with which to compare the new observations. However, information about many of the specimens in these collections (perhaps 90% of 3 billion specimens held globally) have yet to be digitized. The success of ambitious internet-scale citizen science projects, such as at Zooniverse, suggests that public engagement might provide an important strategy to accelerate digitization of that enormous backlog. Out of a series of workshops and hackathons at iDigBio—NSF's National Resource for the Advancing Digitization of Biodiversity Collections Program—emerged the idea of a public participation management system for this domain that would permit the creation of record sets of specimen data and/or media from the iDigBio Cloud, management of their digitization (e.g., transcription or georeferencing) using collaborating tools (e.g., Zooniverse's Notes from Nature or Atlas of Living Australia's Biodiversity Volunteer Portal), monitoring of digitization progress, wide advertisement of the projects, and return of the new data to the data providers and those involved in the digitization. We will introduce this emerging system, called Biospex (www.biospex.org) for Biodiversity Specimen Expeditions. These "expeditions" are batches of digitization tasks with compelling research or societal benefits, an idea from the Biodiversity Volunteer Portal. This management system is primarily for the expedition creators/managers who could be biodiversity specimen curators, members of the public with special interests (e.g., naturalist groups), researchers interested in generating a dataset, etc. We will provide an overview of the management system and its interoperability with the widely used biodiversity data management systems and citizen science tools and discuss lessons learned.

TEXAS' CITIZEN SCIENTIST APPROACH TO EARLY DETECTION OF INVASIVE SPECIES

Justin Bush, University of Texas at Austin
The Invaders of Texas Program has trained citizen scientists to detect and report invasive species throughout Texas since 2005. Since inception, more than 2,000 participants have reported over 16,000 observations that have been validated and delivered into a state and national databases. The program has dramatically and systematically increased early detection, reporting and monitoring of invasive species in critical habitats statewide. Citizen science data from the Invaders of Texas program has allowed us to better understand the distribution of invasive species, allowing for better decision-making, management planning, control and restoration. This presentation will also cover program expansion over time, using citizen scientists to act as first detectors of invasive species that are not established in Texas through the Sentinel Pest Network and development of the Eradicator Calculator, a system to track invasive species treatments, cost and time inputs. Since 2009, the Eradicator Calculator has captured over 500 treatments and yielded interested information to assist land managers and decision makers.

PUBLIC PARTICIPATION IN OBSERVATIONAL AND EXPERIMENTAL SCIENCE: TWO TALES FROM INATURALIST.ORG

Scott Loarie, iNaturalist.org (California Academy of Sciences)

iNaturalist is a social network that connects people to nature through the sharing wildlife observations. To date, the platform has engaged over 50,000 people sharing nearly a million observations. But how are these contributions translated into Science?

On iNaturalist, this occurs through two separate pathways. In the former Experimental pathway, iNaturalist is a platform for hypothesis driven citizen science projects. These projects defer to the organizers to set the scientific agenda including questions and data collection protocols.

In the latter, Observational pathway, iNaturalist acts more like a sensor that gathers large qualities of data in a consistent format and makes these data available for scientific analysis.

This talk will focus on comparing these pathways as they relate to the quantity and quality of data collected, scientific significance, and also their effectiveness engaging the public and helping the public understand the scientific process.

4:10-5:30pm
Session 4F   230B
Talks: Tackling Grand Challenges and Everyday Problems with Citizen Science

FRESHWATER WATCH: CITIZEN SCIENTISTS MONITORING THE GLOBAL FRESHWATER SYSTEM

Diana Eddowes, Steven Loiselle, Charlotte Hall, Neil Bailey, and Malcolm Bradbrook, Earthwatch Institute

Urbanization and intensive agricultural activities have led to the loss of aquatic ecosystem services throughout the world. The inability of decision-makers to manage environmental change is a direct result of their limited capacity to monitor ecosystems and to address emerging sustainability issues on a large scale. An integrated approach to involve new audiences in these issues is key to ensure the sustainable use of our freshwater resources. FreshWater Watch (FWW) is a global freshwater research program which aims to empower citizens, corporations and local communities in the monitoring and management of their local freshwater ecosystems in a scientifically robust, but straightforward and accessible manner. FWW participants form a global network of citizen scientists active in 32 urban areas in Asia, Australia, the Americas and Europe. Following a globally consistent training program, these citizen scientists support leading researchers to address local and global research priorities by obtaining information regarding the hydrological, ecological and chemical conditions of their local water bodies. All measurements follow a common methodology and quality control process and are uploaded to one global online database. An international team of scientists use these data to explore and compare the driving factors of freshwater ecosystem dynamics with respect to differences in climate, land use and catchment conditions. Based on more than 4500 data sets obtained by nearly 1000 active citizen scientists, preliminary results suggest population density, land cover and precipitation timing are key factors controlling aquatic ecosystem dynamics. Furthermore, data from across the globe indicate that smaller water bodies present better ecological conditions than larger waterbodies, which suggests the need for a fundamental shift in our water management priorities. These results are already being used to inform local water resource management plans as well as demonstrate the capacity of committed citizens in monitoring the Global Freshwater System.

WHITE PAPER ON CITIZEN SCIENCE FOR EUROPE: OUTCOMES OF THE PARTICIPATORY POLICY MAKING PROCESS

Fermin Serrano Sanz, Institute for Biocomputation and Complex Physics Systems of the University of Zaragoza, Ibercivis Foundation

SOCIENTIZE is a project funded by the European Commission dedicated to enhance citizen science models and their take up. In this conference, SOCIENTIZE will present the set of policy recommendations created after two years of networking, coordination and research activities. Socientize analyzed the main initiatives, funding programmes and actors in Europe to consolidate a common vision of citizen science as

a wide concept with multiple models of participation and many positive outcomes. We extracted a set of cross-cutting concerns and major areas in need of change and policy action. Each key question was shared with the community in order to propose one single collective response, endorsed and refined as policy recommendations. Those instructions were grouped in three levels: macro (European and national policy actors, including research funders), meso (citizen science infrastructures, scaffolding and mediator initiatives) and micro level (research groups, public organizations, citizen associations, NGOs, grassroots movements...). As a result, this White Paper presents elaborated instructions for topics including: funding strategies, evaluation and monitoring, incentivation and modification of value systems, engagement and training plans deployment of technologies, and the creation of new infrastructures within national member states as well as on a European level. All these outcomes will be presented in this conference. It is important to highlight that the resulting roadmap is not based only on the expertise and ideas of one consortium, but this consortium has actively engaged with relevant stakeholders in Europe and beyond to coherently consolidate these proposed issues. This collective process finds new paths for enhanced research and social innovations leading to actions that respond to the need of the paradigm shift in which we are engaged.

TURTLE SENSE: AN OPEN SOFTWARE AND HARDWARE CITIZEN SCIENCE PROJECT TO MONITOR SEA TURTLE NESTS
Samuel Wantman, NerdsWithoutBorders.net; Thomas Zimmerman, IBM Research; David Hermeyer and Charles Wade, NerdsWithoutBorders.net; Eric Kaplan, Hatteras Island Ocean Center; Britta Muiznieks, National Park Service
A common implementation of a Citizen Science project has a team of experts create a platform that is disseminated to citizens who collect and sometimes analyze data. If the platform is software, it is often distributed electronically, as with a phone app. A software platform may be open source, created by programmers volunteering their time. Projects that require open source hardware created by volunteers—like custom electronics—are more challenging as they require the additional investment of money and materials, and must be physically fabricated and transported. Funds must be found to pay for the cost of hardware development. Relationships need to be forged with non-profit and government institution partners. Trustworthy and reliable volunteers must be found and integrated into the project. These factors make open hardware projects much more difficult to run with a Citizen Science model.
To address these challenges, we created an on-line network, NerdsWithoutBorders.net, to attract and manage technically skilled volunteers to work on environmental and other real-world problems. Our first project, Turtle Sense, is based on both open software and hardware, coordinating the skills of biologists, electrical engineers, and computer scientists to design, build and deploy remote sensors that monitor motion and temperature in sea turtle nests with a goal of predicting hatching. The technology was developed by a small team of volunteers around the country working in partnership with the National Park Service and non-profit institutions in North Carolina. In our model, citizens are not only collecting and analyzing data, they designed, built and deployed data acquisition systems. Experience with our first project will help us design a replicable system that handles the challenges of open hardware projects.

ROLE OF GENERAL AVIATION IN PROMOTING CITIZEN SCIENCE: A PILOT STUDY OF WATER QUALITY MONITORING IN WESTERN LAKE ERIE
Rafat Ansari, NASA
Lake Erie is one of the five Great Lakes in North America surrounded by Michigan, Ohio, Pennsylvania, New York, and the province of Ontario. This lake is a great natural resource for recreation, fresh drinking water, and the hydroelectric power to millions of people. In recent years, the lake's environmental health has been a growing concern. The issue of algal bloom is now a major concern. In the first week of August 2014, the city of Toledo had to shut down the water supply for three days due to algal bloom problem. The community of general aviation (GA) pilots can play an important role in protecting and preserving this great natural resource by monitoring presence of algal bloom since these pilots fly at relatively low altitudes under visual flight rules (VFR). In this presentation we present a proof-of-concept flight study

over Lake Erie from June to September 2014. The stunningly high-quality aerial photographs and videos show an early onset of algal bloom, river plumes, sediment dynamics, and flow patterns that can be used by academia and others in their research and K-12 education. The images, free of any blur and propeller artifacts, were obtained every 5 seconds and matched with geo-referenced data tracking can be used to advance several scientific disciplines. These images can also offer an early warning system to alert communities of ensuing algal bloom along the coastline.

Disclaimer: Dr. Ansari is a Senior Scientist with NASA's Glenn Research Center in Ohio but the work presented here is done in his own time (not funded by NASA). Mr. Schubert is a retired educator from Berea School District in Ohio. He is also an Experimental airplane builder and Editor of Experimental Aircraft Support Publication. They enjoy flying over the beautiful Lake Erie and deeply care for its health.

4:10-5:30pm
Session 4G   230C
Talks: Tackling Grand Challenges and Everyday Problems with Citizen Science

A NOVEL MODEL OF CITIZEN SCIENCE TO BUILD HEALTH LITERACY WITHIN OUR COMMUNITY
Nicole Garneau, Denver Museum of Nature & Science
Successful primary prevention, the avoidance of the disease occurring in the first place, is a key step in community health literacy. Yet it is most effective when it promotes awareness in a way that is positive, personally relevant and accessible to people's everyday lives. To bridge the gap between health literacy and a fun and meaningful experience, we established the Genetics of Taste Lab and sought to build a novel model of citizen science in the space of human health.

Museum visitors are our research participants and the work is conducted by volunteer citizen scientists, including taste data collection, DNA extraction and gene analysis. We have three goals: to advance the range of citizen science projects into public health (in this case, nutrition and obesity), to conduct publishable scientific work, and to evaluate the educational potential of the model. Our educational data show that participants learn about themselves and the role of taste in their nutritional choices. Through peer-reviewed publication of the research we added needed knowledge to advance the scientific field this project serves and concurrently validated our model. Finally, we hit these goals in education and research while maintaining high marks with our citizen scientists: reported high satisfaction, value in their role, high retention rates, and importantly, a complete understanding of the study's design and purpose.

These data serve as evidence that a citizen science married with informal science education can be a foundation for primary prevention of impactful social issues like obesity. This authentic interaction within real research studies promotes awareness though thoughtful execution, while advancing citizen science into the personally relevant arena of human health.

BEE-PATH: EXPERIMENTS ON HUMAN MOBILITY
Josep Perelló, Mario Gutiérrez-Roig, Oleguer Sagarra, and Albert Díaz-Guilera, Universitat de Barcelona, Spain; Aitana Oltra, Frederic Bartumeus, and John Palmer, Consejo Superior de Investigaciones Científicas, Spain
Due to the progress of tracking technologies in smart phones is possible to study empirically human mobility at pedestrian level. Data available for research purposes at this level is scarce and somewhat restricted. ICT companies as, for instance, mobile phone operators have been traditionally recording the locations of the phone calls, but are reluctant to share the data with the scientific community. Bee-Path's approaches to the challenge of gathering data and therefore better understand human mobility with the use of citizen science strategies. The GPS signal from mobile phones is the best option and we thus went straightforward to obtain the full consent from a large number of individuals (450) that agree to participate in our experiment. First experiment was performed during the weekend of 16th and 17th of June of 2012 and within the Festa de la Ciència i la Tecnologia (Science and Technology Fair) of Barcelona with the support of the Citizen Science Office of the Barcelona Lab. We designed an App under the name Bee-Path and a website where data, codes and results are fully accessible. Volunteers were tracked during

the exploration of the stands in the fair. We shared with participants a basic analysis of the data gathered and thus transformed the experiment into a participatory citizen science experience. More than 5,000 valid GPS records were obtained to study 640 flights and 403 stops. In order to reproduce the aggregate statistics we develop a model based on Langevin Dynamics where particles interact with the landscape by means of a dynamic gravitational force field generated by several poles of attractions. The model reproduces with good accuracy collective properties of human in this kind of environments. The approach helps to anticipate spatial distribution of citizens at a neighborhood level and to improve the co-design of public events.

PARTICIPANT EMOTION IN A KNOWLEDGE GAP: MANAGING NATIVE AND NON-NATIVE SONGBIRDS IN A RESIDENTIAL LANDSCAPE

Caren Cooper, North Carolina Museum of Natural Science; Lincoln Larson, Clemson University; Mark Hauber, Hunter College

Ordinary people make management decisions for songbirds across the United States. Citizen science has the potential to coordinate such public stewardship and "backyard" management for a positive cumulative impact. There is scarcity of research, both ecological and social, to guide the design of participatory adaptive management of songbirds by land-owners. We focused on a study system involving bluebird and house sparrow management. Bluebirds are a native species for which people provide nestboxes. House sparrows are a non-native species that competes with native songbirds for nestboxes and that people try to limit. Given insufficient data to directly assess the efficacy of management options, and the reliance of citizen science participation to fill the data gap, we created The House Sparrow Project to begin to assess the decision-making process of citizen scientists. Using pre- and post-surveys and observations of participant engagement in the project, we investigated two questions: (1) What are the primary factors influencing the choice of management actions? (2) Does citizen science participation alter the balance of science-based and emotion-based drivers of management actions? We found that personal experience and emotions matter tremendously in this system. In pre-survey, the best predictors of management orientations were (a) firsthand experience with house sparrow damage and (b) emotional dispositions towards house sparrows. Lethal management (killing adult sparrows) was perceived as having the highest efficacy, but also the most controversial. Non-lethal management (removing nests) was perceived as more acceptable than no intentional management. Comparing pre- and post-surveys, participants who engaged in the project at high levels (submitted data) showed a decrease in support for experience-based management and stable support for science-based management. Participants who engaged at low and moderate levels did not change their views about science versus experience in decision-making.

TACKLING SOCIETAL CHALLENGES IN THE SOUTH: CHALLENGES AND OPPORTUNITIES FOR ENGAGED SCHOLARS IN THE NORTH

Maria Brunette, University of Massachusetts, Lowell

Advancing research about sustainable solutions to maintain healthy communities is a complex task and a challenge for engaged scholars in the 21st century. To have an impact, research deserves to be tackled from various perspectives and most importantly, must use a truly participatory approach where academics and community stakeholders respectfully work together and contribute to produce outcomes and solutions beyond the traditional boundaries of academia. In this presentation, the author shares lessons learned on becoming an engaged scholar in the North (USA) tackling societal challenges in the South (Perú) related to social equity, inclusion and justice. In an attempt to implement successful community-based participatory research (CBPR) approaches with two local research partners to fight Tuberculosis (TB) and improve maternal mortality in resource-poor communities in Lima and the Andes correspondingly, the author not only learned about the long, intense CBPR implementation processes –but most importantly, had the opportunity to strengthen her research capacity –while building capacity locally; learned about the importance of cultural norms, values, and priorities; fostered international collaboration, and witnessed the role of community health workers (promotoras) in maintaining community health projects alive. The author also discusses the importance of creating public awareness engaging the youth—in

particular, to be committed to their communities of origin and become advocates for public health. Ideas for exploiting social media to diffuse cross-disciplinary solutions to community health problems are presented.

BUILDING A MASSIVE BIOMEDICAL KNOWLEDGE GRAPH WITH CITIZEN SCIENCE
Benjamin Good, Max Nanis, Ginger Tsueng, Chunlei Wu, and Andrew Su, The Scripps Research Institute; Josh Peay, Southbird Studios
The life sciences are faced with a rapidly growing array of technologies for measuring the molecular states of living things. From sequencing platforms that can assemble the complete genome sequence of a complex organism involving billions of nucleotides in a few days to imaging systems that can just as rapidly churn out millions of snapshots of cells, biology is truly faced with a data deluge. To translate this information into new knowledge that can guide the search for new medicines, biomedical researchers increasingly need to build on the existing knowledge of the broad community. Prior knowledge can help guide searches through the masses of new data. Unfortunately, most biomedical knowledge is represented solely in the text of journal articles. Given that more than a million such articles are published every year, the challenge of using this knowledge effectively is substantial. Ideally, knowledge such as the interrelations between genes, drugs and diseases would be represented in a knowledge graph that enabled queries like: "show me all the genes related to this disease or related to any drugs used to treat this disease." Systems exist that attempt to extract this information automatically from text, but the quality of their output remains far below what can be obtained by human readers. We are developing a new platform that taps the language comprehension abilities of citizen scientists to help excavate a query-able knowledge graph from the biomedical literature. In proof-of-concept experiments, we have demonstrated that lay-people are capable of extracting meaningful information from complex biological text. The information extracted using this community intelligence framework can surpass the efforts of individual experts in quality while also offering the potential to achieve massive scale. In this presentation we will describe the results of early experiments and introduce our prototype citizen science platform: http://mark2cure.org.

5:30-7:30pm
Ballroom 220B and 220C

POSTER SESSION / RECEPTION
  See CS2015 Poster Session Program for details

HACKFEST: CREATING INTEROPERABILITY BETWEEN PROJECTS, COMMUNITIES, AND DATA
Darlene Cavalier, SciStarter, Science Cheerleader, Arizona State University, *Discover* Magazine; **Steve Gano**, SciStarter**; Greg Newman**, Colorado State University and SciStarter; **Caren Cooper**, North Carolina Museum of Natural Sciences
Bring your creativity, enthusiasm, and talents and we'll make sure you'll have fun!
The CS2015 Hackfest will build upon lessons learned during a similar event at the Citizen Cyber Science conference in London (February, 2014), organized by SciStarter, and NYU with support from the Alfred P. Sloan Foundation. This hands-on event is designed to be a collaborative working session to explore and design ways to create helpful connections between citizen science communities.
Participants and project owners face barriers: Multiple types of logins for many different projects or platforms coupled with an inability to track contributions across projects/platforms, are two examples. This hackfest aims to tap the collective wisdom of San Jose's programmers, designers, artists, program managers and others to design and create new or repurposed tools to help more people get involved in and track their contributions to citizen science projects AND to explore ways projects can share data, volunteers, tools and other resources to rise the tide of citizen science and enable better cross-platform analytics for project leaders while improving the experience for participants.

Daniel Arbuckle (lead developer, SciStarter); Steve Gano (director of product development, SciStarter); Greg Newman (CitSci.org); Russell Neches (UC Davis/Eisen Lab).

Citizen Science 2015 Conference
Oral Presentation Abstracts

*Presenting authors' names are **bolded***
Affiliations are US-based unless otherwise indicated

Thursday, 12th February, 2015

7:10-8:10am
Lobby, Main Level
Coffee / Meet & Greet CSA Board Members

8:10-9:30am
Session 5A   Ballroom 220B
Symposium: Broadening Engagement to Foster Diversity and Inclusion

LINKING CITIZEN SCIENCE AND INDIGENOUS KNOWLEDGE: AN AVENUE TO SUSTAINABLE DEVELOPME
Michalis Vitos (Session Chair), University College London, UK; **Dawn Wright**, ESRI; **Sam Sudar**, University of Washington
Sustainable development is one of the most significant challenges humanity faces nowadays on global and local scales. Although historically communities accumulate immense information regarding the sustainable survival of their surrounding environments, only in the last decade there is growing recognition that Indigenous Knowledge (IK), specifically to Traditional Ecological Knowledge (TEK), is critical for environmental and social sustainability.
In the context of sustainable development, citizen science can empower communities to share and apply their knowledge of local environmental conditions using scientifically accepted methods than can lead to improvements in environmental governance and social-environmental justice.
The challenge is to come up with tools and methodologies that can enable any user, regardless of his educational or literacy level, to understand, collect and share local conditions. Tools must be adapted to the specific socio-economic, ecological, cultural and technical contexts and most importantly, designed to empower users to act upon the analysis.
This symposium aims to bring together researchers and practitioners to share insights in understanding and engaging with underprivileged populations in both the developing and developed world, as well as to showcase research for designing, developing and evaluating Information and Communications Technology (ICT) systems that enable lay users to capture knowledge, report in-situ observations, visualize and discuss results.
Speakers:
Michalis Vitos, University College London: Introduction and
Dawn Wright, ESRI - Emerging Citizen Science Initiatives at ESRI
Michalis Vitos - Sapelli, a data collection platform for non-literate, citizen-scientists in the rainforest
Sam Sudar, University of Washington - Collecting data with Open-Data-Kit (ODK)

8:10-9:30am
Session 5B   Ballroom 220C
Talks: Best Practices for Designing, Implementing, and Managing Citizen Science Projects and Programs

MAKING CITIZEN SCIENCE SUSTAINABLE FOR YOUR ORGANIZATION
Jamie Elizabeth Montague and Chrissy McLean, Port Townsend Marine Science Center
Port Townsend Marine Science Center (PTMSC) has one of the longest standing Citizen Science (CS)

programs in the United States, having engaged over 1,200 citizens in approximately 35 projects over a period of 22 years. In 2013, PTMSC completed a year-long evaluation of its CS program by conducting in-depth interviews and online surveys with nearly 300 volunteers and coordinators from past and current projects. PTMSC looked at several measures of project effectiveness and compared our CS model with CS programs from around the country. Evaluation tools were developed to compare overall value of projects competing for institutional time and attention. This interactive session will provide participants with project and program coordination tools that came from this analysis. Areas addressed include the design, implementation, management, and evaluation of a financially and institutionally sustainable Citizen Science program.

This interactive presentation will lead an audience of citizen science coordinators and volunteers through:
- considering effective tools and techniques for data management,
- balancing scientific and educational goals for the coordinating
organization as well as citizen scientists,
- understanding how to create project selection criteria that
best suit your organization's needs and goals, and
- identifying the fundamentals of financial sustainability

LESSONS IN CITIZEN SCIENCE FROM THE EVOLUTION OF WHALESHARK.ORG

Jason Holmberg, http://www.wildme.org; Zaven Arzoumanian and Jake Levenson, Wild Me
The past decade has seen increasing recognition of the need for regional and global conservation efforts for migratory marine species, such as the whale shark (*Rhincodon typus*), which must be informed by rigorous scientific assessment of their abundance, migration, and other behavioral patterns. However, for rare species, achieving sufficient levels of data collection for analysis often necessitates recruiting citizen scientists and tourists to increase available effort. We present 12 years of experience developing and growing a tightly focused, online portal for collaborative wildlife research fueled by citizen science contribution of data. "Wildbook for Whale Sharks" (http://www.whaleshark.org) is a flagship project for marine citizen science, supporting 100+ volunteers and researchers distributed globally and collecting usable data from 4200+ submitters. Independently validated as a viable mark-recapture tool and spanning multiple disciplines, it tracks 5600+ individual whale sharks across the globe and has facilitated the publication of peer-reviewed papers, proceedings and reports, and graduate theses. We present our lessons learned, such as the use of structured information models and feedback loops, from over a decade of growth and successful project management. We also demonstrate how our open source "Wildbook" platform (http://www.wildme.org/wildbook) and our "Wild Me" social media outreach project (http://apps.facebook.com/wildmeapp) make our scientific and collaborative successes reproducible, inexpensive, mass consumable and informative.

THE EVOLUTION OF VOLUNTEER SCIENCE IN THE USGS NATIONAL GEOSPATIAL PROGRAM

Elizabeth McCartney, U.S. Geological Survey
Using crowd-sourcing techniques, the US Geological Survey's (USGS) Volunteered Geographic Information (VGI) project known as "The National Map Corps (TNMCorps)" encourages citizen volunteers to collect and edit data about manmade structures in an effort to provide accurate and authoritative map data for the USGS National Geospatial Program's (NGP) web-based The National Map. VGI is not new to the USGS, but past efforts have been hampered by available technologies. Over the past two decades, the USGS National Geospatial Technical Operations Center has sponsored various forms of volunteer map data collection projects. As valuable as the updates were, the technology was not yet available to take full advantage of the work done by volunteers. The transition from the database onto the USGS topographic maps remained problematic and continued to require a fair amount of USGS resources to process. In 2008, the program was suspended due to lack of resources. In 2011, improved technology, social media, and ever decreasing resources once again made crowd-sourcing an attractive option. Several pilot projects were launched to determine the viability of bringing back the volunteer mapping program. Building on lessons learned, today, The National Map Corps volunteers are successfully editing 10 different structure types in

all 50 States as well as Puerto Rico and the US Virgin Islands, including schools, hospitals, post offices, police stations and other important public buildings. Using National Agricultural Imagery Program (NAIP) images as the primary base layer, volunteers collect and improve structures data by adding new features, removing obsolete points, and correcting existing data. The success of TNMCorps has not been without challenges including lack of clear steps needed to implement citizen science programs, navigation of the Paper Reduction Act process, and personally identifiable information issues. This talk will discuss the evolution of volunteer science in the National Geospatial Program.

PARTNERING FOR AMPHIBIAN MONITORING: INVOLVING ZOO AUDIENCES IN COLLECTING DATA ON LOCAL WILDLIFE

Katie Remine and Jenny Mears, Woodland Park Zoo; Chris Anderson, Washington Department of Fish and Wildlife

For the past four years, three nationally-accredited Washington state zoos (Woodland Park Zoo, Pt. Defiance Zoo & Aquarium and Northwest Trek Wildlife Park) have collaborated with Washington Department of Fish and Wildlife (WDFW) to recruit, train and coordinate citizens to collect data on amphibian egg masses. The WDFW data collection protocol focuses on presence/absence data on egg masses of eight amphibian species in wetlands throughout western Washington.

Woodland Park Zoo's (WPZ) program—coordinated by WPZ's School & Community Engagement team—engages approximately 65 adults and 15 youth volunteers, divided into 15 teams, in monitoring sites in two counties once a month from February through August. The training session each January consists of classroom training and field practice on amphibian egg mass identification and WDFW's data collection protocol. Participants borrow monitoring tools from WPZ, including hip waders, digital cameras, GPS units, and aquascopes. Training includes aquatic invasive species identification and equipment decontamination protocols so participants can document – and prevent the spread of – aquatic invasives. Participants report data using an online and mobile application developed by WDFW for public observation reporting on state priority species.

This presentation will illustrate WPZ's experience with this collaborative project, including the logistics of partnerships between informal science institutions (like zoos) and government agencies, recruitment, training in data collection protocol, site selection, data submission, presentation of results, and participant retention. The results of participant surveys will be presented, emphasizing the positive participant outcomes of citizen science programs as well as the potential for informal science institutions to draw broad community participation. While the amphibian egg mass data collected is still preliminary, this presentation will provide those interested in engaging citizen scientists in collecting robust data with detailed information on the logistics, benefits, and challenges of implementing and evaluating these types of partnership programs.

CITIZEN SCIENTISTS COUNT! DOES IT MATTER WHO IS IN CHARGE?

Colleen Wisniewski, Reef Check Foundation; Dirk Burcham, Volunteer, Aquarium of the Pacific

Diver-based underwater surveys are essential for the implementation and evaluation of many marine restoration, conservation or management projects. Volunteer citizen scientists are involved in several underwater marine biological surveys in California. These surveys present a unique set of organizational, logistical and cost challenge. We will compare and contrast three different programs conducted in Southern California in which citizen scientists performed diver-based marine monitoring: 1. Catalina Conservancy Divers (CCD), a support group of the Catalina Island Conservancy conducting Key Species Surveys; 2. California Coastkeeper Alliance (CCKA), conducting a Southern California Kelp Restoration Project; 3. Reef Check California (RCCA), conducting statewide rocky reef monitoring. These programs are structured according to three different operational models: CCD is a volunteer managed and staffed program with minimal institutional involvement; CCKA is a time-limited project led by paid staff; RCCA is an ongoing monitoring program led by paid staff. We will share experiences from a volunteer as well as staff perspective in the areas of volunteer training, volunteer retention, volunteer involvement and discuss data management and program costs. Some of the key lessons from this comparison are that (1)

volunteer run programs can be successful and that keeping the project simple is key to continued volunteer participation. (2) A defined end date of a project does not impact volunteer participation. (3) Institutional support and paid staff are needed for projects with complex monitoring protocols and larger regional scope.

8:10-9:30am
Session 5C   Lower Level 20A
Talks: Tackling Grand Challenges and Everyday Problems with Citizen Science

RECENT APPLICATIONS OF CONTINENTAL-SCALE PHENOLOGY DATA FOR SCIENCE, CONSERVATION AND RESOURCE MANAGEMENT
Jake Weltzin, U.S. Geological Survey
The USA National Phenology Network (USA-NPN; www.usanpn.org) serves science and society by promoting a broad understanding of plant and animal phenology and the relationships among phenological patterns and all aspects of environmental change. The National Phenology Database, maintained by the USA-NPN, is experiencing steady growth in the number of data records it houses; these data are now being used in a number of applications for science, conservation and resource management. The majority of the data in the database has been provided by volunteers, or "citizen scientists," participating in the USA-NPN national-scale, multi-taxa phenology observation program Nature's Notebook. In fact, between 2008 and August 2014, the 3,687 active participants registered with Nature's Notebook have contributed over 3.8 million observation records for plants and animals, including historical lilac and honeysuckle data that date back to 1954. This presentation will demonstrate several types of questions that can be addressed by engaging citizen scientists in a standardized national monitoring system focused on field observations of biodiversity. Because the proof is often in the pudding, we will feature a diversity of recently published studies, but will also highlight several new and ongoing local- to continental-scale projects. Projects include continental bioclimatic indices, regional assessments of historical and potential future trends in phenology, sub-regional assessments of temperate deciduous forest response to recent variability in spring-time heat accumulation, state- and management unit- level foci on spatio-temporal variation in organismal activity at both the population and community level, and local monitoring for invasive species detection across platforms from ground to satellite. Additional data-mining and exploration by interested researchers and/or resource managers will likely further demonstrate the value of these data. The bottom line is that "citizen science" represents a viable approach to collect data across spatiotemporal scales often unattainable to research scientists under typical resource constraints.

PRIVACY IN CITIZEN SCIENCE: AN EMERGING CONCERN FOR RESEARCH & PRACTICE
Anne Bowser, Katie Shilton, and Jennifer Preece, University of Maryland, College Park
Citizen science projects increasingly rely on technologies, ranging from stationary sensors to smartphones, to aid in data collection, submission, and retrieval. These technologies enable projects to collect large volumes of data, to collect more precise data, and to engage new audiences (e.g., through games). However, these powerful tools may pose significant threats to the privacy and security of volunteers. Citizen science researchers and practitioners working in health and wellness have raised considerations regarding how technologies and protocols can be designed to support volunteer privacy, such as ensuring that records do not inadvertently fall into the hands of insurance agencies. But privacy in ecology and field science projects has been much less discussed. We expand these efforts by focusing on location-based privacy concerns, which are particularly relevant to ecological monitoring campaigns.
Helen Nissenbaum's theory of Contextual Integrity suggests that individuals form and express privacy concerns based on a mix of unique contextual factors. By applying the theory of contextual integrity to citizen science, our project will examine a range of factors that may impact practitioners' and volunteers' privacy concerns, and how these concerns are addressed. Key factors may include data type, project type, volunteer role, interpersonal relationships, power structures, social norms, unique motivations, and

general values. This presentation describes results from pilot interviews with both practitioners and volunteers involved with projects that collect potentially sensitive data about location. Findings from the analysis of these interviews will inform a best practices guide for supporting volunteer privacy taking into account institutional realities and other constraints.

By voicing these important questions at Citizen Science 2015 and reporting on early findings, we expect to inspire other attendees to think critically about volunteer privacy in citizen science. We also plan to recruit additional projects and volunteers to contribute to our work.

A CITIZEN-ARMY FOR SCIENCE: QUANTIFYING THE CONTRIBUTIONS OF CITIZEN SCIENCE TO OUR UNDERSTANDING OF MONARCH BIOLOGY AND CONSERVATION

Karen Oberhauser, University of Minnesota; Leslie Ries, University of Maryland

The first monarch citizen science program was launched by Dr. Fred Urquhart from the University of Toronto in the 1950's. Since then, thousands of volunteers have been engaged in 17 monarch-focused and more than 14 general butterfly citizen science programs that collect critical data on monarchs at both regional and continental scales. These volunteers have made fundamental contributions to our accumulating knowledge of monarch biology. In what we believe is a first for a single organism, we quantified the amount of time volunteers spend collecting data and the degree to which citizen science has contributed to monarch scholarship. In 2011, we estimate that volunteers spent almost 72,000 hours collecting data on monarch distribution, abundance, behavior, and health. Of 503 monarch-focused research publications that presented new findings from 1940-2014, 17% utilized citizen science data. For papers using field-based data and published after 2000, when several large-scale programs were well established, this value increased to 66% (when papers focused on the Monarch Butterfly Biosphere Reserve in Mexico, where citizen participation is limited, are excluded). We also find that, in contrast to recent reviews, programs that are largely organized and run by citizens also contribute substantially to scholarship suggesting scientists do not need to be the primary force behind a program for it to be successful. However, there are persistent gaps in the use and coverage of monarch citizen science data, and we discuss characteristics of projects that are more likely to result in data analysis and publication. We also show that citizen science volunteers are deeply engaged in all aspects of monarch research and data use, and conservation. Finally, we argue that monarchs provide a model system for understanding the impacts of citizen science on scholarship, public engagement, and conservation.

EMAMMAL CITIZEN SCIENCE CAMERA TRAPPING—COLLECTING BIG DATA TO ANSWER WILDLIFE QUESTIONS

Roland Kays, North Carolina Museum of Natural Sciences & North Carolina State University; Robert Costello, Smithsonian National Museum of Natural History, Washington, DC; Tavis Forrester, Smithsonian Conservation Biology Institute, Front Royal, VA; Joshua Millspaugh, Department of Fisheries and Wildlife Sciences, University of Missouri, Columbia, MO; Tony X. Han, Department of Electrical and Computer Engineering Department, University of Missouri, Columbia, MO

Variation in the abundance of mammals on the landscape affects a broad range of ecosystem processes including herbivory, predation, disease spread, and seed dispersal. However, these patterns, and the effects of human disturbances on them, are poorly understood because of lack of data at the appropriate scales. The eMammal project recruits citizen scientists to survey mammal communities with motion-sensitive camera traps. Over the last two years our volunteers have used camera traps to sample 2300 sites, recording over 2.6 million photographs in ~50,000 trap-nights. We started with a study design addressing hypotheses about the effect of hunting and hiking on wildlife, and are now expanding into developed areas to survey repeated urban-wild gradients. Statistical analysis of animal diversity, abundance, and activity has given us new insight into the mechanisms that regulate animal abundance. For example, parks in developed areas had higher overall animal activity rates but lower species diversity. Hunted areas had lower deer but higher coyote activity than nearby unhunted preserves. Avoidance of hiking trails by animals was minor, and most nocturnal predator species were more commonly detected on-trail. These types of results are only achievable with a large, dispersed database, which would be

impossible to collect with traditional methods. Our next challenge is to maintain the flow of data by expanding our involvement of citizen scientists and broadening our concept of volunteer data collectors. We look to grow the eMammal project by working with other research groups around the world interested in leading their own camera-trapping project. To this end we are developing customizable web portals and image analysis tools that will not only benefit researchers, but help engage more citizens in the fun activity of running camera traps outdoors, and give them the tools to make scientific discoveries with the data on their own.

8:10-9:30am
Session 5D   Lower Level 20B
Story Presentations across Conference Themes
   Session Chair: **Linda Silka**, Director, Margaret Chase Policy Center, University of Maine

THE BEES' NEEDS: THE COSTS AND BENEFITS OF BEING POPULAR
Alexandra Rose, University of Colorado; Virginia Scott, University of Colorado Museum of Natural History

The Bees' Needs (http://beesneeds.colorado.edu), is a field-based research project that is focused in the Northern Front Range region of Colorado. This area is home to over 500 native bee species, one of the most diverse regions in North America. In 2014 we recruited ~250 volunteers and in 2015 this grew to ~500 participants who have helped us address very explicit research questions—how do landscape attributes and land management practices influence native solitary bee and wasp diversity and abundance? To answer these questions we provide volunteers with native bee nesting sites ("bee blocks") on which they collect data every other week throughout the summer months. This project openly seeks to educate and engage volunteers around scientific literacy and conservation biology of native insects. With two field seasons of data, we are starting to make some interesting scientific discoveries, but the number of people who would like to participate has quickly outstripped our capacity to build and distribute enough bee blocks. In this talk I will tell the story of our early scientific findings, insights into volunteer motivation, what we have learned about logistical growing pains, and how we use untrained volunteers to census an extremely diverse set of organisms that they almost never see.

GETTING DIRTY WITH CITIZEN SCIENCE: LESSONS LEARNED FROM ENGAGING THE PUBLIC IN HANDS-ON CITIZEN SCIENCE AT A MUSEUM FIELD STATION
Christine Goforth, North Carolina Museum of Natural Sciences
Citizen science has played an increasingly large role in the informal education offerings at the NC Museum of Natural Sciences and has become a powerful tool for engaging visitors in authentic science. At the Museum's Prairie Ridge Ecostation field station, hands-on, outdoor citizen science programs are offered to the public regularly, from weekly drop-in citizen science hikes to K-12 educational programs to multi-day citizen science training workshops for teachers and environmental educators. Through these programs, we have learned several important lessons about citizen science that have shaped how we develop new public programs, how we train citizen scientists, and how we create new citizen science projects at our institution. This storytelling presentation will describe how we engage visitors in outdoor citizen science at Prairie Ridge and will share the lessons learned through these programs, including 1) the general barriers to participation we've identified for our participants, 2) the value of observing people doing citizen science in the field, 3) how we engage people of all ages and interest levels in citizen science, and 4) how working with environmental education centers and other public outdoor facilities can improve your citizen science projects. Our field station benefits hugely from having an active citizen science program as well, and I'll share some of the ways that our citizen science programming has improved our facility as our visitors learn about science. We spend a lot of time in the field with citizen scientists from all walks of life, observing how and why our participants get involved. Many of the lessons we've learned could be applied by other citizen science practitioners to create more effective and more engaging citizen science projects and programs, so join me as I share what we've learned!

CITIZEN SCIENCE IN MINNESOTA WATERS: LESSONS LEARNED FROM 17 YEARS IN THE TRENCHES
Laurie Sovell, Louise Hotka, and Shannon Martin, Minnesota Pollution Control Agency
Minnesota is water rich: 12,000 lakes, 69,000 miles of rivers, and 10 million acres of wetlands. The Minnesota Pollution Control Agency (MPCA) works to protect and improve Minnesota's environment and enhance human health. As part of its mission, the MPCA is mandated to monitor, assess, protect, and restore these critically important water resources. The MPCA employs a watershed approach to carry out this work, concentrating its monitoring and assessment in specific watersheds so that each of the state's 81 major watersheds is the focus of intensive monitoring once over a 10-year cycle. The abundance of water bodies in the state does lead to spatial and temporal gaps in data collection. In response, the Citizen Stream Monitoring Program (CSMP) was launched in 1998 as a collaborative partnership between MPCA staff and Minnesota citizens. The program engages residents in annual statewide stream data collection initiatives that promote an increased understanding of watershed dynamics. We will share the history of the CSMP, from its early beginnings with a few dozen participants and monitoring sites, to its current roster of over 300 volunteers monitoring at nearly 500 locations statewide. We will chronicle the program's evolution, touching on early recruitment techniques, the incorporation of volunteer data in the state water quality assessment process, and changes to program monitoring equipment to improve data quality and efficiency. We will explore barriers to administering a statewide citizen science program, and retaining participants with whom interaction is limited. We'll also touch on technical limitations the program has encountered over the years, related to data management and reporting. The future holds a challenge, and bright promise, to leverage the dedication and commitment of Minnesota's citizen water monitoring community toward productive efforts to restore and protect the state's natural water riches.

8:10-9:30am
Session 5E   Lower Level 20C
Talks: Making Education and Lifelong Learning Connections

OVERCOMING THE TAXONOMIC ID BOTTLENECK IN WATER QUALITY BIOMONITORING USING A DYNAMIC ONLINE VISUAL RESOURCE
Marti Louw, University of Pittsburgh Center for Learning in Out-of-School Environments
Camellia Sanford Rockman, et al
Reliable species identification is a critical activity in many citizen science projects. Training volunteers to observe relevant characteristics that support identification with confidence, accuracy and efficiency is a perennial challenge. To address this participation barrier in a targeted way, we developed an open educational resource to specifically address the needs of people learning to do stream insect identification for community-based biomonitoring projects and water quality assessment activities in environmental educational programming.
The aquatic macroinvertebrate collection <www.macroinvertebrates.org> was developed in a cross-disciplinary collaboration with partners from entomology, computer science, and the learning sciences, and with valuable design input and participation from regional environmental education and watershed groups. The tool takes advantage of dynamic high-resolution online image environments to create a new kind of annotated multimedia field guide. Users can explore microscope-quality images of stream insects taken from a museum collection of voucher specimens, and zoom in with extraordinary detail to learn about the diagnostic characteristics that differentiate groups and determine pollution tolerance values. Our talk will describe the design-based research approach that we used to define, and iteratively refine the tool with stakeholders. We'll also share findings from our evaluation, which compared learners' use of, engagement with, and opinions about traditional print-based dichotomous keys, illustrated flash cards, and our digital aquatic macroinvertebrate collection to identify unknown insects. Our discussion will center on the tradeoffs between static text-centered materials and dynamic visual learning resources to support volunteers' identification work. Lastly, we suggest implications for the field regarding how new kinds of image-rich online platforms might change the ways that information is shared, observational

practices are supported, and training of citizen scientists is facilitated.

EDUCATIONAL INTERVENTIONS IN ZOONIVERSE PROJECTS
Julie Feldt, Laura Whyte, and Kelly Sutphin-Borden, Adler Planetarium
The Zooniverse education team has been looking for ways to provide deeper engagement opportunities for its volunteers in the citizen science projects they are contributing to. Zooniverse should be providing resources within the project to empower a more diverse group of full-fledged citizen scientists. Google analytics shows that volunteers rarely visit the science pages, therefore the science should be brought to them.
The relaunch of Planet Hunters in Fall 2014 provided Zooniverse with an opportunity to test new methods to more effectively providing participants with further awareness of the science behind the project they are contributing to. Using an innovative system of embedded mini courses, the volunteer will be periodically interrupted during the classification process to expand their knowledge of that project.
Data collected from Planet Hunters will inform the design of future mini courses in other projects, these courses will be designed to provide the interested user more background information into the research and how the citizen science of that project works. These will be a motivator and confidence builder for participants, as well as you make them feel more invested in the project.
This talk will share what has been learned so far about the volunteers' use of the educational tools, the A/B split results from the Planet Hunters interventions and outline a plan to create a template for developing these interventions for science teams to use as guidelines for long-term engagement.

LIFELONG LEARNING AS AN INCENTIVE FOR CITIZEN ENGAGEMENT IN ENVIRONMENTAL ACTIONS
Eva Garcia-Vazquez, University of Oviedo, Spain; Alba Ardura, University of Perpignan, France; Yaisel J. Borrell, Laura Miralles, and Eduardo Dopico, University of Oviedo
Marine species move with climate change, aquaculture, maritime traffic, litter; some settle down in new colonized areas and their populations grow uncontrolled becoming invasive. Early detection is crucial for preventing invaders from spreading, but surveillance and monitoring of all marine waters worldwide is a huge task. Recruitment and training of volunteer citizens is therefore a need for local biodiversity conservation. In this study, researchers from Asturias (North Spain) organized public short informative talks about marine bioinvasions and a workshop for introduction to molecular biology (DNA workshop). At the end of these formative activities they were asked to be members of a Network of Coastal Surveillance. Attendants were classified according to their involvement in lifelong learning programs (yes or not) and working status (employed/unemployed/veterans or retired). Results showed differences between veterans and the rest of participants for acquired learning gains. On the other hand, lifelong learners contributed significantly more to the Network recruits. Taken together, these results suggest an added value of lifelong learning for Citizen Science programs.

KEEPING IT REAL—EMPOWERING YOUTH IN SCIENCE THROUGH WATER QUALITY MONITORING
Biret Adden, Children's Discovery Museum
BioSITE (Students Investigating Their Environment) is a watershed education field program, developed by Children's Discovery Museum of San Jose to change the way students engage with science. Students are empowered as citizen scientists by monitoring and evaluating the health of local creeks as they also explore the complexities of river ecology and human/nature interactions. Students "keep it real" by using authentic scientific equipment, field techniques, and real-time interpretation of results. Water quality monitoring provides a powerful framework for science education, bringing science to life and within reach. However, how can student monitors keep it real for everyone else? Without a local forum for disseminating and sharing their data, BioSITE students are limited in the impact of their work. They benefit from their own scientific experience, but could be even more empowered by connecting and sharing their work with a larger community. How can student monitoring groups work together and with wider organizations to bring greater voice and authenticity to the terrific work they do? In this presentation about BioSITE, youth presenters will share their personal experiences as monitors and their perspectives

on how to "keep it real" for student scientists moving into the future.

GRASSROOTS CITIZEN SCIENCE AT THE END OF THE WORLD: BALANCING BARRIERS AND OPPORTUNITIES IN NEW ZEALAND
Monica Peters, Professor David Hamilton, and Dr. Chris Eames, University of Waikato, New Zealand
New Zealand has a flourishing citizen science movement with initiatives covering a spectrum of volunteer engagement. Both scientist-led and community group-led projects are growing in number and diversity. Additionally, a range of community-friendly tools have been developed to enable community groups to measure variables associated with their environmental restoration projects. To provide insights into future citizen science project development, a questionnaire was emailed to 540 community environmental groups throughout New Zealand. Themes included: support received and required from project partners; monitoring activities carried out; barriers to setting up monitoring programs; monitoring priorities and data use. To further explore the latter themes, a series of interviews (n=34) was carried out with resource managers and scientists. Questionnaire participants (n=296) underscored the necessity for long-term support across project partners while the twin barriers for monitoring program establishment comprised shortfalls in funds and volunteers. In spite of this many groups have well-established monitoring programs (≥6 years). Terrestrial monitoring predominated but groups also reported considerable interest in future water quality monitoring. While most data were used for guiding restoration management, the majority of groups that provided data to resource managers were unaware of how those data are used. Interviews underscored data validity concerns though most interviewees acknowledged the potential utility of community-generated data. Citizen science is a highly dynamic field with ecologically literate community groups uniquely positioned to have greater input into environmental decision-making. Findings are discussed against a backdrop of continued environmental declines, much needed cohesion and strategic direction for citizen science nationally, and proposed collaborative approaches for managing New Zealand's freshwater resources.

8:10-9:30am
Session 5F   Lower Level 20D
Talks: Digital Opportunities and Challenges in Citizen Science

AURORASAURUS: CROWDSOURCED CITIZEN SPACE WEATHER SCIENCE
Andrea Tapia and **Nicolas Lalone**, Penn State University; Elizabeth MacDonald, NASA; Michelle Hall, Science Education Solutions
Elizabeth MacDonald, NASA; Michelle Hall, Science Education Solutions
We have created Aurorasaurus, a website, a mobile application and a scientific tool that allows a community of users to better predict sightings of the aurora borealis. Aurorasuarus combines limited space weather science data, participant sightings and the analysis of social media data into a better prediction engine. This then serves to alert interested parties as to nearby sightings.
During the testing of our prototype, we found that the Kp index, a key measure of auroral activity, correlates strongly with the number of aurora-related tweets. This suggests that volunteered Twitter data is a valid indicator of real-world events. The years around 2014 are the latest solar maximum recurring on an eleven-year solar cycle. Now is the time when aurora is more likely over populated areas, and this is the first solar maximum with social media, an unprecedented opportunity to engage the public, the scientific community, and the media.
Space weather scientists have only coarse means to predict where the aurora will occur. However, a network of observers on the ground can provide ground truth, which could enable nowcasts. We anticipate an order of magnitude increase in accurate knowledge of where and when the aurora are visible by augmenting existing observations and models with real-time ground truth. Combined with data from Earth-based and satellite observatories, this allows Aurorasaurus to offer near real-time predictions of auroral activity in both text and map form, likely with much greater accuracy and timeliness than the current state of the art.

User observations of the aurora—collected from Twitter as well as an entry form offered on the website itself—are displayed on a map as pins. We augment this web implementation with a mobile application, in order to make Aurorasaurus more fully available in the field, where its services are most useful.
http://www.aurorasuarus.org

CITSCI.ORG: A COMPREHENSIVE CITIZEN SCIENCE SUPPORT PLATFORM

Greg Newman and Russell Scarpino, Colorado State University (CSU)/CitSci.org; Alycia Crall, Virginia Tech; Jim Graham, Humboldt State University; Nicole Kaplan, Stacy Lynn, and Melinda Laituri, CSU

Citizen science programs are increasing in number, breadth, and popularity. These programs operate at multiple spatial and temporal scales, address myriads of topics, generate volumes of diverse scientific data, and involve numerous stakeholders. To be effective, such programs must ask questions, form teams, manage members, identify protocols, collect data, share results, and evaluate success. On face value, these tasks may seem simple. In reality, they are diverse, complex, and demanding of limited resources. To address these challenges, we built CitSci.org (www.citsci.org)—an open, comprehensive, and fully customizable cyber-infrastructure support system for citizen science programs. Our objective was to support the full spectrum of both program and data management needs. We aimed to support both participant management (e.g., different roles and privileges) and data management (e.g., integration, standardization, analysis, visualization, and sharing). Currently, CitSci.org empowers program coordinators to create their own projects; manage members and roles; build data sheets; define protocols (e.g., plot types, measurements, and units); synchronize online and mobile data sheets; streamline data entry; visualize data on tables, maps and charts; automate customized real-time analyses; and get participant feedback using customized surveys. Thus far, CitSci.org has supported 97+ programs resulting in 53,744+ site characteristics and 28,285+ species observations. The programs supported include both bottom-up, co-created efforts and top down, contributory approaches. Here, we discuss the opportunities afforded by CitSci.org to support the needs of citizen science programs. We detail current capabilities, discuss informatics needs for sharing and integrating data, present lessons learned for developers and users alike, and illustrate challenges encountered, possible solutions, and future directions. We conclude by discussing the importance of, and challenges associated with, sharing measurements and units across projects and developing tools that transcend diverse topics while remaining topically relevant.

THE CHALLENGES AND BENEFITS OF AGING CITIZEN SCIENTISTS: LOOKING AHEAD TO THE NEXT THIRTY YEARS OF LOON COUNTING IN MAINE

Susan Gallo, Maine Audubon

The Common Loon is an iconic bird of Maine's lakes and ponds. Its dramatic plumage, large size and haunting calls make it a bird that Mainers know and love. For the last three decades, The Maine Loon Project at Maine Audubon has organized a dedicated group of over 1,000 "loon counters" with the objective of improving loon habitat and enhancing loon conservation. These citizen scientists have literally watched out for Common Loons, monitoring habitat, measuring productivity, collecting carcasses, and participating in an annual loon count on the third Saturday in July. With the knowledge gained as a result of this group's efforts, we've helped improve shoreland zoning rules, protect water quality, limit the use of lead tackle, and create a dedicated group of advocates speaking up on behalf of loons and lakes. We've also been able to monitor a population that is highly at risk from a changing climate. But past success is not necessarily indicative of future success. The Maine Loon Project faces many challenges in the coming decades, not the least of which is an aging but yet still dedicated group of citizen scientists. The primary challenge of working with this group is a lack of digital experience, which can make the streamlining of communication difficult and more time-consuming, especially as new counters come on-line expecting a digital interface. The benefits of nurturing and retaining this group however include a vast long-term knowledge of lake and loon history that is literally irreplaceable. Finding a way to attract and keep new citizen scientists in this digital age while maintaining aging counters for the next decade or more is a challenge. Strategies like finding digital "mentors", recruiting younger family members with digital

expertise, and offering digital outreach and education to older counters may help bridge the growing technological gap.

WYOBIO CITIZEN SCIENCE PROGRAM AS A PLATFORM FOR INNOVATIVE PROGRAMMING, DATABASE DESIGN AND LONGEVITY OF DATA
Teal Wyckoff, University of Wyoming, Wyoming Geographic Information Science Center; Brenna Marsicek and Dorothy Tuthill, University of Wyoming Biodiversity Institute
The Wyoming Biodiversity Citizen Science Initiative, or WyoBio is a new citizen science initiative and online mapping application designed to provide students and interested citizens with access to information about Wyoming's biodiversity. The program allows users to upload, download and view observation data in conjunction with species distribution and range information. Species observations can be overlaid with a host of other information from geology and elevation, to vegetation types and anthropogenic disturbances. While the program is geared toward a young audience, the creation of the digital back-side of the program was rigorous, challenging, interdisciplinary and done with an eye for long-term data collection, serving and storage. Our team of biologists, educators, database experts and website programmers and designers collaborated to tackle the challenges of creating a sustainable application that is aesthetically pleasing and engaging. With an extensive amount of data organized in an easy to use format, WyoBio is designed to appeal to both students and other interested citizens alike – sparking their interest in the natural world and its diversity of species. The mapping application is designed to capitalize on new tools available in the ever-advancing world of spatial technologies to meet the unique needs of the end user. In this presentation, we will share our methods for data management and database design, visualization and interpretation, as well as techniques used to develop a user interface that is elegant and appropriate for children but driven by the integration of technology from backend databases to the front end web interface.

LEVERAGING TECHNOLOGIES TO EMPOWER CITIZEN SCIENCE AND PUBLIC INVOLVEMENT WITH WATER QUALITY, BIOLOGICAL AND ENVIRONMENTAL MONITORING
Maria Gonzalez, Clean Water Team
Improving and protecting water quality for aquatic life depends on a solid framework for monitoring to protect and restore this beneficial uses. The task is not a simple one nor can it be done cheaply. To fulfill stewardship missions, NGO's and agencies need to find innovative ways to become more efficient, productive and expand our programs at a lower cost. Promoting and supporting citizen monitoring (citizen science + volunteer monitoring) with the use of wed-based and portable digital tools can be a huge asset. The use of Internet-based resources and portable apps has been instrumental to the success of the Clean Water Team in helping volunteer monitors reach their goals. To meet the demand for supporting, educating and training volunteer staffed programs the Clean Water Team and its partners have been using and developing various digital tools (guidance documents, SOP's, QAPP advisor, virtual instruction modules, educational and training videos, digital reference collections, apps, devices….). These new and emerging technologies offer ways to provide better services to citizen monitors so that aquatic biodiversity can be improved and protected. The program's efforts have supported the acquisition of usable data of known quality, expanded agency databases, the continuation of government-NGO partnerships, and provided increased value to citizen monitoring efforts in California's watersheds. The expansion and popularity of maker groups, meet-ups, and STEM programs concerned with science and nature offer greater potential for leveraging technology for future citizen science efforts with water quality monitoring.

9:40-11:00am
Session 6A   Ballroom 220B
Talks: Broadening Engagement to Foster Diversity and Inclusion

DEVELOPING PARTNERSHIPS, GIVING VOICE TO KYRGYZ AND TIBETAN HERDERS: EMPOWERMENT OF UNDER-REPRESENTED SOCIETIES THROUGH CITIZEN SCIENCE

Marc Foggin and Christian Hergarten, University of Central Asia, Kyrgyzstan

Building collaborative partnerships for conservation or sustainable development presents challenges in any socio-political context, but has proven to be particularly difficult with pastoralist societies. This could be the result of preconceived notions about traditional practices by government or other development extension workers, or could be due to pastoralists' distrust of external stakeholders. Either way, failure to work together with mutual respect and trust can lead to failed projects.

Two case studies are presented from the high mountains of Central Asia and the Tibetan Plateau. In Kyrgyzstan, an applied research project on adaptive governance of natural resources recently was begun with a Citizen Science (CS) approach focused on pasture and water resources. The basic premise of the project is that co-generation of knowledge can help to enhance governance systems and overcome persisting soviet mindsets predicated on an authoritarian understanding of knowledge and expertise. A second project under development in Kyrgyzstan aims to introduce CS-based field activities in rural schools for improving environmental education while generating local-level environmental data. In China, a long-term community development project with Tibetan pastoralists also has sought to develop mutually beneficial partnerships with a nature reserve, based on the co-management of wildlife populations including snow leopard. In each case, CS can provide 'voice' to local citizens.

Even as CS studies may differ in the disciplines or specific approaches they adopt, all can help to increase levels of community engagement and the inclusion of people and groups heretofore largely under-represented in development governance structures and decision-making processes. Adopting a CS model may not only strengthen human resources for research projects and promote awareness and outreach potential, it also can help empower marginalized participants. However to achieve this goal sufficient time must be invested in the art and process of listening and understanding, which are prerequisites for building trust.

TELLING STORIES: THE ROLE OF SCIENCE NARRATIVES AS TOOLS FOR SOCIAL CHANGE

Erin Robinson, Canisius College; Erin Heaney, Clean Air Coalition of WNY

Stories provide the intimate details of life that individuals are willing to share, which may often go unnoticed. They shape feelings, emotions, and perceptions about given topics, as well as provide context to any given reality. Stories give voice to thoughts and feelings that may have been overshadowed, in addition to those heard loud and often. In Tonawanda, New York, we have engaged in a qualitative research endeavor meant to collect stories from those willing to share their experiences with living among and beside air pollution and legacy industrial pollution. Creating an oral community history of living with pollution in an effort to compliment the quantitative data that supports air quality problems in the Tonawanda area. State and local officials have recognized these issues and have embarked studies that analyze data collected through community driven air testing, as well as permanent air monitoring facilities throughout the Tonawanda region. However, despite being armed with this data that shows air quality problems, including significant releases of benzene and formaldehyde, residents are frustrated with the continual denial of a public health threat to the area. This research intends to provide support for the problem in a different way. It serves to complement the air quality numbers, so often documented through statistics, by showing how air quality impacts residents' everyday lives. Citizens then have a toolbox approach to address their quality of life issues and build on a body of citizen science that serves to explain their everyday reality to health and other public officials.

COMBINING CITIZEN SCIENCE WITH PARTICIPATORY RESEARCH APPROACHES: A PROGRESS REPORT ON THE USE OF PARTICIPATORY MAPPING STRATEGIES FOR SMALL-HOLDER FARMER EXPLORATION OF LAND ACCESS IN THE CALIFORNIA CENTRAL COAST

Adam Calo, Kathryn de Master, and Amber Sciligo, University of California, Berkeley, Environmental Science, Policy, and Management (ESPM); Tapan Parikh, UC Berkeley, School of Information; Maggi Kelly,

UC Berkeley ESPM; Darin Jensen, UC Berkeley, Department of Geography; Sarah van Wart, UC Berkeley, School of Information
Does citizen science break down or reinforce the barriers between expert and citizen? Many citizen science endeavors view participants as an expanded sensor network that may gain experiential understanding of an important scientific issue in the process. This approach has direct and spin-off benefits, but often forms research questions and methods in academic isolation, creating an exclusive environment in the name of scientific accuracy and research expediency. For our research project, within the newly formed Berkeley Food Institute, we build upon the potential benefits of citizen science by engaging local, small-scale growers in data collection on agricultural issues. However, adhering to the tenets of participatory and transdisciplinary research, we attempt to form an inclusive process, where a spirit of collaborative inquiry dictates research questions and methods. We believe that participatory mapping may be an especially useful tool in making citizen science more inclusive. In particular, information technologies may be able to make legible local knowledge forms like lived experience, narrative data, and trial and error. We believe these data, presented and analyzed in the form of a GIS, have the potential to act as a pivot between traditional scientific knowledge and more situated knowledges, thereby improving the "reach, relevancy, and rigor" of science.

Our presentation will discuss our progress thus far in invoking best practices of participatory research on land access for smallholder producers in the agricultural region of Santa Cruz and Monterey counties of California. We will discuss pitfalls and challenges of this approach as well as the potential transformative nature of transdisciplinary research in food systems. In particular, we hope our presentation can challenge citizen science practitioners to reflect on the inclusivity of their research projects and provide insight into ways to take the best from both fields of citizen science and participatory research.

THINKING ABOUT THE "CITIZEN" IN CITIZEN SCIENCE
Brittany Davis, Allegheny College

There is strong evidence supports the development of volunteer-based citizen science monitoring projects for coral reef ecosystems, particularly given their appeal to divers and snorkelers, who could become citizen scientists with training by local nongovernmental organizations (NGOs). The citizen science literature has focused more on the potential data, its utility, and its scientific implications than it has on the background of those volunteering as citizen scientists. Where volunteers' backgrounds have been examined, it has been primarily to assess their education. The assumption is that volunteers are citizens, and thus have an interest or stake in data they are collecting. However, on Utila, Honduras, marine-focused citizen science projects have relied heavily on the efforts of foreign tourists who scuba dive. In 2009, a local NGO relied on these divers (tourists and foreign dive professionals) to collect data about lionfish sightings in an effort to understand the extent of their presence in the region. This paper argues that researchers and project organizers should identify ways to include the local community in citizen science projects to increase support for the project and potential conservation-related outcomes. Using the lionfish monitoring project as an example, this paper illustrates how the local community was excluded from the project and the resulting lost educational opportunities. While tourists learned how to safely capture and consume lionfish, many in the local community remained afraid of the fish and its toxins. Increasing citizen interest in monitoring and capturing lionfish by engaging them in the citizen science project will assist in local species control, diversify participation by including a currently underrepresented group, and spread the benefits of citizen science projects more broadly. Specific ways to include the local community are discussed to illuminate the possibilities and challenges researchers face.

INCREASING PARTICIPATION IN REGIONAL VISION THROUGH STUDENT-LED ENGAGEMENT
Alexander Sun and Emma Sun, Envision Utah Youth Council; Lisa Sun, Envision Utah/Brigham Young University Law School

We describe the efforts of the Envision Utah Youth Council in organizing students to help lead a broad, statewide campaign to conduct research and gather information that will form the basis for a broad,

inclusive discussion regarding the future of the state of Utah. In this conversation, the lived experience of everyday people is combined with the expertise of scientists in a wide variety of fields, including environmental quality, transportation engineering, urban planning, energy, and disaster mitigation, to help shape a region's future growth and urban form. Utah is currently undertaking a ground-breaking regional visioning effort spear-headed by a public-private partnership called Envision Utah to help generate clear choices for Utahns on issues critical to Utah's future. The process includes educational outreach to citizens to present state-of-the-art knowledge and modeling of different potential choices, followed by the development of scenarios for voters and lawmakers based on educated feedback from citizens about their values and preferences.

Engagement and research was conducted in a first phase through the use of interactive and informational games, and the Youth Council developed strategies to encourage their peers to participate in the games that combine expert data and modeling with survey questions designed to elicit citizen preferences. The games spanned a variety of issues, including energy, water resources, transportation and housing, and education. A second ongoing phase of research links these games and other efforts to more formal school curricula (e.g. science, human geography, economics, etc.).

We also discuss the challenges and successes of the Youth Council in (1) promoting involvement by a demographic that has the most direct stake but that has traditionally been excluded from such conversations (youth / students), and (2) broadening participation of the traditional demographic (adults) through engagement of and leadership by students.

9:40-11:00am
Session 6B   Ballroom 220C
Speed Talks: Across Conference Themes

SUPPORTING GLOBAL CITIZEN SCIENCE WITH A MIXED MEDIA INFORMATICS FRAMEWORK
Kevin Smith and Laura Read, Tufts University; Fernando Salas, University of Texas at Austin
Operationalizing citizen science requires leveraging the full multiplicity of tools and information pathways accessible to the international community. In some cases this means smartphone applications, but in others it means 90's-era text messaging, or even simple pen and paper. Evidence for a mixed-media approach to reporting meteorological and hydrologic measurements can been seen in areas across the world, especially in rural and impoverished communities without access to government resources or standard technologies. This project describes an on-going effort in the Peruvian Andes, where site-specific limitations on access to networks and technology prevent the development of a general approach for data capture and transmission. We describe the process of developing a framework for modular informatics infrastructure designed specifically to cater to a broad array of data sources and formats. At the heart of the system is an ordinary email account that serves as a staging area for incoming data from a variety of sources, such as text messages, smartphone applications, and Internet forms. The software superstructure validates, sorts and imports email contents and registers meta-data into a formal database. The database can then be used to support a variety of data-relevant presentation modes, including standardized web services such as CUAHSI WaterOneFlow.

9:40-11:00am
Session 6C   Lower Level 20A
SPEED TALKS (6C) HAVE SHIFTED TO BALLROOM 220C
MPA WATCH MOVED TO 6C FROM 8F
Panel: Best Practices for Designing, Implementing, and Managing Citizen Science Projects and Programs

MPA WATCH: THE EVOLUTION OF A LOCALLY-BASED CITIZEN SCIENCE MONITORING PROGRAM INTO A STATEWIDE NETWORK

Ryan Meyer (Session Chair), Ocean Science Trust; **Dana Murray**, Heal the Bay; **Jeanee Natov**, Otter Project; **Zach Plopper** and **Diane Castaneda**, Wildcoast; **Tom Ford**, Santa Monica Bay Restoration Foundation; **Aaron McGregor**, California Ocean Science Trust

MPA Watch is a citizen-science monitoring program that trains volunteers to observe and collect data about human uses inside and outside California's newly-established marine protected areas (MPAs). Through MPA Watch, trained volunteers categorize observed human uses into a set of activities using standardized protocols, which provides information about how the public uses coastal areas. Data are meant to inform the management, enforcement, and science of California's MPAs and can help to demonstrate how human uses are changing as a result of MPA implementation. In addition, these human use data can inform a variety of needs unrelated to MPAs (e.g., public safety staffing, amenity provision, loss of interim resource use in the event of closure). By involving local communities in this important work, MPA Watch programs inspire and empower stewardship, and educate citizens about California's ocean ecosystems.

What started as a small monitoring project in one region along the coast has expanded into a statewide network in the matter of a few years. In this panel, MPA Watch program managers and other collaborators will trace this programmatic evolution. Presenters will highlight collaborative efforts to ensure consistent and efficient implementation across regions, including both technical and programmatic issues in need of coordination. This will involve discussion and reflection on practices and principles for aligning methods and protocols, recruiting and retaining a diverse volunteer base, capitalizing on partnerships across science and management, leveraging resources across distributed programs, and advancing the use of social science activities in support of monitoring. Presenters will also highlight next steps for the statewide network, including the challenges and opportunities for growing and sustaining this effort overtime.

ENGAGEMENT OF CITIZEN SCIENTISTS—THE UNDERUTILIZED TOOL IN OUR MONITORING TOOL BOX
Jana Newman and Natalie Sexton, US Fish and Wildlife Service

Creating a conservation community is critical to the success of the National Wildlife Refuge System mission of protecting wildlife and their habitat. Engaging citizen scientists in our conservation work can be a valuable component of our monitoring tool box. And yet, we find it continues to be overlooked by most station biologists.

For example, when surveyed, a majority of refuge staff recognized the importance of phenology data to understand and manage for environmental change but lack personnel to collect this information. Interestingly, few stations were engaging citizen scientists to collect this information.

To encourage and support field stations to engage citizen scientists to collect phenology data, we partnered with USA-National Phenology Network to establish an online portal for Service staff. The portal provides direct access to established scientific protocols, the on-line data information system and presentation tools, and resources and success stories.

Unfortunately, after a year's time, less than a handful of refuges are participating in this effort. Why? To be sure, engaging citizen scientists has a cost. The logistics and staff required to manage volunteers can be more involved than managing field staff. There is also some hesitancy from biology staff as phenology, coupled with citizen science, is often viewed as an education and outreach activity, not monitoring.

We will discuss the challenges faced engaging citizen scientists in inventory and monitoring and strategies to overcome these hurdles, such as development of a framework and resources for Service personnel to help them effectively engage the public in inventory and monitoring activities. We will continue to establish partnerships with organizations that have a proven track record to engage the public in scientifically valid studies, such as USA-NPN.

LINKING GROUND-BASED VOLUNTEER OBSERVATIONS WITH MODERATE-RESOLUTION SATELLITE OBSERVATIONS OF PHENOLOGY
Cathlyn Stylinski, Kavya Pradhan, and Andrew Elmore, University of Maryland Center for Environmental Science

Complex large-scale environmental issues, such as plant-community response to climate change, require both extensive ground-based observations and remote-sensing platforms suitable for integrating observations and modeling at landscape scales. Citizen science offers a promising means of gathering broadly distributed ground-based observations while also enhancing public understanding of science. As part of a larger study to visualize forest adaptive capability under current and projected climates, we are exploring challenges of linking ground-based volunteer phenological observations with continental-scale imagery from the Moderate Resolution Imaging Spectrometer (MODIS). We are partnering with three established citizen science programs to acquire volunteer data of forest trees (National Phenology Network (NPN), Project BudBurst and Plant Watch) and have focused on NPN data thus far. We used multiple strategies to assure the quality of both datasets including (1) shifting to adjacent MODIS pixels dominated by forest and (2) limiting NPN observations to those that were accompanied by observations immediately prior to the development of the phenophase. We found moderate correlation between dates of MODIS' greenness measure and dates of relevant phenophases reported by NPN volunteers for dominant forest species, including sugar maple, dogwood and tulip poplar, as well as for cloned lilacs that have been planted around the U.S. Correlations were weak or absent for other species, such as balsam poplar and quaking aspen, possibly because they are less prevalent in the forest at the observation sites. Our results suggest that citizen science and remote sensing observations can be comparable measures of phenology but will require significant data filtering and would benefit from guiding volunteers in sampling more frequently (particularly before key phenophases) and in selecting large homogenous forest stands. Our data also indicate that some species may better capture the average forest phenological response to the environment, which aligns with satellite measures of landscape phenology.

IS CITIZEN SCIENCE WORTH IT: IDENTIFYING NATURAL RESOURCE MANAGERS' VALUES THROUGH COST BENEFIT ANALYSIS
Brian Fauver and Greg Newman, Colorado State University; Amy Masching, Denver Zoological Association; Megan Mueller, Rocky Mountain Wild
Citizen science is heralded as an excellent management tool that provides useful data, an increase in community engagement, and scientific outreach to targeted audiences. Even with these several benefits of citizen science, managers are slow to adopt citizen science programs into their operations. This may be due to a lack of knowledge of actual costs of citizen science projects. In this case study, four natural resource managers were interviewed about the cost benefit analysis of citizen science projects they operate. This case study involved citizen science projects from the National Park Service, United States Fish and Wildlife service, Colorado Parks and Wildlife, and Fort Collins Natural Areas. Projects were evaluated through cost inventory. These results were then discussed with the relevant natural resource managers. Data collected through this project proved to be difficult due to highly variant projects. However, this case study illustrates the individual nature of citizen science and natural resource managers and natural resource agencies.

DATA VISUALIZATIONS AS CRITICAL FEEDBACK MECHANISMS FOR PARTICIPANTS: A BRIEF LOOK AT HOW TO CREATE GOOD ONES
Rhiannon Crain and Kevin Ripka, Cornell Lab of Ornithology, Cornell University
Giving participants feedback about the data they help to collect can be a critical (and sometimes ignored) part of a healthy citizen science cycle. One study on participant motivations in citizen science projects noted "When scientists were not cognizant of providing periodic feedback to their volunteers, volunteers felt peripheral, became demotivated, and tended to forgo future work on those projects" (Rotman et al, 2012). In that same study, the authors indicated that scientists tended to overlook the importance of feedback to volunteers, missing their critical interest in the science and the value to participants when their contributions were recognized. Prioritizing feedback for volunteers adds value to a project, but can be daunting for project staff. This speed talk will cover three different kinds of visual feedback that can be utilized to keep participants in-the-loop. We'll cover strengths and weaknesses of each visualization and point people to tools available on the Web to help create powerful visualizations.

COASST—CREATING SUCCESSFUL EDUCATIONAL OUTCOMES THROUGH POSITIVE PERSONAL CONNECTIONS
Erika Frost, Julia Parrish, and Jane Dolliver, Coastal Observation and Seabird Survey Team (COASST)
The Coastal Observation and Seabird Survey Team (COASST), based at the University of Washington, is a successful citizen science program with a 16-year history of collecting highly rigorous, monthly data on coastal beaches in the North Pacific, from northern California to the Arctic Circle. COASST currently engages ~800 participants in our beached bird module, collecting high quality, verifiable data to establish a baseline index of seabird mortality. COASSTers regularly spend hours per survey—rain or shine—and some spend more than a day transiting to and from their sites. Why? COASST creates lifelong-learning connections by establishing and maintaining a positive personal connection with each participant joining the program. The foundation of this on-going relationship is deeply rooted in the 6-hour, in-person expert training session conducted in dozens of coastal communities. After training, participants are fully equipped with the tools necessary to both conduct surveys and continue their learning process over time. Within a week, staff and students in the COASST office have checked in with each new participant. Our connection deepens with individualized feedback on beached bird identification skills, a bimonthly e-newsletter promoting skills practice, access to a network of scientists to help identify other interesting finds on the beach, an annual report presenting the year's data, and in-community refreshers and evening talks. Continuous support from COASST staff and our team of 20 undergraduate interns ensure that COASST participants are constantly learning and actively contributing to the success of our program. This level of engagement is one of the central reasons COASST participants remain with the program; our retention rate tops 80% annually and some volunteers have been with the program since its inception in 1998.

THE VANISHING FIREFLY PROJECT: AN INTERDISCIPLINARY, STUDENT-DRIVEN CITIZEN SCIENCE PROJECT
Michelle Cook and Renee Lyons, Clemson University
The Vanishing Firefly Project is a citizen science project asking participants to engage in an annual census of fireflies. Over the past four years, the project has grown from a single-day event held in one location in SC to an international count of fireflies over the summer months. The project, which started as the research interest of two scientists, has grown into a team of computer scientists, cyberinfrastructure specialists, science educators, and education outreach specialists. Through this interdisciplinary collaboration, the goals of the project have expanded from data collection and ecological analysis to mobile phone app development, database design and administration, social media outreach, and citizen science education. However, what makes our project unique is that much of the work is led and implemented by undergraduate students.
Since the spring of 2013, the project has operated as a Creative Inquiry at our university. Creative Inquiry projects simultaneously engage students in learning and undergraduate research at the same time. Students work in interdisciplinary teams with faculty advisors to tackle a problem they find of interest. Last year, students determined the training protocol, created adult and child versions of the training videos, and evaluated the impact of this project on citizen scientists. Students developed and published the mobile app, managed the database, and created a means for real-time visualization of the data. Students initiated and managed social media pages on Facebook and Twitter, as well as analyzed our reach through the Social Media Listening Center. Our students' efforts during the last academic year culminated in participation at the EPA P3 (People, Prosperity, and the Planet) competition—a student design competition for sustainability—where they were awarded "honorable mention" in recognition of their work on this project. This year, we will continue to improve our project through the leadership and efforts of students.

9:40-11:00am
Session 6D   Lower Level 20B
Story Presentations across Conference Themes

Session Chair: **Linda Silka**, Director, Margaret Chase Policy Center, University of Maine

EQUITY, DIVERSITY, AND INCLUSION: UNDERSTANDING PERCEPTIONS OF SUCCESS
Karen Purcell, Cornell Lab of Ornithology, Cornell University
Is it possible for an Informal Science Education (ISE) program to feel successful in its attempts to work with an underserved community only to realize that the community thought it was a failure? Theoretically, we all know that creating inclusive programs is necessary and, perhaps, we have a vague understanding of how to go about it. However, "best practices" for improving equity, diversity, and inclusion can break down quickly when we begin to implement projects. In many cases we don't really know what success or failure mean; definitions vary depending on your perspective.
Why have ISE institutions not made significant advances in the field of citizen science in fostering diversity, equity and inclusion? Is it because we lack understanding of inclusive approaches? Do we understand good practices but lack cultural competence to put them in place? Do we simply lack the funds, resources, and/or commitment to get the job done? Is it a lack of will? Or is something else entirely going on? Exploring the implementation of accepted practices within context is key to understanding community perspectives, realities, and unspoken measures of success.
Through true stories we will explore perceptions of success and failure by both ISE institutions attempting to work with underserved communities and by the communities themselves. We'll share first-hand experiences that highlight stark differences in perspectives. The stories will illustrate how the best intentions can break down quickly and how 'best practices' can become meaningless when implementing projects.
These stories are the basis for a newly funded NSF grant: Examining Contextual Factors that Influence the Implementation of Projects Designed to Improve Cultural Diversity in Informal STEM Programming. The grant, a collaboration among the Cornell Lab of Ornithology, ASTC, and Garibay Group, will explore practice and implementation of informal learning programs in communities with culturally diverse communities.

CHICAGO WILDLIFE WATCH: DIVERSIFYING ZOONIVERSE VOLUNTEERS?
Laura Whyte, Adler Planetarium; Seth Magle, Lincoln Park Zoo
Reflective of the 74% male STEM workforce in the United States, early studies of Galaxy Zoo found that 82% of participants were male. While newer projects, which are in a diverse range of scientific disciplines, have a higher rate of female participation, of around one third, there is still a great deal of work that needs to be done if the Zooniverse is going to engage a more diverse audience in terms of age, gender and socio-economic background.
Imbedded in Chicago's museum campus, the Adler Planetarium has been building Zooniverse citizen science projects for several years in collaboration with it's major partner the University of Oxford. These highly successful projects achieve large international audiences, 2% of who are from the Chicago area.
In late 2013, the Urban Wildlife Institute from the Lincoln Park Zoo provided the Zooniverse at the Adler Planetarium with a unique opportunity to approach the promotion of a citizen science project from an entirely different perspective. Rather than seeking an international audience these two well known, and well respected, cultural institutions would attempt to work together with the local community to complete the analysis of a one-million image data set that included hugely engaging images of urban wildlife that the people of Chicago could find in their own back yard. This project was expected to appeal to local educators, families and volunteers who would not normally consider themselves able to participate in citizen science projects.
Chicago Wildlife Watch was launched in September of 2014 and this presentation will describe how the technology and techniques developed to attract and maintain a large international user base were adapted to appeal to a local audience and the lessons learned from this approach.

"TUESDAY CHEWSDAY!" ACTIVE RECRUITMENT OF CITIZEN SCIENTISTS FOR A RODENT MONITORING PROJECT IN NEW ZEALAND

Heidy Kikillus, Victoria University of Wellington, New Zealand
While New Zealand has no native land mammals (with the exception of bats), it does have an impressive array of unique and indigenous bird species. Alarmingly, many of these are now endangered due to the introduction of predatory mammals, such as rodents, mustelids, and hedgehogs. In the capital city of Wellington, the ZEALANDIA wildlife sanctuary has been established to protect native species. It is surrounded by a predator-proof fence, however some birds are capable of flying over it and dispersing into the surrounding suburbs, where they often encounter predators.
The "Tuesday Chewsday" project aimed to undertake a census of suburban pests with the help of local residents. In order to have a representative sample in the area surrounding ZEALANDIA, we randomly-generated hundreds of addresses within our target zone and sent out information letters asking households if they would like to take part. Participating households placed a 'chewcard' (commonly-used monitoring tool) in their gardens for a week and then placed it in their mailbox for collection by the researchers. This talk will tell the story of our active recruitment process of Citizen Scientists, response rates, public engagement, follow-up, disasters encountered, and lessons learned. We hope to repeat this survey in a year or two to monitor any changes in the resident pest population and in household attitudes towards conservation.

9:40-11:00am
Session 6E   Lower Level 20C
Symposium: Digital Opportunities and Challenges in Citizen Science

HUMAN-CENTERED TECHNOLOGIES FOR CITIZEN SCIENCE
Andrea Wiggins (Session Chair)
This symposium will showcase research and development at the intersection of citizen science and information technologies, bringing together researchers across social, information, and computer sciences to present work that is typically published in journals and conference proceedings unfamiliar to most of the citizen science practitioner community. The symposium goal is to share the latest insights from scholars whose research focuses on understanding and supporting citizen science through technology, and to promote knowledge exchange and collaboration opportunities among the speakers and attendees.
  Speakers: Andrea Wiggins - Introduction: Project Diversity and Design Implications
  Mobile and Social Technologies:
  Anne Bowser, University of Maryland - Gamifying Phenology with Floracaching App
  Michalis Vitos, University College London - Sapell, A Mobile Data Collection Platform for Non-Literate Indigenous Communities
  Muki Haklay, University College London - Geographical Human-Computer Interaction for Citizen Science Apps
  Matt Germonprez, University of Nebraska Omaha - Enacting Citizen Science through Social Media
  Developing Infrastructures:
  Jen Hammock, Smithsonian Institution - An Infrastructure for Data Distribution and Use
  Yurong He, University of Maryland - Improving Biodiversity Data Sharing among Diverse Communities
  S. Andrew Sheppard, University Minnesota and Houston Engineering, Inc.: Facilitating Scalability and Standardization
  Stuart Lynn, Adler Planetarium and Zooniverse: Developing Tools for the Next Scientific Data Deluge
  Contributors and Communities:
  Jenny Preece, University of Maryland - Motivating and Demotivating Factors for Long-Term Participation
  Kevin Crowston, Syracuse University - Technology features and participant motivations
  Charlene Jennet, University College London - Identifying and Promoting Creativity
  Carl Lagoze, University of Michigan - Inferring Participant Expertise and Data Quality

9:40-11:00am
Session 6F   Lower Level 20D

Panel: Tackling Grand Challenges and Everyday Problems with Citizen Science

FURTHERING SCIENCE AND PUBLIC ENGAGEMENT: NATURAL HISTORY MUSEUMS AS CENTERS TO DEVELOP AND PROMOTE CITIZEN SCIENCE
John Tweddle (Session Chair), Natural History Museum, London; **Heidi Ballard**, University of California, Davis; **Lila Higgins**, Natural History Museum of Los Angeles County; **Alison Young**, California Academy of Sciences; **Christine Goforth**, North Carolina Museum of Natural Sciences
Through their unique combination of collections, scientific and public engagement expertise, and wide audience reach and trust, natural history museums (NHMs) can form fantastic hubs for citizen science. Over the past decade an incredible diversity of NHM-based citizen science projects have emerged, with widely differing ambitions: from engaging visitors of all ages in the process of biodiversity and environmental research, to digitizing specimen information, delivering public-facing exhibits and training teachers and educators.
This panel discussion will explore the experiences of a series of NHMs that have active and successful citizen science programs. It will share key findings, identify critical questions and knowledge gaps, and involve the audience in a lively debate about the role that NHMs can play in developing citizen science as a field.
As researchers and practitioners, the panel will examine the concrete ways in which NHMs can bring citizen science to new audiences, conduct relevant research in an urban context, and embody the integration of scientific research with education and outreach goals that the field of citizen science strives for. In light of this potential, we ask what has worked and what hasn't, what questions can citizen science in museums help to answer, and what can we learn from NHMs particular ability to provide multiple entry points, multiple levels of engagement and multiple forms of citizen science all under one "roof"—whether physical or virtual? At the same time, how can citizen science advance the goals of natural history museums and similar institutions that focus on both research and education?
These questions and more will engage panelists and participants in discussion of the fundamental question: how can we improve the capacity of both natural history museums and citizen science as a whole to address key scientific challenges, as well as education and engagement of public audiences.

11:00am-12:50pm
Session 7AB   Ballrooms 220B and 220C
OPEN-FORMAT SESSION

11:20am-12:40pm
Session 7C
Panel: Digital Opportunities and Challenges in Citizen Science

CITIZEN SCIENCE AND DISASTERS: THE CASE OF OPENSTREETMAP
Robert Soden (Session Chair), University of Colorado, Boulder; **Mikel Maron**, Humanitarian OpenStreetMap Team; **Dale Kunce**, American Red Cross; **Nama Budhathoki**, Kathmandu Living Labs; **Lea Shanley**, University of Wisconsin-Madison
OpenStreetMap (OSM), often called the "Wikipedia of maps," is a global project to collaboratively create a free and open map of the world. Since 2009, the Humanitarian OpenStreetMap Team has coordinated the OSM community to support situational awareness of humanitarian agencies during a wide range of disasters around the world. During the 2013 Typhoon Yolanda emergency for example, over 1600 distributed volunteers from over 80 countries worked to digitize high resolution satellite imagery, mapping the location of critical infrastructure and damage to roads and buildings. The data created by these volunteers supported the relief efforts of the Red Cross and other responding organizations. Organizations like the World Bank and The United States Agency for International Development (USAID) have also sought to utilize OSM in partnership with at-risk communities to collect data to inform disaster preparedness and mitigation activities. This panel will feature both scholars as well as practitioners

involved in some of these projects. Following a series of brief presentations that introduce relevant case studies, the panelists will seek to questions such as:

What are the characteristics of OSM that have led to its adoption in humanitarian response events?

Has non-experts' participation in OpenStreetMap changed scientific practices of disaster risk and impact assessment? If yes, how?

What are the barriers to incorporate OSM data into official disaster management workflows?

What strategies are being taken to help OSM volunteers produce more accurate and trustworthy data?

How can we improve our current approaches to OSM for enhancing its citizen' ownership?

This will be an interactive session with significant time set aside for audience contribution.

11:20am-220pm
Session 7BB   Ballroom 220C

BIOBLITZ: DOWNTOWN SAN JOSE

Rebecca Johnson, California Academy of Sciences, and **Scott Loarie**, iNaturalist.org, California Academy of Sciences

Join us as we document the biodiversity of parks and green spaces within walking distance of the San Jose Convention Center. How many species can we find in downtown San Jose? With careful observation and documentation who knows what we can discover together. Participants only need to bring a smartphone (or a camera) and their powers of observation to help catalog the plants and animals surrounding the hustle and bustle of Silicon Valley.

Bioblitzing is an excellent way to build current knowledge of biodiversity, detect invasive species, build coalitions of local stakeholders, engage people of all ages with biodiversity and strengthen sense of place, stewardship ethic and build community. The California Academy of Sciences, iNaturalist.org and Nerds for Nature will hold a short BioBlitz in the natural areas around downtown San Jose. Depending on interest and logistics, areas may include: Guadalupe River Park, the Discovery Meadow, San Jose State University, William Street Park, and Saint James Park.

iNaturalist powered grassroots bioblitzes gather scientists, citizen scientists, land managers, and more, all working together to find and identify as many different species as possible—everything from ants to redwoods! Bioblitzes not only help land managers build a species list and atlas for their parks, they also highlight the incredible biodiversity in these urban oases.

Participants use the iNaturalist app to document their plant and animal observations, and we end each bioblitz with a "wrap session" that allows the group to see what everyone found and help each other with identifications. We look forward getting out in nature and Bioblitzing with all of you!

11:20am-12:40pm
Session 7D   Lower Level 20B
Symposium: Best Practices for Designing, Implementing, and Managing Citizen Science Projects and Programs

USING A CITIZEN SCIENCE APPROACH TO CHANGE THE FACE OF ENVIRONMENTAL PUBLIC HEALTH RESEARCH

Monica Ramirez-Andreotta (Session Chair), University of Arizona; **Sara Wylie**, Northeastern University; **Liam O'Fallon**, National Institutes of Health/National Institute of Environmental Health Sciences; **Elizabeth Yeampierre**, Lawyer, Community Activist

Citizen science (CS) efforts have traditionally been associated with ecological studies and big data projects that are primarily directed by academics or agencies. Increasingly, CS is becoming part of environmental health (EH) research. Community members are leading/developing their own projects or co-developing projects via community-academic partnerships to address environmental contamination, mitigate exposure, and prevent deleterious health outcomes. This symposium highlights the unique nature of CS-EH research by presenting: 1) CS programs aimed at improving exposure assessments and EH in health

disparate communities, 2) How these programs transform investigations (e.g. low cost, accessible monitoring tools) and the production and sharing of results, and 3) The unique scientific and political challenges faced by CS-EH research given the potential for findings with implications for policy and industry, the difficulties of connecting CS research to regulatory action, and the challenges of establishing a relationship between an exposure and health outcomes.

The following presenters will discuss the importance of CS in EH, their experiences developing best practices for data generation, as well as ethical, collaborative, and justice challenges associated with EH studies:

• CS and NIEHS Partnerships for Environmental Public Health (Liam O'Fallon, Program Analyst)
• CS and Risk Communication at Hazardous Sites (Monica Ramirez-Andreotta, Environmental Scientist)
• Designing New EH Research Tools for CS (Sara Wylie, Social Scientist)
• Local Knowledge and Co-producing Data (Elizabeth Yeampierre, Lawyer, Community Activist)

Other practitioners will give speed talks describing their CS efforts to achieve EH justice. This symposium will advance our current understanding of CS by introducing attendees to a new milieu in which CS approaches are implemented, connecting citizen scientists working on EH issues, sharing research collaboration practices, and exploring methods for co-generating data at hazardous wastes sites.

11:20am-12:40pm
Session 7F   Lower Level 20D
Panel: Broadening Engagement to Foster Diversity and Inclusion

DIVERSE PERSPECTIVES ON YOUTH-BASED CITIZEN SCIENCE: EXPERIENCES AND LESSONS LEARNED FROM WORK WITH YOUNG SCIENTISTS
Colin Dixon (Session Chair), University of California, Davis; **Abby Nickels**, LiMPETS, Farallones Marine Sanctuary Association; **Katie Levedahl** and **Neal Ramus**, California Academy of Sciences;
Kathy Soave, The Branson School; **Humberto Bracho**, East Bay Academy for Young Scientists, UC Berkeley; **Kevin Cuff**, East Bay Academy for Young Scientists, UC Berkeley; **Emil Harris**, UC Davis; **Kim Zhen**, **Megan Torio**, and **Victor Rios**, East Bay Academy for Young Scientists; **Frankie Gerraty** and **Alina Rainsford**, Sustainable Seas Monitoring Project; **Jose McDevitt-Hickey** and **Andrew Le**, Careers in Science, California Academy of Sciences

Despite the recent expansion of youth-focused citizen science programs, as a field we are only beginning to examine the goals, needs, assets and outcomes of working with youth, both in and out of school contexts. This panel will draw together perspectives of youth, educators, and researchers to provide "360 degree" portraits of youth-based citizen science. Panel speakers include educators, program directors, education researchers, and youth participants themselves. Representing two programs working across five in-school and out-of-school sites in the San Francisco Bay area, we will share lessons widely applicable to the goals of broadening engagement and documenting best practices in citizen science. Specifically, this session has two central aims:

(1) To build an in-depth, multi-voiced understanding of youth-based citizen science. Each of the groups will present descriptions of their work, including youth experiences and educator "lessons learned" about facilitating participation in scientific research. Speakers will discuss questions they still struggle with, and describe the challenges of balancing multiple project goals.

(2) To address a key question for the field as a whole: what is the impact of intensity and duration of participation in citizen science? Each group will speak to short-term impacts, as well as outcomes of long-term participation and particular innovations for sustaining youth involvement. Speakers will describe strategies for overcoming barriers to long-term participation, including emphasizing for youth the impact of their project work, building community-based and institutional partnerships, designing multiple pathways for participation, and providing opportunities for teaching and leading by youth.

The panel will include brief presentations by program coordinators, educators and youth participants working with the LiMPETS and EBAYS programs on issues in marine biology, air quality, and water quality.

It will also include framing and summary remarks from educational researchers, and time for in-depth question and answer with audience members.

12:00-1:00pm
Lunch Break

1:00-2:30pm
Session 8.AAAS   210ABEF
Panel: Communicating Science (AAAS Event)

PUBLIC ENGAGEMENT FOR SCIENTISTS: REALITIES, RISKS, AND REWARDS (AAAS PANEL) *
Bruce V. Lewenstein (Session Chair), Cornell University**; Elizabeth Babcock**, California Academy of Sciences**; Heidi Ballard**, University of California, Davis**; Anthony Dudo**, University of Texas at Austin**; Nalini M. Nadkarni**, University of Utah
Scientists involved in public engagement activities—such as participation in public communication, citizen science projects, or social media—may experience a tension between their academic and public engagement identities. Learn practical, research-based insights to understand the realities, risks, and rewards for scientists participating in public engagement.
* *Pre-registration. You must be on the list in order to attend.*

1:00-2:30pm
Session 8A HAS SHIFTED TO 8F, LOWER LEVEL 20D

1:00-4:00pm
Session 8B   Ballroom 220C
Symposium - Digital Opportunities and Challenges in Citizen Science and Challenges
and *Best Practices for Designing, Implementing, and Managing Citizen Science Projects and Programs*

DATA QUALITY PRACTICE IN CITIZEN SCIENCE: CALIBRATING A NEW KIND OF INSTRUMENT
Yurong He (Session Chair), University of Maryland, College Park; **Todd Suomela**, University of Alberta; **Andrea Wiggins**, UM; **Karen Martin**, Pepperdine University; **Steve Kelling**, Cornell Lab of Ornithology; **Hillary Burgess and Kate Starbird**, University of Washington; **Stuart Lynn**, Zooniverse.org; **HeeJun Kim**, University of North Carolina at Chapel Hill; **Kristin Stepenuck**, University of Wisconsin Extension; **Ed Washburn**, US Environmental Protection Agency; **Julian Turner**, Colorado State University/CoCoRaHS
Data quality has become an increasing concern as the popularity of citizen science has grown. An array of data quality mechanisms have been proposed, developed, and implemented in many citizen science projects. An essential question for this new discipline is: "Can citizens and citizen science programs be trusted to provide useful data for scientific research?" In this symposium we develop a new perspective for considering citizen science as an innovative scientific instrument that extends the possibilities for measurement beyond the traditional approaches employed by scientists. The symposium combines talks about insights gained from specific Citizen Science projects with talks that provide analyses from literature and website reviews.
　Speakers:
　Todd Suomela, University of Alberta - Citizen Science as a New Kind of Instrument
　Andrea Wiggins, UM - Sensors and Processors: A Human Computation Perspective on Citizen Science Data Quality
　Yurong He, University of Maryland - A New Framework and Literature Review for Data Quality Mechanisms
　Karen Martin, Pepperdine University - Data Quality in Grunion Greeters: Lessons Learned About Training, Follow-Up, and Asking the Right Questions
　Steve Kelling, Cornell Lab of Ornithology - Measuring the Data Quality of eBird Participants

Hillary Burgess, University of Washington - Collaboration, Iteration and Adaptation: Marine Debris Module Development in COASST

Kate Starbird, University of Washington – Reflections on Tweak the Tweet, a Crisis Reporting Microsyntax and a Crowd-Powered Information Processing Effort

Stuart Lynn, Zooniverse.org – Assuring and Managing Data Quality in Zooniverse

HeeJun Kim, University of North Carolina at Chapel Hill - Building Trust Mechanisms in Crowdsourcing Applications

Kristin Stepenuck, University of Wisconsin Extension - Smoothing out the Riffles: Ensuring Quality Data in Volunteer Stream Monitoring

Ed Washburn, EPA Office of Research and Development - An EPA scientist's Perspective on Citizen Science and Data Quality

Julian Turner, Colorado State University/CoCoRaHS - "Who Changed My Data?" CoCoRaHS Data Quality Control and Provenance Challenges Inherent to a Fluid Data Set

1:00-4:00pm
Session 8C   Lower Level 20B
Symposium: Broadening Engagement to Foster Diversity and Inclusion

SUPPORTING MULTI-SCALE CITIZEN SCIENCE: LEVERAGING THE LOCAL, ADDRESSING THE GLOBAL
Mark Chandler (Session Co-Chair), Earthwatch Institute; **Russell Scarpino** (Session Co-Chair), CitSci.org;
Abe Miller-Rushing, National Park Service; **Lila Higgins**, Natural History Museum of Los Angeles County;
Greg Newman, Colorado State University
Citizen science presents opportunities to engage the public in environmental priorities and help meet science needs for conservation and environmental protection. There are citizen science projects now in most cities and habitats, counting and measuring much of the world's biodiversity and environmental parameters. Unfortunately, the aggregation and presentation of these data across taxa and/or other environmental variables remains problematic. Even when projects collect data on the same variables, these data may not be standardized, documented, or stored in ways that can easily be shared. Scaling-up citizen science through linking many different local programs is gaining interest. Environmental managers recognize the potential of this approach to generate knowledge for local, regional, and global responses to grand environmental challenges such as climate change, habitat loss, pollution, loss of biodiversity, and others--all of which are intertwined. This symposium seeks to identify barriers and opportunities to scaling-up citizen science to address grand challenges in biodiversity conservation and environmental protection. Drawing from a range of local, regional, and global citizen science programs, presenters will explore how citizen science might contribute to large-scale grand challenges while maintaining their relevance to other scales and issues. Specific topics of presentations and open discussion include: (1) scaling citizen science from local to global scales, (2) the role of support platforms in supporting multi-scale citizen science, and (3) the role of common data standards and protocols for data sharing and integration across platforms.

1:00-2:30pm
Session 8D   Lower Level 20B
Symposium: Research on and Evaluation of the Citizen Science Experience

ENGAGING CITIZEN SCIENTISTS IN EMERGING ENVIRONMENTAL THREATS & DISASTERS
Aubrey Miller (Session Chair), National Institutes of Health/National Institute of Environmental Health Sciences (NIH/NIEHS); **Liam O'Fallon** and **Chip Hughes**, NIH/NIEHS; **Kim Anderson**, Oregon State University; **Erin Haynes**, University of Cincinnati/College of Medicine
Community residents possess capacity and critical local knowledge of their physical and social environments. Engaging with communities, therefore, can help to promote sound environmental health policies, protect residents and workers, help to ensure safe development/use of resources, and inform

future planning by building robust understanding of environmental exposures of concern. Such critical information is particularly important to provide to socioeconomically and culturally disadvantaged communities that suffer a disproportionate burden of exposures and disease related to environmental impacts. This session explores the need and opportunities for citizen science (CS) in the face of disasters and emergence of potentially new environmental threats, such as hydrofracking. Presentations will provide case studies that highlight the benefits, as well as the challenges, in using CS approaches to promote environmental public health. Panelists will focus on user-friendly tools and technologies for assessing environmental exposures, data quality & management, and interpretation of information and risk communications. How have citizen scientists, emergency responders and other workers been engaged in disasters? How is CS instrumental in collecting environmental exposure data about hydraulic fracturing, monitoring releases of hazardous pollutants? How can we promote effective CS training and education, interactions with researchers, and engagement with officials to support public health. Discussions will stress the capacity building, education, and hands-on training to empower impacted communities to better understand, measure, and participate in time-critical environmental issues and situations. Session objectives include discussion of:
1) The important need and role of citizen science in supporting responses to emerging environmental threats and disasters;
2) The use and limitations of exposure assessment tools and data;
3) The generation of useful data through effective planning and partnerships,
4) Interpretation of data, ethical considerations, and communicating results;
5) Promotion of evidence based environmental health actions;
6) Fostering education & training to measure and understand environmental exposures.

1:00-2:30pm
Session 8E   Lower Level 20C
Symposium: Best Practices for Designing, Implementing, and Managing Citizen Science Projects and Programs

ETHICAL DIMENSIONS OF CITIZEN SCIENCE RESEARCH
Caren Cooper (Session Chair), North Carolina Museum of Natural Science; **Lea Shanley**, University of Wisconsin-Madison; **Anne Bowser**, Woodrow Wilson Center; **Holly Menninger**, North Carolina State University; **Madhusudan Katti**, California State University, Fresno; **Janet Stemwedel**, San Jose State University; **Dianne Quigley**, The Northeast Ethics Education Partnership
There are many ethical dimensions to research that involves collaboration between scientists and the volunteers, and only a portion of which is covered by IRB oversight. Citizen science projects are designed in many ways that may heighten or lessen particular ethical concerns. In this symposium, the first six speakers will share stories (not academic talks) that highlight different ethical dimensions for research carried out utilizing methods of citizen science. Topics covered include (1) Data privacy and confidentiality (Shanley), (2) Participation vs. exploitation in community-based research context and in the context of gamification and persuasive computing (Bowser), (3) Participant safety and liability (Menninger), (4) Ownership and intellectual property (Katti), (5) Transparency, openness, and data sharing (Lang), and (6) suitability and shortcomings of disciplinary-specific codes of ethics and of traditional ethical review and oversight (Stemwedel). The seventh speaker (Quigley), will summarize key principles and provide practical advice for practitioners, covering beneficence and maleficence, community informed consent, fair recruitment, and cultural competence. The last portion of the symposium will involve a moderated (Cooper) panel discussion with the audience.
The object of the symposium is to generate discussion around challenging ethical dimensions of citizen science research. Anyone involved in citizen science, in any way, will find these ethical issues of high relevance. The formation of the Citizen Science Association provides potential capacity for the community to address these ethical issues.

1:00-2:30pm
Session 8F   Lower Level 20D
Panel: Making Education and Lifelong Learning Connections

NATURAL RESOURCE VOLUNTEERS AND CITIZEN SCIENCE: BRINGING TOGETHER A COMMUNITY OF PRACTICE
Michelle Prysby (Session Chair) and **Alycia Crall**, Virginia Master Naturalist Program, Virginia Tech; **Michelle Haggerty**, Texas Master Naturalist Program, Texas Parks and Wildlife; **Mark Larese-Casanova**, Utah Master Naturalist Program, Utah State University; **Adina Merenlender**, University of California Naturalist Program, University of California-Berkeley; **Karen Oberhauser**, Minnesota Master Naturalist Program, University of Minnesota; **Marilyn Smith**, StreamWatch
This panel discussion will lay the groundwork to bridge two communities of practice: the citizen science practitioner community and the Master Naturalist program community. Master Naturalist programs are state and local programs aimed at engaging individuals in natural resource education and service. The programs, now in more than 30 states, are connected through a national network, the Alliance of Natural Resource Outreach and Service Programs (ANROSP). Citizen science and Master Naturalist programs have a great deal in common: both focus on engaging and training volunteers; both strive to engage underserved audiences; both focus on connecting people with science processes and the natural world; and the success of both depends, in large part, on continued engagement. Both communities have much to gain through partnering. Citizen science programs can gain access to a cadre of volunteers with training in natural resources, familiarity with local natural areas, volunteer management infrastructure, and incentives to volunteer. Master Naturalist programs can connect their volunteers to meaningful service opportunities.
In this session, we will (1) provide an overview of Master Naturalist programs and ANROSP; (2) highlight existing successful Master Naturalist–citizen science partnerships; (3) discuss ways that partnerships between Master Naturalists and citizen science programs can support lifelong learning; and (4) gather input on developing sustained collaboration between these two communities. We have selected panelists who represent a range of Master Naturalist program models and geographic locations, and we also have included the volunteer perspective. Following a brief overview of Master Naturalist program models, we will use guiding questions to gather each panelist's perspectives on the topic. We anticipate that this will be an interactive session during which we will seek specific input from attendees on ways they could partner with Master Naturalist programs and work together to develop plans to move new collaborations forward.

2:00-3:00pm
Coffee Available

2:40-4:00pm
Session 9A   Ballroom 220B
Panel: Research on and Evaluation of the Citizen Science Experience

THE BRAVE NEW WORLD OF CITIZEN SCIENCE: REFLECTING CRITICALLY ON NOTIONS OF CITIZENSHIP IN CITIZEN SCIENCE
Eugenia Rodrigues (Session Chair), University of Edinburgh, UK; **Erinma Ochu**, University of Manchester, UK; **Shannon Dosemagen**, Public Lab for Open Technology and Science; **Esther Turnhout**, Wageningen University, the Netherlands; **Rick Hall**, Ignite!, UK
Citizen Science (CS) advocates often claim that CS is 'science for the public by the public'. This assertion could be easily dismissed on the basis that it's used as a slogan to quickly establish what CS is and does. However, as CS initiatives become widespread and acquire a place in 'mainstream' science and culture, there is a danger that this short statement is accepted without further questioning. We invite the CS

community to experience, discuss and critically assess CS in relation to the question: what is the place of the 'citizen' in CS? Indeed, CS comes in various guises: it can involve the public to various degrees or it can be led by the public; the motivations, governance, objectives, formats and methodologies are equally diverse and multifaceted; the results and impacts range from the non-descript to the highly significant. This diversity of CS practices, models and notions warrants reflection on the 'feeling of what happened,' the experiences of the citizens in CS. And, this debate cannot be separated from 'which' citizens we are talking about, that is, how are citizen scientists conceived? What notions are put forward when a programme, initiative or activity is prepared? And what is the role that the citizens see themselves performing or fulfilling? One could argue that in the context of CS the 'user' and the 'producer' of the experiences are often enmeshed, but to what extent is the citizen herself accountable for her experience? And if not, what are her rights and how can they be negotiated? With contributions drawn from crowdsourced stories, this session aims to archive and further the debate on the extent to which CS initiatives intersect with everyday life, progress the democratisation of knowledge-making and connect with wider notions of citizenship.

2:40pm
Session 9D   Lower Level 20B
Symposium: Broadening Engagement to Foster Diversity and Inclusion

PATHWAYS TO MORE EQUITABLE AND PRODUCTIVE PARTNERSHIPS: JOIN US IN A WORLD CAFÉ TO DISCUSS HOW WE CAN OVERCOME BARRIERS TO PARTICIPATION IN 'CITIZEN' SCIENCE
Rajul Pandya (Session Chair), Thriving Earth Exchange, American Geophysical Union; **Rose Eitemiller**; **Patricia Iwasaki**, Taking Neighborhood Health to Heart; **Jonathan Long**, US Forest Service PSW Research Station; **Monica Ramirez-Andreotta**, University of Arizona; **Daniela Soleri**, University of California, Santa Barbara
Scientists alone can't solve society's most pressing challenges, even when those challenges depend on, or emerge from scientific advances. Effective, equitable responses start with broad and inclusive engagement at the community level. To better realize that goal, we need to strengthen the more participatory forms of the citizen science portfolio, in which the public has an equal or central role in all aspects from identifying questions to interpreting and acting on findings. Using an interactive discussion and synthesis, this symposium will investigate the barriers to greater public participation, and individual and systemic ways to overcome those barriers. Which types of barriers, including social (e.g., how are different sources of knowledge viewed, conflicting values among researchers and community members), institutional (e.g., funding, leadership continuity), and technical (e.g., availability of appropriate methods or tools), are most challenging? How can scientists and the public address those barriers? How might organizations begin to dismantle those barriers? After brief examples of barriers and responses presented by experienced practitioners, the rest of the symposium will be devoted to the World Café method that facilitates engaged conversations in small groups. We will consider barriers to greater public participation and control, and explore effective ways for community members, scientists, and institutions to overcome them. Short essential ideas will be recorded and posted on Instagram; a concluding synthesis will be made available on the CSA website, and provided to the CSA Board. Practitioner experts: R Eitemiller, Community Coalition of Dewey-Humboldt, AZ; PG Iwasaki, Taking Neighborhood Health to Heart; JW Long, US Forest Service Co-Organizers (optional): R Pandya, Thriving Earth Exchange, AGU, (pandya@ucar.edu); M Ramirez-Andreotta, U AZ (mdramire@email.arizona.edu); D Soleri, UCSB, (soleri@geog.ucsb.edu) Presenting Author: Practitioner experts and co-organizers Corresponding Author: soleri@geog.ucsb.edu

2:40-4:00pm
Session 9E   Lower Level 20C
Symposium: Broadening Engagement to Foster Diversity and Inclusion

CITIZEN MICROBIOLOGY: ENGAGING THE PUBLIC IN THE STUDY OF INVISIBLE LIFE
Holly Menninger (Session Chair), North Carolina State University; **David Coil**, MicroBEnet, University of California, Davis; **Jenna Lang**, Project MERCCURI, UC Davis; **Daniel McDonald**, American Gut Project, Colorado University, Boulder; **Bethany Dixon**, Western Sierra Collegiate Academy; **Sally James**, Freelance Science Writer; **Patrik D'Haeseleer**, BioCurious and Counter Culture Labs

Increased public interest in both microbiology and citizen science, combined with technological advances in DNA sequencing, has recently led to the rise of many "citizen microbiology" projects including Wild Life of Our Homes, the American Gut Project, and Project MERCURRI. Citizen microbiology faces a number of special challenges for public engagement that set these projects apart from many other successful, ecologically focused projects: microbes cannot be seen with the naked eye, are often feared as the cause of disease, and are typically identified by genetic sequences, not physical characters. On the flipside, citizen microbiology projects are uniquely positioned to help participants engage in meaningful and intensely personal ways with topics that have significant consequences on human health and well-being (i.e., microbiome, overuse of antibacterial agents, sick building syndrome).
The objective of our citizen microbiology symposium is to shine a spotlight on this emerging field and discuss opportunities and challenges both unique to citizen microbiology and shared in common across more traditional citizen science projects. Our session will start with five-minute speed talks presented by stakeholders from all aspects of citizen microbiology (scientists, participants, project managers, teachers) to provide brief project overviews and set the context for discussion: (1) Wild Life of Our Homes and Belly Button Biodiversity (Menninger); (2) American Gut Project (McDonald); (3) Project MERCURRI (Lang); (4) Microbes in the Classroom (Dixon); (5) DIYbio and the citizen microbiology connection (D'haeseleer); (6) Participant perspective on citizen microbiology (James). Speakers will then transition to a moderated panel discussion (led by Coil) to discuss cross-cutting topics like data visualization, data return and sharing, managing participant expectations, biosafety, and participant privacy.

2:40pm
Session 9F   Lower Level 20D
Symposium - Best Practices for Designing, Implementing, and Managing Citizen Science Projects and Programs

OUR ANCESTORS ARE IN THE WATER, LAND, AND AIR: USING AN INTEGRATIVE APPROACH OF INDIGENOUS AND WESTERN RESEARCH METHODS FOR COMMUNITY-BASED PARTICIPATORY ENVIRONMENT AND HEALTH RESEARCH
Heather Castleden (Session Chair), Associate Professor, Queen's University, Ontario, Canada; **Sheila Francis**, Community Research Partner, Pictou Landing First Nation, Nova Scotia, Canada; **Diana Lewis-Campbell**, Ph.D Candidate, Dalhousie University; **Kim Strickland** and **Colleen Denny**, Community Research Associates, Pictou Landing First Nation, Nova Scotia, Canada
For generations, A'se'k—now known as Boat Harbour—was a culturally important place for the Mi'kmaq of Pictou Landing First Nation. For almost 50 years, Boat Harbour has been receiving the toxic wastewater of a bleached kraft pulp mill, leading to degraded ecological integrity and human health concerns. Since 2010 the Pictou Landing Native Women's Association has mobilized, partnering with a team of researchers led by Dr. Heather Castleden, to conduct research driven by the guiding question: "Are we getting sick from Boat Harbour?" The team engages in community-based participatory health research through Two-Eyed Seeing; they integrate Indigenous and western approaches to research to create space to build trust, cross-cultural respect, and leverage the knowledge and experience of both the academic and community-based researchers. As a result, the team is jointly conducting an eco-health risk assessment by balancing air, water, and toxicity testing with oral histories, community mapping, and ceremony and using both academicians and community-based citizen scientists to conduct the data collection and analysis.
The team has had many successes, despite operational challenges, over their four-year partnership. This roundtable will explore the institutional and community-based barriers, challenges, and successes faced

while operating between two worlds. Each presenter will share a digital story, a powerful tool for knowledge translation that emphasizes personal voice and experiences (such stories tend to promote transformational learning; they are also reflective of Indigenous oral tradition), to facilitate interactive roundtable discussion. Each story relays a different narrative from academic and community perspectives, exploring the successes and challenges of our work together, particularly with respect to the role that community members had as citizen scientists in terms of collecting air and water samples. The roundtable will conclude by sharing recommended approaches and strategies for navigating and overcoming community and institutional barriers.

4:10-5:10pm
Ballroom 220B
Keynote Address

EYEWIRE: WHY DO GAMERS ENJOY MAPPING THE BRAIN?
Amy Robinson, Executive Director, Eyewire
Citizen Science revolves around community—our collective discoveries wouldn't be possible without millions of passionate participants around the world. How does this happen? EyeWire, a game to map the brain played by over 160,000 people, places great emphasis and interacts regularly with its highly active player base. Amy Robinson, EyeWire's Creative Director, will share several key short stories about the growth and development of this community. We will dive into spectacular successes and stunning failures, exposing best practices for crowdsourcing science with community and design in mind.

Amy Robinson is a crowdsourcer. She is the Executive Director of EyeWire, a game to map the brain from MIT and Princeton University played by over 150,000 people worldwide. In EyeWire, gamers solve 3D puzzles that map out neurons, allowing neuroscientists to chart synaptic connections among neurons and thus begin to decipher the mysteries of how we see. EyeWire is the first of many games to map the brain. Amy was recently named to the 2015 *Forbes* 30 Under 30 in the games category. She is a longtime TEDster and founded the TEDx Music Project, a collection of the best live music from TEDx events around the world.

5:10-5:30pm
Ballroom 220B
Closing Session   CSA Board Members