National Park Service
U.S. Department of the Interior

Natural Resource Stewardship and Science

Call to Action Item # 7 “Next Generation Stewards”

A Success Story

Natural Resource Report NPS/NRSS/BRD/NRR—2016/1357

ON THE COVER
Aquatic macroinvertebrate inventory at Rocky Mountain National Park during 2012 NPS/National Geographic Society Rocky Mountain BioBlitz.
Photograph courtesy of National Park Service

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Natural Resource Report NPS/NRSS/BRD/NRR—2016/1357

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Abstract

Opportunities for public engagement in biodiversity discovery is exemplified by efforts at Yellowstone NP, NPS photos.

In August 2011 the National Park Service issued "A Call to Action," providing guidance to all NPS staff and partners to advance the mission of the Service into its second century. Call to Action Item #7 "Next Generation Stewards," envisioned addressing lack of knowledge about park biodiversity and declining relevance of parks and their resources to diverse audiences through biodiversity discovery activities such as BioBlitzes. Specifically the Action Item called for: "Creating a new generation of citizen scientists and future stewards of our parks by conducting fun, engaging, and educational biodiversity discovery activities in at least 100 national parks, including at least five urban parks by 2016 (NPS 2011)." Parks were encouraged to consider activities that addressed their individual needs, resources, constraints, partners, and audiences. Response from the parks was so enthusiastic that Call to Action Item #7's initial park participation goal was accomplished two years early. Building upon this success, the National Park Service instigated a nationwide BioBlitz as a signature centennial project, with the key objectives of participation by at least 100 parks in 2016 and involvement of thousands of public participants. At the time of this writing (November 2016), 129 parks have registered to participate.

This report provides an overview of Call to Action Item #7, as well as invited papers from multiple authors that illustrate the truly collaborative nature of this endeavor. Included are discussions of key components such as data management and youth engagement; communication strategies, resources, and products; examples of individual park biodiversity discovery efforts; and illustrations of partner involvement. The success of Call to Action Item #7 is a commencement rather than a conclusion, engendering an obligation and opportunity to grow and build upon the foundation that has been laid. This report also shares a vision and recommendations to continue to document the biological resources of the parks, build our next generation of citizen stewards and scientists through biodiversity discovery, and use the information from these ventures to inform park management and conservation strategies.

Acknowledgements

This report was a collaborative effort from National Park Service staff and partners. The report received guidance and support from National Park Service Biological Resources Division Chief Elaine F. Leslie and Deputy Division Chief, Linda Drees. Staff from the NPS Natural Resource Stewardship and Science Directorate, including Kelly Coy, Kiersten Jarvis, Kassandra Hardy, Allison Peterson, Jen Williams, Gillian Bowser, Peter Budde, and Simon Kingston provided content and review. Contributions describing NPS biodiversity discovery efforts across the Service were received from Gretchen Baker of Great Basin National Park, and Janice A. Hinsey of the Heartland Inventory and Monitoring Network. Examples of partners that have joined their efforts with those of NPS were documented by Carrie Seltzer (National Geographic Society), Todd Witcher (Discover Life in America) and Paula Ehrlich (E. O. Wilson Biodiversity Foundation).

The variety of opportunities for public engagement in biodiversity discovery is exemplified by efforts at Yosemite NP, NPS photo.

Introduction

Biological diversity ("biodiversity") refers to the variety of living organisms on our planet and encompasses life at ecosystem, species, and genetic levels. It is estimated that at least 8.7 million species exist on Earth (Mora et al. 2011). A growing body of evidence indicates an exceptionally rapid loss of biodiversity over the last few centuries (Ceballos, et al. 2015). We are losing what we don't even know exists—the vast majority of species on our planet are still unknown. The question has been posed as to what difference it makes if some species are extinguished. One answer is that life on Earth is connected in ways we don't fully understand and loss of a single species could affect countless others. All living organisms, from the smallest microbe to the largest mammal, contribute to the maintenance and regulation of diverse ecosystems. The biodiversity of our planet provides us with key ecological services, including drinking water, oxygen to breathe, food, medicine, decomposition of waste, and helping our planet withstand natural disasters. Conservation of our planet's biodiversity is a shared responsibility and privilege—and it equates to conserving our very existence.

The National Park System, including a total of 413 units in every state, the District of Columbia, American Samoa, Guam, Puerto Rico, and the Virgin Islands, and encompassing more than 84 million acres, holds critical preserves of biological diversity; however these areas are not static ecosystems, nor are they immune to environmental stressors that affect species worldwide, such as habitat loss, invasive species, diseases, population pressures, and climate change. The same lack of knowledge observed at a worldwide scale is similarly reflected in the microcosms of parks, where an estimated 80-90 percent of species are still undiscovered, including many invertebrates, microorganisms, non-vascular plants, and fungi. It is likely that significant environmental changes will appear in these lesser-known groups before they are reflected in large, iconic animals; therefore this knowledge gap makes it difficult to recognize impending threats and hampers our understanding of how the pieces of park ecosystems "fit together."

An additional challenge towards conservation of park biodiversity comes in the form of current social trends, which indicate a disconnection of youth from nature and declining relevance of the national parks and their resources to the American public. Lack of relevance, compounded by lack of knowledge pose a troubling, potentially dangerous, equation towards accomplishing stewardship of park biological resources (Kareiva 2008).

A partial solution resides in "Biodiversity Discovery," an NPS initiative that fosters activities and events, such as BioBlitzes, which seek to document species in parks through public involvement. A BioBlitz is a short term biological inventory in which scientists and volunteers of all ages and backgrounds work together to compile a "snapshot" of living creatures in the host parks. The first known NPS BioBlitz was held at Kenilworth Park and Aquatic Gardens in Washington, D. C. The first large-scale biodiversity discovery program, an All-Taxa Biodiversity Inventory (ATBI), began in Great Smoky Mountains National Park in 1997 through the coordinated efforts of the park and its nonprofit partner, Discover Life in America. Since then, many parks—large, small, urban, wild, naturally or culturally oriented—have initiated their own biodiversity discovery efforts.

In August, 2011, the National Park Service issued "A Call to Action," providing directional guidance to all NPS staff and partners to advance the mission of the Service. The benefits of initial biodiversity discovery efforts in terms of scientific gain, public engagement, and partnering were so apparent that expansion of biodiversity discovery activities in parks became one of an initial 36 key NPS Call to Action Items.

Overview of Call to Action Item #7 "Next Generation Stewards"

The benefits of initial biodiversity discovery efforts in terms of scientific gain, public engagement, and partnering were so apparent that expansion of biodiversity discovery activities in parks became one of an initial 36 key NPS Call to Action Items.

Purpose Statement

Create a new generation of citizen scientists and future stewards of our parks by conducting fun, engaging, and educational biodiversity discovery activities in at least 100 national parks, including at least five urban parks (NPS 2011).

Initial Planning

Planning for accomplishment of Call to Action Item #7 envisioned an overarching strategy of public inclusion, the premise that biodiversity conservation and discovery efforts could and should encompass a wide range of scopes and possibilities, and the assumption of several working propositions:

- Proposition 1: Biodiversity discovery offers a unique means of accomplishing NPS mission goals by repackaging what the parks are already doing (science, education, community building, partnerships, stewardship) in a different way.
- Proposition 2: Every citizen should have the opportunity to engage in discovery of life in our national parks. The definition of a "new" species shouldn't be limited to a species that is new to a species list, but should also include a species that is new to a visitor who has never encountered or observed it before.
- Proposition 3: Park managers are encouraged to tailor their biodiversity discovery efforts to best suit particular park needs, available resources, and management goals. Park planners have wide latitude in determining the type of biodiversity discovery activity, program duration, taxonomic focus, and types and numbers of public participants.
- Proposition 4: Biodiversity discovery is a landscape of relationships and partnering, including scientists with managers, scientists with educators, park staff with communities, educators with scientists, communities with partners, and more.

Participant at the 2012 NPS/National Geographic BioBlitz at Rocky Mountain NP investigates aquatic macroinvertebrates, NPS Photo.

Goals and Objectives

Call to Action Item #7 envisioned expanding the scope of Biodiversity Discovery activities so that:

- More parks participate on varying levels
- Diverse audiences, especially children, participate
- Ongoing and new partnerships with multiple organizations and stakeholders develop
- NPS management practices and programs incorporate citizen science

While the short term goal of Call to Action Item #7 was to engage at least 100 parks in Biodiversity Discovery by the NPS centennial in 2016, the long range objective envisioned institutionalizing biodiversity conservation, planning, and public engagement as fundamental to the mission of the NPS and creating a new generation of citizen scientists and stewards (NPS, 2011).

Evaluation of Success

The primary measurement of success was to achieve the park participation goal. Additional metrics of success included the number of discovered species, the number of participants, especially children, and the development of biodiversity educational products and activities to increase biodiversity awareness (NPS, 2011).

Results and Accomplishments (2011-2015)

Response from the parks to accomplish biodiversity discovery activities was so enthusiastic that the initial goal of Call to Action Item #7 was exceeded as of July 2014, with participation by 117 parks. The number of involved parks rose to 130 by 2015. Building upon this success, the NPS Natural Resource Stewardship and Science Directorate, Biological Resources Division (BRD), proposed a nation-wide BioBlitz as a signature NPS centennial event.

For combined results of 2011-2015 biodiversity discovery activities and the 2016 National Parks BioBlitz, see Appendix A.

Table 1. Results of Call to Action #7 Biodiversity Discovery Efforts (2011-2015)	
130	Parks participated in a Biodiversity Discovery effort of multiple levels and scopes, including All Taxa Biodiversity Inventories (ATBI), bioblitzes, and multi-park inventories. This number includes parks that participated in a Service-wide bee inventory in climate sensitive NPS habitats and a multi-park project to examine mercury levels in dragonflies.
36,500+	Participants, including professional scientists, educators, students, children, families, NPS staff, and park visitors. Projects ranged widely in number of participants.
8,400+	Species have been found during the course of Biodiversity Discovery efforts. This number includes species which were previously not known to exist in a specific park, as well as species that are new to science.
1,500+	Species have been found during the course of Biodiversity Discovery efforts that are new to the host park's species list.

The National Parks BioBlitz (2016)

The National Parks BioBlitz will continue throughout 2016, engaging thousands of people in the exploration and documentation of the biodiversity in our parks. The desired outcome of this signature event is twofold: to contribute to knowledge of living organisms in parks across the Service and to inspire next generation scientists and stewards.

See Appendix B for a list of all 2016 National Parks BioBlitz participatory parks. See Appendix C for preliminary reports from participatory parks.

Table 2. Components of the 2016 National Parks BioBlitz

Component	Parks
The 10th annual NPS/National Geographic BioBlitz at multiple parks in the National Capital Region with an accompanying Biodiversity Festival on the National Mal1.	Rock Creek Park, Monocacy NB, Chesapeake and Ohio Canal NHP, Harpers Ferry NHP, George Washington MP, Theodore Roosevelt Island NM, Catoctin Mountain Park, Piscataway Park, Kenilworth Park and Aquatic Gardens, Antietam NB, President's Park, Prince William Forest Park, Wolf Trap National Park for the Performing Arts, Manassas NP
Large "Showcase BioBlitzes" occurring simultaneously with the DC BioBlitz, in each of the other NPS Regions	Northeast: First State NHP Southeast: South Carolina national parks, including: Kings Mountain NMP, Cowpens NB, Ninety Six NHS, Congaree National Park, Fort Sumter National Monument and Charles Pinckney National Historic Site Midwest: Cuyahoga Valley NP Intermountain: Bandelier NM Pacific West (Northwest): Ebey's Landing NHR, Vancouver NHP, Klondike Gold Rush NHS (Seattle Unit), Lewis and Clark NHP, Mount Rainier NP, North Cascades NP, Olympic NP, San Juan Islands NHS Pacific West (California Coastal Parks): Santa Monica Mountains NRA, Channel Islands NP, and Cabrillo NM Alaska: Bering Land Bridge National Preserve and Gates of the Arctic National Park and Preserve
BioBlitzes of different sizes and scopes	Occurring throughout the centennial year in parks across the Service.
Use of iNaturalist	The iNaturalist digital app is being used as the recommended data management tool during the National Parks BioBlitz to deliver real-time information on species finds. Information from events occurring during the week of May 16-22 were broadcasted on jumbotron screens at the Biodiversity Festival on the National Mall. Verified data will be included in National Park Service databases and international databases tracking biodiversity on the planet.

Constitution Gardens, National Mall, scene of the 2016 Biodiversity Festival, a signature part of the NPS/ National Geographic National Parks BioBlitz—Washington, D. C. NPS Photo.

Table 3. Overall Results of the National Parks BioBlitz (as of November 2016)	
129	Parks across the Service registered to host a BioBlitz during 2016. During the week of May 16-22, 2016 approximately 70 parks participated concurrently.
122,560+	Observations have been made to date using iNaturalist
11,995+	Species were documented in parks across the country to date. Numbers are expected to increase significantly as identification of species continues.
80,000+	People (at a minimum) overall participated in the 2016 National Parks BioBlitz. At the Washington D. C. event alone, at least 10,000 people participated and 2,600 area school children were engaged.
Top 10	National parks and participating partners shared their BioBlitz activities via social media, using the hashtags #BioBlitz2016 and #FindYourPark. During the weekend of May 20-21, #Bioblitz2016 ranked in the top ten most discussed topics worldwide on Twitter.

National Parks BioBlitz Highlights

Highlights from simultaneous events during the week of May 16-22, 2016:

- At Cabrillo National Monument, Green Abalone (Haliotis fulgens) was documented. For the past thirty years, abalone have faced substantial conservation concerns due to overharvesting and disease.
- Knife River National Park conducted an ArcheoBlitz. A centuries-old bison tooth was found at Big Hidatsa Village, which was occupied from about 1740 to 1850. DNA extracted from this tooth can provide data on bison populations before their near-extinction at the end of the 19th century.
- At Great Smoky Mountain National Park, experts teamed up with more than 200 5th grade through high school and documented more than 100 species of pollinators.
- Craters of the Moon National Monument and Preserve conducted a lichen survey, adding several new species to their park list. One of those identified is Xanthoria elegans, a species known to have resided on the International Space Station for a year and a half.
- Channel Islands National Park broadcasted a dive with renowned oceanographer and National Geographic Explorer, Dr. Sylvia Earle, with support from the National Park Trust. The feed was featured online and on the jumbotrons on the National Mall and enabled the public to follow the exploration of the one of the richest marine ecosystems in the world, the giant kelp forest.

Biodiversity Discovery Communication Strategy and Tools

(Sally Plumb, Kassandra Hardy, Kiersten Jarvis)

Communication Strategy

The purpose of the National Parks BioBlitz Communication Strategy (Strategy) was to define and establish consistency for communications processes and procedures pertaining to information sharing, distribution, and coordination. The resulting strategy has been and will continue to be retooled to serve other events and initiatives, including future BioBlitzes, which need substantial communication efforts.

The Strategy identifies key messages, key audiences, talking points, communication objectives, frequently asked questions, and a detailed timeline of communication products release dates and responsible parties. Communication tools are clearly outlined, including purposes for which they are to be used. Tools include: InsideNPS articles, briefings for NPS leadership, News Release templates, Marketing Toolkit, webinars, social media strategies, and more.

NPS BioBlitz Resources Site

An online NPS BioBlitz Resources Site with detailed information and planning resources has been established to provide tools for parks planning biodiversity discovery efforts into the future. Included are detailed recommendations and examples for initial considerations (setting goals, determining the event's scientific focus, identifying audiences, planning a biodiversity festival, and engaging partners), detailed planning advice and recommendations (law and policy, safety, engagement, science, and communication), iNaturalist information, a media library, and contact information.

Webinar Series

The National Parks BioBlitz Webinar Series featured presentations about the components commonly encountered in BioBlitz planning. Park staff, partners, and members of the general public, totaling more than 550 people, joined this eight-part series every Thursday during January and February 2016. Topics included: an introduction to the 2016 National Parks BioBlitz, using iNaturalist, planning a biodiversity festival, implementing use of the Institutional Animal Care and Use Committee, collections management, and general BioBlitz health and

Feed from a dive in a giant kelp forest in Channel islands National Park was broadast on jumbotron screens on the National Mall during the 2016 National Parks BioBlitz. NPS Photo.

The National Park Service used a variety of communication products to accomplish the National Parks BioBlitz: screenshot of internal NPS BioBlitz resource planning site. NPS photo.

The National Park Service used a variety of communication products to accomplish the National Parks BioBlitz: screenshot of an overall communication strategy, a webinar series, an internet biodiversity subject site. NPS Photo.

safety protocols. All webinar presentations are recorded and can be found on go.nps.gov/bioblitzwebinarseries (NPS access only).

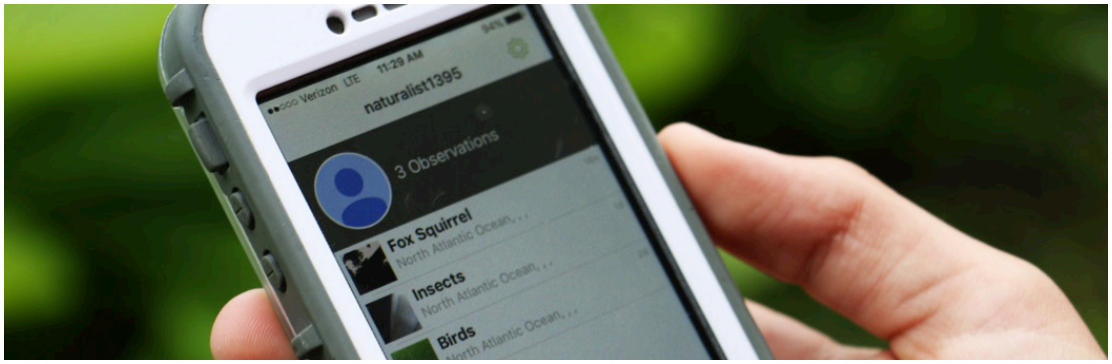
Social Media

The scale of this year's BioBlitz presented an unprecedented opportunity to engage the public via multiple social media platforms and to help advance the Centennial goal of connecting with and creating the next generation of park visitors, supporters, and advocates. Throughout 2016, anyone attending a BioBlitz event, including NPS staff, partners, and participants, were encouraged to post their stories using the hashtag #BioBlitz2016.

By sharing photos, videos, and comments with social media, BioBlitz stories from across the country illustrate an exciting and constantly changing vista of both combined effort and individual flavor that are the hallmarks of the National Parks BioBlitz.

NPS staff used iNaturalist to share interesting finds and observations through the Facebook and Twitter features. Facebook was updated at least twice per day during the cornerstone event at Washington D. C. and posts encouraged dialogue. BioBlitz participants, partners, and parks posted updates, photos, interesting events, agenda items, and "retweeted" using Twitter, resulting in the hashtag #BioBlitz2016 trending in the top ten topics on Twitter worldwide several times during the weekend of May 20-21, 2016. Periscope was used to feature "Ask a Scientist;" to stream the Opening/Closing Ceremony of the Washington D. C. BioBlitz; and to host interviews centering on the question: "What does BioBlitz or conservation mean to you in one word?" Instagram was used to post photos using hashtags and captured photos of the Washington D. C. BioBlitz event features, including scenery, Opening Ceremony, special exhibits, species tallies, and Closing Ceremony; Flickr was used to post photos in a BioBlitz album with appropriate metadata. The album then went into a photo gallery on various park's websites.

Example templates of hashtag cards and signage that were used to promote hashtag usage are found in Appendix D. They are also available through the social media link above.



Using iNaturalist during the 2016 National Parks BioBlitz. NPS photo.

Data Management in the National Park Service

National Geographic Society BioBlitzes

Background

As detailed in a recent article in Park Science http://www.nature.nps.gov/ParkScience/index.cfm?ArticleID=660 (Budde and Kingston 2014), the methods used to record species observations during National Park Service (NPS)/National Geographic Society (NGS) BioBlitzes have changed over time as new technologies became available. In the early Call to Action years, field observations were noted on paper datasheets, then entered into an electronic database by data managers. The data sheets included a unique identification number on each sheet, making the information easier to trace to a team leader, as well as easier to find within the database. The database application was based on a desktop NPSpecies application, allowing for closer ties to the host park's updated NPSpecies list.

In 2012-13, the desktop database migrated to a higher-powered system, which provided greater capacity for multi-user editing and added protection against accidental data loss. A new user interface allowed BioBlitz volunteers to enter field observations directly into the database for advanced review and editing. Internet-based observation tools came into use, as species observations made via Project Noah (www.projectnoah.org) were imported into the BioBlitz database and counted.

Paper field data sheets continued to be used during the 2014 BioBlitz at Golden Gate National Recreation Area, however the iNaturalist mobile application was also adopted, allowing participants to contribute observations using their mobile devices. NPS data managers developed requirements for modifications to iNaturalist in order to make it more compatible for BioBlitz efforts. Use of iNaturalist also permitted crowd sourcing of identifications—that is, soliciting help from the online community of users.

Despite advancements in technology, in the days and even years following a BioBlitz, data management staff will finalize data entry into NPS data systems, such as the Interior Collections Management System (ICMS), the Integrated Resource Management Applications (IRMA) Voucher system, and the IRMA Observations application. NPSpecies remains the constant the National Park Service uses to communicate the depth of biodiversity in the parks and is used for quality assurance during a BioBlitz to ensure that legitimate species names are associated with observations and to highlight discoveries of species that are new to a park. Finally, NPSpecies is updated after a bioblitz to reflect the new state of knowledge as to what species are known to occur in a park.

Expanding the use of iNaturalist during the 2016 National Parks BioBlitz is discussed in the following invited paper.

Evolution of iNaturalist Use by the National Park Service—Expanding the Reach and Benefit of a Standard Suite of Natural History Observation Tools

(Simon Kingston, Allie Petersen, Pete Budde, NPS Centennial Data Rangers)

From Adoption to Scaling Up

A 2014 Park Science article (Budde and Kingston 2014) chronicled the evolution of biodiversity documentation from use of custom databases and paper data sheets to adoption of iNaturalist as the preferred tool for capturing natural history observations in NPS BioBlitzes. iNaturalist was used again to great success during the 2015 Hawai'i Volcanoes National Park BioBlitz.

For the 2016 National Parks BioBlitz, documentation of species observations is being accomplished entirely through the iNaturalist mobile apps on iOS and Android mobile devices and the web-based iNaturalist application, omitting the need for paper datasheets entirely. This relieves the Centennial Data Rangers (BioBlitz data management team) of the burden of staffing data entry stations for entering paper datasheets and helps to improve the quality of observations by encouraging BioBlitz participants to photograph their natural history observations.

For this nation-wide endeavor, iNaturalist is being used in more than 120 parks and 140 BioBlitz events, many of which occurred during a single weekend (May 20-22, 2016). The Centennial Data Rangers support individual park iNaturalist BioBlitz Projects, as well as multi-park BioBlitz Projects, including regional efforts across parks (Pacific Northwest and Southern California Coastal); a collaborative effort between NPS and state parks across an entire state (Wings Across South Carolina); and an NPS Servicewide Project, which highlights results of BioBlitzes in parks across the country occurring in the Centennial year.

To accomplish an endeavor of the magnitude of the National Parks BioBlitz, the Centennial Data Rangers began preparations well in advance. Groundwork was necessary to ensure that iNaturalist could successfully be used as a tool for BioBlitzes of varying sizes and scopes. This work included:

- Best available NPS boundaries were sourced and loaded to iNaturalist as "Standard" places, meaning that they had the same standing as countries, states, and counties, and were easier to discover and reference than "Community Curated" (i.e. user-defined) iNaturalist Places.
- Species Lists were edited in the NPSpecies data system and loaded in iNaturalist as Species Checklists for many of the NPS units, especially those hosting "Showcase" events. These Species Checklists provide parks with a point of comparison to determine species observed during the BioBlitz that had not previously been recorded in the park.
- More than 60 iNaturalist Species Guides were created by parks to help visitors identify organisms seen during the BioBlitzes. These guides may be downloaded to visitors' phones and used in the field to make observations of species being documented.
- More than 140 BioBlitz Projects were created in iNaturalist to automatically capture iNaturalist observations made within park boundaries during the National Parks BioBlitz events. These projects have a standard "look and feel" and include:
    - A common branded header featuring the NPS Centennial and National Geographic logos
    - A compelling natural image and title information
    - Event counts (observations, species, observers)

- Leaderboards
- Map
- Journal
- Images of recent observations

Post-Blitz Follow Up

While some 2016 National Parks BioBlitzes haven't yet occurred, many parks have already hosted their events and preparations are being made for post-BioBlitz species observations follow up. Though making observations is "Part One" of a BioBlitz, "Part Two" is identifying organisms that have been observed and determining which observations are credible.

Guidance is currently being distributed to parks on how to identify observations, deal with common observation problems, and review observations once the subject has been identified. When the park has finished reviewing, those observations that are credible can be submitted to update the park's NPSpecies species lists.

Making iNaturalist Accessible for BioBlitzes

- Training Materials: The decision to use iNaturalist entirely for BioBlitz data management necessitated the responsibility of helping park staff and public participants use this new tool effectively. Members of the NPS data management team worked closely with colleagues at iNaturalist and the National Geographic Society to develop a suite of training materials and guidance that ranged from the basics of making an iNaturalist observation through more advanced uses, including creating species guides and identifying observations. This suite of training materials took on many forms on many platforms, including:
  - iNaturalist Getting Started web pages: These resources are housed in the "Help" section of the iNaturalist website.
  - National Parks BioBlitz Google site: A series of Google Documents and a webinar were made available to NPS staff (and for download and distribution to non-NPS personnel) through a Google site that also includes guidance about how to facilitate this training to various BioBlitz participant groups.
  - Videos created by iNaturalist: A fun, engaging way to introduce people to the basic functions of iNaturalist as well as testimonials from NPS park staff who have made the leap from paper datasheets to iNaturalist.
- iNaturalist Pro-Observer Model - The iNaturalist Pro-Observer role was developed in response to a need to increase the quality and integrity of the species data collected during the BioBlitz. Input from participants who utilized iNaturalist during the Golden Gate (2014) and Hawai'i Volcanoes (2015) NPS/ National Geographic BioBlitzes included that iNaturalist had the potential to become more of a tool of frustration rather than discovery. Scientists and participants were at risk of becoming exasperated with the application or were simply not comfortable with the technology. To address this concern, "Pro-Observers" were introduced during planning for the 2016 National Parks BioBlitz, with the role of facilitating the creation of a large volume of high quality observations in iNaturalist during the biological inventories. Pro-Observers were available to assist the inventory lead and public participants with using the iNaturalist app. Expertise in a taxonomic group is not required for a volunteer to serve as a Pro-Observer, rather he or she must have a passion for biodiversity, the ability and willingness to learn iNaturalist, and patience to assist members of the public of all ages and backgrounds with this data management tool. More information

and a sample training timeline can be found on the Pro-Observer page of the NPS National Parks BioBlitz Google site.

Training materials remain available beyond the 2016 National Parks BioBlitz, while we continue to promote iNaturalist as a way to explore the biodiversity of our national parks.

Getting the Word Out

To raise awareness of the 2016 National Parks BioBlitz, the NPS published the 130+ BioBlitz iNaturalist Projects on two citizen science online platforms:

- SciStarter, a national database of formal and informal research projects and events looking for citizen scientist volunteers;
- Federal Crowdsourcing and Citizen Science Catalog , the product of a 2015 White House Office of Science and Technology Policy (OSTP) memorandum that directs Federal agencies to catalog agency-specific projects in a government-wide online database and website and provides access to both the Catalog and a citizen science toolkit and community of practice.

It Takes a Village

National Geographic Society (NGS)— NGS has been instrumental in the NPS adopting iNaturalist as an observation data management tool, in fact NGS first suggested that NPS evaluate iNaturalist for use in the 2014 Golden Gate National Parks BioBlitz. NGS also provided invaluable perspective and practical experience from use of iNaturalist in their Great Nature Project.

California Academy of Sciences (Cal. Academy)— iNaturalist was developed and is maintained by Cal. Academy. NPS entered into a cooperative agreement with Cal. Academy to "...engage in cooperating activities focused on promoting scientific research, fostering a greater understanding of species distribution and the communities they form, and improving ecological inventory and education related to NPS lands." Specifically, the NPS entered into a task agreement to collaboratively engage in:

- Data management for the NPS Centennial BioBlitzes using iNaturalist
- Protecting sensitive species information from iNaturalist observations in NPS units
- Developing web-based visualizations of bioblitz results from iNaturalist
- Update training materials on use of iNaturalist
- Perform research, monitoring, and educations programs
- Use of iNaturalist in informing management decisions
- Information collected and maintained through iNaturalist mobile and web-based tools provide a rich dataset that can ultimately be used by park resource managers as they confront management decisions. Several opportunities are worth noting:
    - Invasive species: The arrival of potentially invasive species and range expansion of existing invasive species require park managers to be vigilant. Through Early Detection and Rapid Response (EDRR) activities, park managers can treat invasive species before they spread to the point where eradication is no longer feasible. Invasive species observed and recorded in iNaturalist through citizen science efforts or during systematic surveys may be crucial for park managers to become aware of incipient populations.
    - Rare, threatened, or endangered species: Taxonomic information on individual species maintained by iNaturalist provides details on their conservation status based on crosswalk to authoritative lists, such as the IUCN Red List and US Fish and Wildlife Service

Threatened and Endangered Species List. Observations of species with designated conservation status provide another set of information towards documentation of the occurrence and, potentially, abundance of these species both in and adjacent to NPS-administered lands. This allows the NPS to determine all management actions for the protection and perpetuation of federally, state, or locally listed species through park management planning processes.

- Species of management concern: The iNaturalist architecture provides a mechanism for park units to create a customized species checklist to identify species of management concern, due to a number of situations (such as rare, declining, sensitive, or unique species or populations and their habitats, or risk of exploitation). In the event species of concern are observed, their locations can be obscured so the public cannot navigate to the precise location, but park project curators can access these data and apply information in management decisions.

Integrating iNaturalist data into other NPS data systems

As noted earlier, credible observations in iNaturalist that have been vetted by NPS data managers can be used to update species occurrence information in the NPS-managed biodiversity data system—NPSpecies. Additionally, there are a number of other programmatic data systems and processes that could benefit from the integration of iNaturalist species observations, including:

- National Invasive Species Information Management System (NISIMS): NISIMS is the NPS standard invasive species data management tool. NPS adopted this tool from the Bureau of Land Management and modified it to standardize the collection, management, and reporting of invasive species data at the national and park levels. Observation data from iNaturalist can be a critical source of NISIMS "weed infestation" data to document when a new species infestation has been identified either as part of a formal monitoring program or as a result of incidental observations.
- Wildlife Health Morbidity and Mortality Observations (WHMMO): WHMMO is an application used by the NPS Wildlife Health Team to track wildlife mortality and morbidity in park units. Incidental observations of wildlife species with annotations about behavior indicative of health condition or fatalities that are recorded in iNaturalist could supplement formal reports that are submitted through the application for necessary diagnostic testing.
- Natural history observations: Currently, the Bureau uses NPS Form 10-257, "Natural History Field Observation" to provide a standard process for park visitors to record species observations and share their information with parks. These data points typically represent the basic "who, what, and where" about a species, but lack, in most cases, any evidence (e.g., photograph) of the observation, accurate location information, and even credible taxonomic identification (except in the case of charismatic flora and fauna). Replacing these paper forms with the inherent capabilities of iNaturalist mobile tools would improve quality and simplify management of these incidental park- visitor observations.

Strength and Value in Numbers

There is significant value in a large quantity of high-quality natural history observations. Intentional outreach to organizations with shared geographic and thematic or programmatic interests would increase the adoption and use of iNaturalist as a common information management platform for seamless biodiversity data. Several organizations with which parks typically interact can be aligned with the NPS in the adoption of a standard tool:

- Natural Heritage Programs: The Natural Heritage Network is made up of independent heritage programs that are located in all 50 states. Each of these network members track and rank rare species and habitats using a standard set of criteria. The feasibility of using iNaturalist as a tool to maintain observations of the number and variety of species found within their respective geographic areas would provide a baseline of information that would benefit parks and other land management organizations.
- Cooperative Invasive Species Management Areas (CISMAs): CISMAs are a partnership of federal, state, and local government agencies, tribes, and various interested groups that manage invasive species in a defined area. Acknowledging that species, including noxious or invasive weeds, do not recognize administrative boundaries, these groups work cooperatively to address the effects of invasive species across boundaries. As a result, parties agree it is to their mutual benefit and interest to work cooperatively to inventory and monitor for these species; adoption of iNaturalist could be a useful approach.

Conclusion

Use of the iNaturalist suite of tools provides a platform that has supported NPS distributed BioBlitz data management needs over the past several years, and demonstrates great potential to satisfy other known and emerging biodiversity discovery needs. The NPS is reaping the benefits of joining a vibrant and growing community of online naturalists who contribute their observations and identifications to the commons for the good of science. This aligns well with our goal to understand what species occur in our parks so that we can ensure the agency "...preserves unimpaired the natural and cultural resources and values of the national park system for the enjoyment, education, and inspiration of this and future generations."

Specimens collected during a BioBlitz awaiting identification. NPS photo.

Taxonomists in Parks (TIP)

In August 2011, NPS, Boston Harbor Islands Alliance, and Harvard University began exploring the feasibility of creating a Taxonomist in Parks (TIP) program. The program developers sought ways to address a nationwide dearth of taxonomists, find innovative ways to accomplish taxonomic identification of species, provide educational and outreach materials, and partner with support organizations. A preliminary proposal outlining the concept and components of a TIP program was distributed for comment and received responses from more than 80 professional and amateur taxonomists, curators, and park staff. Three topics that received the most comments were: (1) providing compensation for taxonomists; (2) ensuring that data are entered into park databases and are accessible to the scientific community and the public; and (3) the deposition of specimens in non-NPS collections.

Accomplishments

- Collaboration with the NPS senior curator of natural history to identify regional institutions to enter into specimen repository agreements with NPS. Negotiations were implemented with Harvard University's Museum of Comparative Zoology to draft such an agreement. During this process, Harvard University became a member of the North Atlantic Coast CESU.
- In June 2013 a prototype "Photoblitz" was implemented to design a process whereby participants could document biodiversity without physical collection. This pilot project took place at Boston Harbor Islands National Recreation Area and focused on insects, with 13 photographers ranging widely in photographic and entomological expertise. Over a 4.5-hour photo-inventory period, a total of 248 observations were contributed by participants to a project website on iNaturalist for transfer to a virtual arthropod identification site, BugGuide, as well as to individual taxonomic specialists. By July 2013, 52 species had been identified, including 14 new species records for the park. This effort contributed greatly to further exploration of iNaturalist as a tool for documentation of species in biodiversity discovery efforts.
- Collaboration (Fiscal Year 2012-13) with the Encyclopedia of Life resulted in development of a model for biodiversity educational tools: Bee Observer Cards, as well as a field guide to invasive plants of Boston Harbor Islands, http://eol.org/info/disc_observer
- The present widespread use of iNaturalist represents a significant step forward in addressing several of the topics raised as significant taxonomic issues in biodiversity discovery projects. It must be noted, however, that identification of organisms to the species level often requires physical specimens and analysis that cannot be accomplished through photographs alone.

Seven –year-old Imani is exposed to one of her greatest fears, a "creepy crawly" at the 2013 NPS/National Geographic BioBlitz at Jean Lafitte National Historical Park and Preserve and becomes "hooked" on exploring biodiversity.

Working Together

Accomplishment of Call to Action Item 7 brought out the best of the National Park Service in many ways—its mission to conserve, its quest for scientific discovery, its desire to involve and engage visitors and youth, its ability to partner, and its willingness to share and inspire.

From the onset, this action item was founded upon a premise of inclusion and upon an ideal that anyone can contribute and make a difference. In recognition of the truly collaborative nature of this Action Item, the remainder of this report "gives voice" to multiple disciplines, parks, and partners that contributed to this rich success story.

Profiles of Park Biodiversity Discovery Efforts - BioBlitzes at Great Basin National Park

(Gretchen Baker)

Introduction

What's that insect? That question was difficult to answer in Great Basin National Park. Although many taxa, including plants, mammals, birds, reptiles, and fish are well documented in the park, little was known about invertebrates. Park staff attended a BioBlitz session at the George Wright Society meeting in Portland in 2009 and realized this was a technique to help fill this data gap.

Great Basin National Park (GRBA) is a relatively small park service unit (77,000 acres) and remote (130 miles from the nearest large population center), located in the high desert of Nevada. The isolated area limits the pool of subject matter experts and volunteers willing to attend. Because of the small land area and inaccessibility of many areas within the park, a yearly BioBlitz which focused on different units or regions of the park was not an option. Instead, the park adopted Acadia National Park's BioBlitz model: focusing on one order or class of organisms per year.

Purpose

The primary objectives of BioBlitzes at GRBA:

- Conduct inventories for taxa not included in the National Park Service Inventory and Monitoring Program
- Determine what invertebrate species are present in the park
- Expand the number of species known to occur in the park
- Collaborate with subject matter experts from various agencies and universities to strengthen park partnerships
- Engage citizen scientists to help develop park stewards
- Share results to initiate additional studies within GRBA

- Establish an invertebrate reference collection for park staff and visiting researchers

Methods

In 2009, the park established a partnership with Southern Utah University to assist with the park's first BioBlitz. Park staff decided to limit the BioBlitz to one order of invertebrates because of the volume of specimens that would likely be generated, the park's limited facilities and remote location, the number of expected participants, and the anticipated amount of time needed to identify specimens after sampling concluded.

The 2009 Beetle BioBlitz was a success, and the following year GRBA held another event. The momentum has continued to hold, and an annual BioBlitz, with a different order or class of invertebrate or vertebrate is studied each year. The availability of a lead taxonomist decides the focus of the event. The lead taxonomist is responsible for leading a workshop, demonstrating sampling techniques, identifying specimens to family level during the event, and providing the expertise, staff, and lab capacity to identify the specimens to a lower taxonomic level by the following year.

Description of the Events

The park has hosted eight BioBlitzes over the past eight years with a budget range of $500 to $7,500 and between 25 and 150 participants (Table 4). During the 2010 BioBlitz, inclement weather negatively affected sampling and led to an extension of the event from 24 to 48 hours. The longer sampling period also increased participation. We were fortunate to have one BioBlitz participant, Dr. Ken Kingsley, volunteer to serve as the first taxonomist-in-the-park. Dr. Kingsley spent one week each month during the summer of 2012 collecting, organizing, and curating the growing invertebrate collection. The Nevada State Entomology office has also been an indispensable partner, bringing additional collecting equipment, microscopes, and knowledgeable staff to make each event run smoothly.

Results

A potentially new species to science (Acanthetropis sp. nov.) was documented during the Hymenoptera BioBlitz in 2011, and the Arachnid BioBlitz documented two new orders (Solfugids and Scorpions). In addition, some tiny moths were found during the Lepidoptera BioBlitz that may be new species. Over 80 families have been added to the park's taxonomic list, along with numerous genera and species, providing a more complete species list for the park. The information gained from these BioBlitzes can help direct the park where to focus more intense sampling and additional research, as well as better understand the biodiversity.

Many participants say they have a new understanding of the park and look forward to participating in future BioBlitzes.

Recommendations

For those who would like to make BioBlitzes regular events at their site, following are recommendations:

- Plan early; we often start planning a year in advance
- Find an excellent taxonomist who likes dealing with the public; being able to explain why and what they're doing helps create more stewards
- Maximize the science; we try to get a lot of information on our data forms so that we end up with more than a simple inventory
- Foster partnerships; working with the State Entomologist's Office and several universities and environmental groups has helped build our base
- Maintain good communications; all those who sign up get emails with additional information as the date approaches
- Have fun!

BioBlitzes have been a valuable tool at Great Basin National Park to learn about the understudied, often overlooked taxa that are abundant all around us.

Table 4. Summary of BioBlitzes at Great Basin National Park							
Year	**Order/Class**	**Common Name**	**Lead Taxonomist**	**# Participants**	**# Families Added**	**# Species Added**	**Notes**
2009	Coleoptera	Beetles	Jeff Knight, Nevada State Entomologist	40	9	25+	Organizational support from Southern Utah University
2010	Orthopteroids	Crickets, Grasshoppers, Related	Dr. Andrew Barnum, Dixie State College	25	4	15	Inclement weather
2011	Hymenoptera	Bees, Wasps, Ants	Dr. James Pitts, Utah State University	80	25	100+	First 48-hour event
2012	Diptera	Flies	Dr. Riley Nelson, Brigham Young University	50	15	30+	NPS Biodiversity Coordinator Sally Plumb attends
2013	Arachnids	Spiders, Mites, Ticks, Pseudoscorpions, Solfugids, Scorpions	Dr. Paula Cushing, Denver Museum of Nature & Science	60	10+	30+	Night-time activities attract significant attendance
2014	Lepidoptera	Butterflies, Moths	Dr. Paul Opler, Colorado State University	60	20+	200+	Several field trips with experts were offered
2015	Ephemeroptera, Plecoptera, Trichoptera	Mayflies, Stoneflies, Caddisflies	Dr. Boris Kondratieff, CSU, and Dr. Riley Nelson, Brigham Young University	35	2	10+	Some micromoths found during BioBlitz may be new to science
2016	Aves	Birds	Dr. Elisabeth Ammon, Great Basin Bird Observatory and Kevin Wheeler, UDWR	150	0	1	Centennial BioBlitz was the first to look at vertebrates, trying to increase our knowledge of a Class during a specific time period

HerpBlitz Participants. NPS photo.

Profiles of Park Biodiversity Discovery Efforts - HerpBlitz at Pecos National Historical Park

(Jen Williams)

Background

The Wildlife Conservation Branch (WCB) within the NPS Biological Resources Division received a Technical Assistance Request (TAR) during fiscal year 2015 to design a program for monitoring the status and trends of reptiles and amphibians in Pecos National Historical Park (PECO).

Previous surveys in PECO documented five amphibian and eight reptile species (Parmenter and Lightfoot 1996, Johnson et al. 2003). Parmenter and Lightfoot used visual encounter surveys, while Johnson et al. (2003) employed the following sampling techniques: noose-and-pole capture methods while walking transects, coverboards, drift fence arrays, aquatic turtle traps, and anuran calling surveys. Both of these studies were described as "limited in scope" and Johnson et al. (2011) recommended conducting a more comprehensive herpetofaunal survey over all habitat types.

Study Area

PECO is located in the Pecos River Valley in north-central New Mexico in the Rocky Mountain conifer vegetation zone (Johnson et al. 2011). The park totals 6,670 ac and has two units – the Pecos Unit and the Glorieta Battlefield Unit, the latter of which contains two sub-units: Cañoncito Sub-unit and Pigeon's Ranch Sub-unit. Approximately half of the park's acreage was sampled because surveys were restricted to the Pecos Unit west of the Pecos River. Piñon-juniper, interspersed with Ponderosa pine and Douglas-fir, and piñon-juniper cover about 70 percent of the unit.

Participants

Participation in the HerpBlitz was by invitation only. On July 11, 2016, 28 herpetologists, natural resource professionals, and herp hobbyists met at PECO to conduct a one-day HerpBlitz. Participants included PECO staff and individuals from five partnering agencies / organizations: Warren Wilson College, the Colorado state chapter for Partners in Amphibian and Reptile Conservation (CO PARC), New Mexico Highlands University, U.S. Forest Service, and National PARC. There were also two private citizens who were assistants/guests of invited participants.

Methods

Survey methods included coverboards (six coverboards were deployed in May of 2016 for snakes), hoop turtle net traps (two were baited and installed in wet areas), and visual encounter surveys. The blitz began around

Left: Wandering Gartersnake (Thamnophis elegans vagrans). Right: Plateau Striped Whiptail (Aspidoscelis velox). Photos by J.J. Apodaca

7:30 am and concluded at 4 pm, with a one-hour break for lunch.

Results

Neither the coverboards nor the hoop turtle net traps yielded captures. However, visual encounter surveys were successful; we encountered nine species of six families and seven genera. Two species were not yet documented in PECO—Variable Skinks (Plestiodon multivirgatus epipleurotus, formerly Southern Many-lined Skinks [Eumeces multivirgatus epipleurotus]) and Chihuahuan Spotted Whiptails (Aspidoscelis exsanguis, formerly Cnemidophorus exsanguis). No specimens were collected and removed from the park.

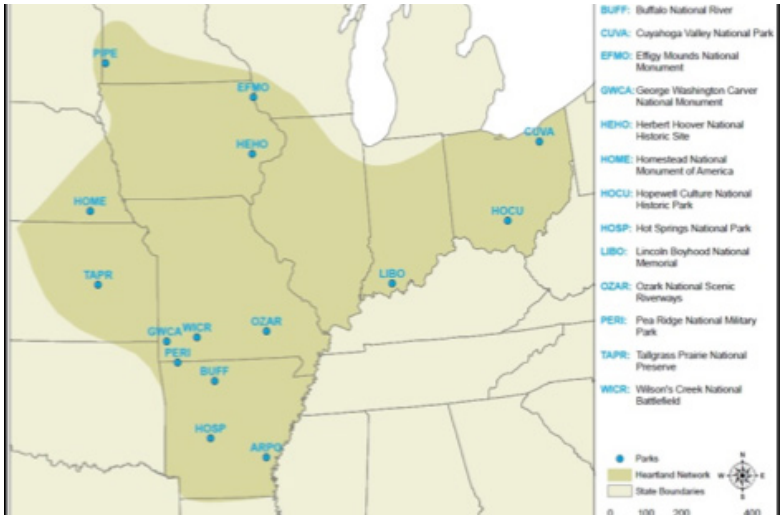
The TAR was to monitor the status of amphibians and reptiles in PECO. Prior to developing and implementing a monitoring program, an inventory must first be done. In the absence of baseline information, trends cannot be determined.

Of 41 amphibian and reptile species expected to occur in PECO, only 15 have been documented in the park. BioBlitzes provide only a snapshot in time of what species are present on an area. Weather conditions can strongly influence capture success of herpetofauna; Johnson et al. (2003) attributed their low capture rate to drought conditions.

Recommendations

A comprehensive inventory should be conducted long term over multiple seasons and conditions in a multitude of habitat types to increase chances of capture success. The Glorieta Battlefield was not sampled for herpetofauna during the blitz or during either of the previous herpetofaunal surveys. This unit should be included in future surveys.

Buhlmann and Graeter (2013) contains a table detailing methods that can be used to conduct a comprehensive herpetofaunal inventory, as well as how to monitor the population trends on an area. Each row in the table corresponds to an individual amphibian or reptile species and all species in the U.S. and Canada are included in the table. This table could be consulted when developing an inventory and monitoring program for PECO.



Heartland Network Park Map. NPS photo.

Profiles of Park Biodiversity Discovery Efforts - Heartland Inventory and Monitoring Network (HTLN) BioBlitzes

(Janice A. Hinsey, Aquatic Ecologist, HTLN)

Introduction

In 2013, the Heartland Inventory and Monitoring Network (HTLN) staff set out to help our network parks meet the Director's Call to Action goal for the "Next Generation Stewards" (NPS 2011) and to grow the parks' natural resource knowledge base while making science fun for a new generation of citizen scientists as park stewards. For most HTLN parks, the large iconic NPS/National Geographic Society BioBlitzes are simply not feasible given constraints on personnel and fiscal resources.

Laying a Foundation

HTLN held three BioBlitz events (2013 and 2014) as a foundation upon which to develop a plan to conduct multiple, smaller events that: 1) focused on a few, under-studied taxa groups or habitats; 2) accommodated 20-40 volunteers per event; and 3) required minimal park staff involvement and funding per event (Hinsey and Johnson, 2014 and 2015a). These events were a great success and resulted in the development of a Natural Resource Report Planning and Conducting a BioBlitz Event at a National Park Service Unit (Hinsey and Johnson 2015b).

Providing Widespread Guidance

This plan was used by our network parks during the 2016 National Parks BioBlitz Initiative and is currently being utilized by Parks Canada in planning their national BioBlitz initiative. The plan was also made available to all NPS units as part of the 2016 National Parks BioBlitz online planning guidance https://sites.google.com/a/nps.gov/centennialbioblitz/?pli=1.

A video highlighting the second BioBlitz at George Washington Carver National Monument (GWCA) was filmed and produced by a Missouri State University student, available at: https://www.youtube.com/watch?v=UJllzkqnIX4.

Results

To date, there have been 12 BioBlitz events conducted by nine parks in the HTLN network from 2013 through 2016. These efforts have resulted in a total of 944 volunteers who collected 1906 unique taxa (213 taxa previously not reported in a park), and reached more than 1800 visitors. Table 5 provides a summary of the BioBlitz events conducted in HTLN network parks. For those events held in 2016, taxa

Table 5. Park Staff Comments from 2016 National Park BioBlitzes	
Arkansas Post National Memorial (ARPO)	In addition to the BioBlitz, ARPO had several outdoor exhibits and events for park visitors including: Guided Nature Tour to the Bald Eagles Nest, Owl Pellet Dissection, Army Corps of Engineers (USACE) Water Safety Booth, USACE Aquatic Invasive Species Program, Mammal Track Casting, Furs & Pelts Touch Table, and Insects of Arkansas Exhibit (UAM & UCA)."
Buffalo National River (BUFF)	"Relationships built with teachers indicated that [future] BioBlitz events will be better represented by areas schools now that the value of these events is understood."
Cuyahoga Valley National Park (CUVA)	"Cuyahoga Valley was chosen to be the Midwest Region's showcase park for this event. Cuyahoga Valley sits between two major cities in Ohio, Cleveland and Akron."
George Washington Carver National Monument (GWCA)	"A total of 30 scientists and volunteer citizen scientists participated in BioBlitz, including a National Weather Service meteorologist who functioned as the iNaturalist ambassador."
Hot Springs National Park (HOSP)	"Adding so many species of fungi that had never before been recorded in the park and educating so many members of the public are exciting BioBlitz success stories for our park."
Tallgrass Prairie National Preserve (TAPR)	"Numerous exhibits related to native prairie plants and pollinators throughout the weekend (thanks to the KNPS [Kansas Native Plant Society] folks), guest speakers from various organizations presenting on monarch and other butterflies and wildflower gardening, native bees, land management etc."

results are preliminary. These numbers should only grow and hopefully result in new taxa being added to park records. Three additional events are planned for later in 2016, including a Bee BioBlitz at Homestead National Monument (HOME), and a meadow restoration for pollinator habitat event at Lincoln Boyhood National Monument (LIBO).

The iNaturalist results included 5727 observations, 1260 species, and 360 observers to date. Not all events utilized iNaturalist; however several parks (GWCA, HOME) intensively promoted the use of iNaturalist and recruited volunteers to serve as "iNaturalist Ambassadors" during their events. iNaturalist was useful in engaging park staff, volunteers, and visitors. Given today's internet technology, smartphones, and social media, iNaturalist may be an effective means to engender park stewards.

Activities and exhibits held in conjunction with HTLN BioBlitzes included:

- Biodiversity fairs and festivals (ARPO, HOME, TAPR)
- Educational center open house (BUFF)
- National Public Lands Day (GWCA)
- Missouri Geographic Alliance (MGA) exhibit (GWCA) - MGA provided iNaturalist information and observation sheets center and refreshments for volunteers
- Boy Scout Merit Badge University (GWCA)
- Park Friends organizations provided refreshments as needed (BUFF, GWCA)

Benefits

These biodiversity discovery events helped:

- Document the biodiversity of parks in service-wide databases (e.g. IRMA, NPSpecies) with science-based surveys
- Park interpretive staff increase their knowledge of the park's natural resources and promote interdisciplinary collaboration among park staff and with outside professional scientists, universities/colleges, non-profit organizations (Audubon Society, Master Naturalists, and Native Plant Societies, etc.), and state/federal agencies

Table 6. Summary of BioBlitz events conducted in Heartland Inventory and Monitoring Network parks (2013 through 2016).

			Field team results				iNaturalist results as of 6/29/16		
Park Name	**Date**	**Focal Species**	**Volunteer**	**Taxa**	**New to Parks**	**Visitors**	**Observation**	**Species**	**Observers**
ARPO	4/23/2016	Terrestrial arthropods, small mammals, reptiles, amphibians	20	22	TBD*	57			
BUFF	10/18/ 2014	Water mites Caddisflies (larvae and adults)	13 38	18 TBD*	18 TBD*	10 6			
CUVA	5/20-21/ 2014	All Taxa, MWR's Showcase Park	700	818	TBD*	400	4951	835	318
EFMO	5/20-21/ 2016	Moths and other insects, night and day-time collections	15	225	TBD*	10			
GWCA	9/27-28/ 2013 9/27/ 2014 5/21/ 2016	Aquatic insects, plants, small mammals, water mites Land snails, butterflies, moths, grasshoppers and their relatives Vascular plants/wildflowers, woody plants/ trees, and fungi	24 16 30	141 44 197	89 36 TBD*	15 37 320	112	78	13
HOME	5/21/ 2016 October 2016	Birds, plants, bugs, including macroinverts and nematodes Bees	35	275	TBD*	146	372	185	13
HOSP	5/21/ 2016	Reptiles and fungi	11	72	70	365	188	78	9
LIBO	Scheduled for Fall: Meadow restoration for pollinator habitat								
PIPE	5/21/ 2016	All taxa	5	61	TBD*	2	80	61	6
TAPR	6/18-19/ 2016	Butterflies	37	33	0	445	24	24	1
		TOTALS	944	1960	213	1803	5727	1260	360

*TBD—these data are not available at this time

- Park Friends groups increase their involvement in biodiversity activities
- Introduce park staff and a new group of citizen scientists to biodiversity through the use of smartphones and iNaturalist observations
- Establish volunteer park "iNaturalist Ambassadors" who can be utilized throughout the year.

Conclusion

Overall, HTLN has found that these small-scale BioBlitz events take less staff time and financial resources compared to large-scale events. Coupled with iNaturalist, small-scale events help provide a more long-term sustainable approach to biodiversity activities and stewardship in the parks. In addition, they place less demands on park staff, which encourages participation in similar events for many years to come. BioBlitz events should not be overlooked for our cultural parks that include natural resources filled with biodiversity. These BioBlitz events and citizen scientists have indeed helped "bridge the gap" between broad-based biodiversity inventories and intensive vital signs monitoring.

Plant inventory at the 2015 NPS/National Geographic Bioblitz at Hawai'i Volcanoes National Park. NPS photo.

Profiles of Park Biodiversity Discovery Efforts - NPS/ National Geographic Society BioBlitzes

Background

The National Geographic Society's (NGS) work and commitment to stewardship of the natural world has led to collaboration with NPS to advance biodiversity discovery and education. From 2007-2010, NPS and NGS achieved one high profile, large-scale BioBlitz per year for the ten years leading up to the NPS 2016 Centennial. Each year the BioBlitz was hosted by a different NPS unit close to a major urban area.

The primary goals of these endeavors included a safe and credible scientific investigation of the host parks' biological resources, while simultaneously engaging underserved, urban audiences. Other goals included providing opportunities for scientists, students, and the general public to work together; highlighting and advancing education about the importance of biodiversity; connecting science to technology; building community and partnerships; and increasing the knowledge of park species.

These two day events centered around a 24-hour inventory period in which teams of scientists, students, teachers, families, and other community members worked together to identify as many species as possible. The event also included a biodiversity festival featuring hands-on learning activities, speakers and exhibits. The BioBlitzes took place at Rock Creek Park (2007), Santa Monica Mountains National Recreation Area (2008), Indiana Dunes National Lakeshore (2009), Biscayne National Park (2010), Saguaro National Park (2011), Rocky Mountain National Park (2012), Jean Lafitte National Park and Preserve (2013), Golden Gate National Recreation Area (2014) and Hawai'i Volcanoes National Park (2015). The 2016 NPS/NGS BioBlitz was centered in the national parks in and around Washington, D. C. and was the cornerstone event of a nationwide BioBlitz in which more than 120 parks participated, many concurrently with the NPS/Washington D. C. event.

BioBlitz Planning

The BioBlitzes resulting from this collaboration were high-profile and often attended by internationally known scientists, entertainers, speakers, dignitaries from international parks, and representatives from

the highest level of NPS and Department of the Interior.

Executing a BioBlitz on this scale was challenging and took approximately a year to plan and implement. Logistics were complex, monetary investment considerable, and safety to humans and the host park's resources paramount. A planning team from NGS worked with NPS Natural Resource Stewardship and Science Directorate staff and a planning team of the host park. Park planning teams were interdivisional, including staff from natural resources, education, public affairs, information technology, safety, law enforcement, and maintenance.

Key components of the event included: special educational activities and inventories for K-12 school groups; a Scientist Base Camp; a Biodiversity Festival with exhibit booths from environmentally focused organizations; public presentations and demonstrations; widespread use of social media; and a 24-hour inventory species period in which people of all ages and backgrounds investigated a wide breadth of taxonomic groups. Components that required significant advance planning often included collections identification and management, data management, compliance, festival layout, and recruitment of scientists, school groups, and exhibitors.

The 2007 NPS/NGS BioBlitz at Rock Creek Park was a pilot project and served to identify areas upon which to build and improve. This initial effort, involving approximately 900 participants, evolved into a robust program that has served more than 10,000 participants in a single event, resulted in the discovery of thousands of species both new to parks and new to science, and garnered widespread national and international attention. Both Italy and South Korea have planned and executed BioBlitzes using the NPS/NGS BioBlitz model, and often the word "BioBlitz" is now equated with these efforts.

More information on the NPS/NGS collaboration and Bioblitzes covering the Call to Action years (2011-2016) is discussed in the following invited paper (see page 45).

Table 7. Results of the NPS/National Geographic Society BioBlitzes as of the events' Closing Ceremonies

Park	Year	Participants	Species found
Rock Creek Park	2007	1000	661
Santa Monica Mountains National Recreation Area	2008	6,000	1,700
Indiana Dunes National Lakeshore	2009	6,000	1,200
Biscayne National Park	2010	2,500	972
Saguaro National Park	2011	5,500	859
Rocky Mountain National Park	2012	5,000	490
Jean Lafitte National Historical Park and Preserve	2013	3,000	458
Golden Gate National Recreation Area	2014	9,000	2,300
Hawai'i Volcanoes National Park	2015	6,000	352
National Parks BioBlitz: Washington D. C.	2016	10,000	1,200
Total		48,000	10,192

Voices of Call to Action #7 - Profiles in Partnering

Introduction

Recognizing that biodiversity discovery requires widespread collaboration and support, NPS designated "maintenance and development of partnerships with multiple entities" as a key goal of Call to Action Item #7. Park partners serve vital functions in a Biodiversity Discovery program's development and outreach. They may help coordinate the program; increase the scope of available resources; fundraise; provide and notify volunteers; develop program educational components; provide outreach and education into the local community; provide program infrastructure; and more.

Examples include:

- Since 2007, the National Park Service (NPS) and National Geographic Society (NGS) have collaborated to achieve one large-scale BioBlitz per year for the ten years leading up to the NPS 2016 Centennial. Each year the BioBlitz is hosted by a different NPS unit close to a major urban area.
- The Big Thicket Association partners with Big Thicket National Preserve to sponsor the preserve's All Taxa Biodiversity Inventory, "Thicket of Diversity"
- Discover Life in America (DLIA) funds and organizes the ATBI at Great Smoky Mountains National Park, bringing some of the world's top researchers into the Smokies. DLIA also engages the public with educational programs and opportunities
- The Harvard Museum of Comparative Zoology has collaborated with the National Park Service and Boston Harbor Islands Partnership to inventory insects and other invertebrates in Boston Harbor Islands National Recreation Area, and develop educational products and curriculums based on the inventory discoveries.
- U.S. Geological Survey and Harvard Museum of Comparative Zoology have collaborated with NPS in a widespread effort to examine the effects of climate change on bees through surveys in multiple parks.
- The E. O. Wilson Biodiversity Foundation has assisted in development of a mentoring program for the NPS Biodiversity Youth Ambassadors, assisted numerous parks in accomplishment of biodiversity discovery and outreach efforts.
- Numerous universities and schools have provided scientific and taxonomic expertise and advanced biodiversity education.
- Collaboration with California Academy of Sciences has enabled the widespread use of iNaturalist as a means to document biodiversity in parks, allow public access to the generated scientific data, and engage people of all ages and backgrounds in biodiversity discovery.

The Call to Action years saw an increase in collaboration to accomplish biodiversity discovery, especially as more and more parks became involved. The 2016 National Parks BioBlitz has garnered national excitement and involvement by numerous entities, including with the National Geographic Society, National Geographic Network of Alliances for Geographic Education, the Nature Conservancy, NatureServe, Friends groups, numerous federal and state agencies and more.

Biodiversity Discovery efforts accomplished during the Call to Action years have also generated international excitement:

- In June 2012, the Omani Ministry of Environment and Climate Affairs (MECA), DOI International Technical Assistance Program and NPS sponsored a Science Fellow to come to the United States for 8 weeks to shadow the NPS

Biodiversity Discovery program and advance biodiversity awareness in Oman.

- During the 2012 NPS/NGS BioBlitz, students from Costa Rica participated in the event and an agreement between NPS and Costa Rica's Sistema Nacional de Areas de Conservación was signed.
- Italy accomplished its third BioBlitz, modeled on the NPS-NGS BioBlitzes, July 2014.
- Simultaneous BioBlitzes took place at Jean Lafitte NHPP and Italy's Giardino di Ninfa, resulting in international collaboration between the planning teams and an attempt at international communication between BioBlitz participants via skyping.
- The 2012 Diptera BioBlitz at Great Basin National Park was attended by participants from Germany, Hungary, and Oman.
- Representatives from sister parks of Hawaii Volcanoes NP attended the 2015 NPS-NGS BioBlitz.
- A representation from Parks Canada attended the 2016 National Parks BioBlitz—Washington, D. C. to gain information on how to accomplish a nation-wide BioBlitz, as a possible activity to celebrate Canada's 150th anniversary in 2017.
- Korea and Italy have modeled BioBlitzes, based on National Park Service/National Geographic Society BioBlitzes.
- Representatives from Slovenia and Montenegro received guidance from NPS BioBlitz planners and are now planning first-time BioBlitzes.

The following invited contributions from example partners showcase their widespread and generous efforts to support and advance biodiversity discovery, awareness, and conservation in the national parks.

Profiles in Partnering - National Geographic Society—Collaboration in Biodiversity Discovery and Education

(Carrie Seltzer)

In the last five years, the National Park Service (NPS) and National Geographic Society (NGS) continued to grow the BioBlitz partnership that began in 2007. Each year, BioBlitz reached thousands of people (including hundreds or thousands of school children) and documented several hundred species in each park. In total for the four events from 2012 and 2015, approximately 23,000 people participated in BioBlitz, including 7,000 students. Here are brief highlights:

2012: Rocky Mountain National Park outside Denver, CO

- More than 5,000 people, including over 2,000 schoolchildren, participated.
- The initial scientific species count was 490. Possible new records included a lizard, nine insects, and 13 nonvascular plants.

2013: Jean Lafitte National Historical Park and Preserve in New Orleans, LA

- More than 3,000 people, including over 1,500 school children, participated.
- Initial scientific species count was over 450, with well over 1,500 observations made over the two days. Several new invasive insects were also among the finds.

2014: Golden Gate National Recreation Area in San Francisco, CA

- More than 9,000 people, including over 2,700 schoolchildren, participated.
- Initial scientific species count was over 2,300, with well over 8,600 observations made over the two days, including 80 species new to the park and sightings of 15 endangered species.

2015: Hawai'i Volcanoes National Park in Hawai'i

- Approximately 6,000 people, including 850 schoolchildren, participated.
- At least 352 species were documented in over 1,700 observations, including 22 species new to the park and 83 threatened species.

Since 2014, iNaturalist has been collaborating on BioBlitzes with NGS and the NPS. Through a cooperative agreement between NPS aOr maknd the California Academy of Sciences (where iNaturalist is based), NPS can promote the use of iNaturalist in parks as a method of collecting biodiversity data. This has allowed for real-time updates of what was happening at each BioBlitz and in all parks across the country. iNaturalist staff worked with staff from the NPS Natural Resource Stewardship and Science Directorate and NGS to develop new data visualizations to summarize BioBlitz data. iNaturalist also automatically shares research-grade observations with the Global Biodiversity Information Facility which allows the scientific community much greater access to the records and therefore increases their utility.

For the NPS centennial in 2016, the National Parks BioBlitz initiative took BioBlitz to the next level by engaging parks all across the country, in addition to featuring a cornerstone event in the National Capital Region. More than 125 BioBlitzes took place in 2016 in NPS units across the country. National Geographic's Network of Alliances for Geographic Education collaborated with NPS on at least 102 of these events. Resources created by National Geographic for the DC event, including educational materials, tutorials, promotional materials, and signs, were shared throughout the park service and network of Alliances to support

other BioBlitzes. This was made possible in part through support from American Express.

The cornerstone event of the 2016 National Parks BioBlitz was in the National Capital Region, with biodiversity inventories taking place in 13 parks and a Biodiversity Festival on the National Mall at Constitution Gardens. Sponsorship from Southwest Airlines supported the attendance of National Geographic Explorers and photographers. At the festival, 40 local and national conservation organizations had booths with hands-on activities. Two jumbotrons displayed live updates from iNaturalist with leaderboards for the most contributed observations, most commonly observed species, threatened species, and introduced species. The jumbotrons featured nationwide totals and numbers specific to each park. A new addition to the festival this year was the "Bugs, Bats, and Brews" event, which targeted young professionals and featured National Geographic Explorers, engaging talks, comedy, a beer garden, and live music on Friday night. More than 1,500 people attended this event.

More than 2,500 students attended the Biodiversity Festival and/or biodiversity inventories at the cornerstone event alone. National Geographic provided in-person professional development training and classroom materials to over 50 teachers and supported the creation of new standards-aligned activities for use in the classroom before and after BioBlitz. The post BioBlitz activities emphasize working with real data from the BioBlitz. Verizon lent 375 tablets with cellular data plans to ensure that each class of students was able to make BioBlitz observations and share them with iNaturalist.

Biodiversity inventories throughout the National Capital Region were led by more than 210 experts and assisted by 170 iNaturalist Pro-Observers who ensured that the data were entered properly. National Geographic assisted with the recruitment of, communication with, and scheduling for these 380 BioBlitz volunteers and hosted a dinner attended by approximately 260 people volunteers and park staff. Verizon generously donated 45 mobile Wi-Fi hotspots to facilitate uploading observations to iNaturalist at each of the parks since Wi-Fi access is limited. More than 1,450 people registered in advance to attend inventories and additional walk-ups were also welcome.

Based on an iNaturalist project tracking observations from all NPS units for all of 2016, more than 6,000 people have contributed 125,298 observations of 12,240+ species as of October, 2016. This includes observations from organized BioBlitzes, as well as those from people exploring on their own. The scientific impact of BioBlitz will continue to grow and long outlive the events themselves. Approximately 3,000 iNaturalist records from 2014 and 2015 BioBlitzes have been shared with the Global Biodiversity Information Facility (GBIF). This year, more than 29,000 records have already been shared with GBIF and that number will continue to rise. More than 1,000 records of at least 325 threatened species are included in that count.

The impact of the centennial BioBlitz on participants (general public, students, teachers, experts, and iNaturalist Pro-Observers) is still being evaluated by National Geographic and collaborators at the UC Berkeley Lawrence Hall of Science and a final report will be available later in 2016.

Profiles in Partnering - Discover Life in America—NPS Partner in Biodiversity Research and Education

(Todd Witcher, Executive Director – Discover Life in America)

Every summer in Great Smoky Mountains National Park, as the evening shadows settle on the mountains and the mist rises in the coves, fireflies twinkle with cool yellow-green light, blinking their messages to each other and delighting us with mysterious beauty. Anyone who has witnessed the spectacular displays of "synchronous fireflies" in the Smokies comes away enthralled with the light show, and curious about the interesting lives of these little beetles. We want to learn more!

Discover Life in America (DLIA) is leading the way in revealing nature's diversity and wonder. Through the amazing project known as the All Taxa Biodiversity Inventory (ATBI), we are surveying all life forms in Great Smoky Mountains National Park. We have already found thousands of creatures that science knows very little about; yet thousands of living things remain undiscovered.

Picture an evening in the Smokies with the fireflies sparkling, the gentle breeze blowing, and the creatures of the forest hidden in the darkness. Now think about those creatures. What are they? Where are they? Are they rare or abundant? What is their role in nature? How do they fit together to make the ecosystems work? These questions remain largely unanswered, but we must find the answers in order to maintain and restore our natural world and the many values that nature provides – from clean water to abundant wildlife to medical breakthroughs in cancer or Alzheimer's research.

Discover Life in America (DLIA) is the non-profit organization coordinating the ATBI with Great Smoky Mountains National Park. Hundreds of researchers from around the world, plus citizen scientist volunteers, teachers, and students all donate thousands of hours to the discovery and documentation of life in the Park and to education about this rich heritage.

Accomplishments:

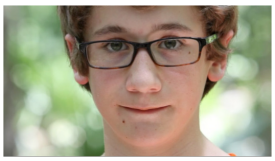
- DLIA and its partners have discovered almost 1,000 species brand new to science, plus an additional 9,140 species not previously known in the Park.
- We have trained over 700 volunteers to assist the ATBI.
- We have granted almost 1 million dollars to over 200 scientists and educators to support their efforts to discover the biological riches of the Great Smoky Mountains.
- We have sponsored dozens of "Bio-Quests," such as Beetle Blitzes, Fern Forays, Lepidoptera Quests, Quests, and other intensive field surveys have been sponsored.
- Our education programs provided young people with the chance to learn biology from some of the world's foremost authorities.
- We have created a database and website to gather and share valuable information and communicate the excitement of discovery to scientists, Park managers, and the world.
- The Smokies ATBI has become the model for future ATBIs around the world, with similar efforts now blossoming at Big Thicket National Preserve in Texas , Yellowstone National Park, Tennessee State Parks, and more than a dozen other locations. We need you! Help us to learn – for conservation –for science – for medical breakthroughs We are in a race against time to complete this survey of the tremendous natural diversity of Great Smoky Mountains National Park. As threats, like air pollution, invasive plants, exotic insects and diseases, and the pressures from development along Park borders gain speed, we are losing the race to find and understand what nature has and

how to keep it together.

- In 2016, to celebrate the National Park Service Centennial DLIA hosted two fantastic Bioblitzes on each side of the park- in North Carolina on April 22 and in Tennessee on May 12. Working with local schools these Bioblitzes focused on park pollinators and engaged students from 5th grade through high school. Both these Bioblitz events were huge successes, although we didn't find as many pollinators as we'd hoped we did document many other species, including:
- Hosted more than 300 students, teachers and volunteers
    - Used iNaturalist for the first time in documenting biodiversity in the Park
    - Documenting more than 100 species
    - Added more than 300 observations to the database
    - Partnered with the local National Geographic Affiliates – North Carolina Geographic Alliance and Tennessee Geographic Alliance as well as Friends of the Smokies and Great Smoky Mountain Association.

An original vision of Discover Life in America and this Smokies ATBI was to "help shape and inspire the next generation of scientists." After more than sixteen years of service, this project continues to expand, discover and amaze all generations. We look forward to the next 100 years of National Parks and are doing our part to fulfill the Call to Action Item #7 "Next Generation Stewards:" A Foundation for Resource Protection and Citizen Engagement.

Profiles in Partnering - E.O. Wilson Biodiversity Foundation



Biodiversity Youth Ambassador Ben Clark. Photo courtesy of the E. O. Wilson Biodiversity Foundation.

(Paula Ehrlich, President and CEO of the E. O. Wilson Biodiversity Foundation)

The E.O. Wilson Biodiversity Foundation's mission is to foster a knowing stewardship of our world through biodiversity research and education initiatives that promote and inform worldwide preservation of our biological heritage. We believe that by enhancing our public understanding of biodiversity, we can foster a culture of stewardship in which people are inspired to conserve and protect the natural world.

The 2016 National Park Service (NPS) centennial has created a unique impetus for biodiversity research and education initiatives in the U.S., and the E.O. Wilson Biodiversity Foundation (EOWBF) has actively worked with the NPS on these initiatives by: 1) participating in the National Park Service/National Geographic (NPS/NGS) BioBlitzes, 2) helping to build and foster the Biodiversity Youth Ambassador program, and 3) working with individual parks (esp. Rocky Mountain National Park and Great Smoky Mountains National Park) to support their Biodiversity Discovery efforts.

The ability to successfully preserve biodiversity and our natural heritage depends upon an authentic grassroots support system of people who have a deep and personal experience of nature. It depends upon a public citizenry who explore and participate in the science of biodiversity and the practice of global biodiversity conservation. The EOWBF's goal is to bring people into nature and biodiversity by creating and promoting methods of teaching and doing research in nature that are highly participatory. We aim to encourage personal moments of discovery and transformation that enhance public understanding of nature and science, and heighten the communal sense of urgency regarding the need to preserve the living environment and its biological diversity.

National Park Service/National Geographic BioBlitz

The mantra of the EOWBF is engagement, and engagement from the beginning. We aim to nurture a movement culture of environmental stewards by innovating in ways of presenting the natural world to young people and the broader public in order to draw them into a fuller sense of the importance of the living environment to themselves, their families, and future generations. Execution on this objective through BioBlitz has been a time-honored tradition of the Foundation. The inauguration of the Foundation was celebrated with a two-day BioBlitz in New York City's Central Park on June 22–23, 2006, in collaboration with the Explorer's Club, the American Museum of Natural History, and the Boston Museum of Natural Science. In May 2013, the Foundation was an exhibitor and speaker at the NPS/NGS BioBlitz at Jean Lafitte National Historical Park and Preserve near New Orleans, Louisiana. The EOWBF's exhibit at this BioBlitz featured the opportunity to write "Letters to Ed" in association with the April release of E.O. Wilson's book, "Letters to a Young Scientist" and the Foundation initiated its Collaborative Storytelling Project.

E.O. Wilson has said, "There is no greater high than discovery." With the Collaborative Storytelling Project, the EOWBF aims to capture the moments of personal discovery and transformation that occur as young people connect with the natural world at BioBlitz. The Collaborative Storytelling Project uses interviews, oral histories, documentary photography, and video and web-based projects to explore moments of discovery. As the Foundation works to foster a new generation of enthusiastic explorers and informed citizens, we hope these stories will inspire and connect us all around the importance of environmental conservation and biodiversity.

ATBI/BioBlitz SWAT team catalyzes biodiversity inventory and research. Photo courtesy of E. O. Wilson Biodiversity Foundation.

The first video short created by the project, Inspired by Nature, captures the voices of four students who came to Jean Lafitte National Historical Park and Preserve near New Orleans, Louisiana, for a NPS/NGS BioBlitz in May 2013. (See http://eowilsonfoundation.org/inspired-by-nature/.) The video captures their sense of awe about the natural world as they work together with volunteer scientists, teachers, and other community members to find and identify as many species of plants, animals, microbes, fungi, and other organisms as possible within the 24-hour event. By sharing these stories, the EOWBF aims to strengthen our individual and collective experience of the importance of our biological heritage, and inform and inspire a grassroots network of future environmental stewards.

Inspired by Nature was featured in the October 2013 issue of National Geographic Kids (on the iPad app) and National Geographic Kids News Bites, and on the National Geographic BioBlitz website. Multiple FaceBook pages have posted the video, including the National Park Service and National Park Foundation. Printed images from the BioBlitz Collaborative Storytelling Project are currently being exhibited in the Inspired by Nature exhibition at the Wegner Gallery in Environment Hall at the Nicholas School of the Environment at Duke University (http://eowilsonfoundation.org/inspired-by-nature-exhibition/).

In March 2014 and May 2016, the Foundation was an exhibitor and continued to collect material for the Collaborative Storytelling Project at the NPS/NGS BioBlitz at Golden Gate National Parks near San Francisco, CA and at the 2016 NPS/NGS Washington, D. C. BioBlitz. The focus of our exhibit at the National Mall was E. O. Wilson's grand vision for Half-Earth, and children who visited the exhibit learned about how the goal to conserve half the Earth for the rest of life could help save 85 percent of the species on the planet. Young people were asked, "If you save half of the Earth for nature, what would you save?" (https://eowilsonfoundation.org/2016-bioblitz-exhibit-focuses-on-engaging-children-in-half-earth/) and were encouraged to express how nature and biodiversity make them feel:

"It makes me feel like I'm me with no filter, just simple Me!"—Student Participant

"Nature makes me happy because you discover new things."—Student Participant

The NPS Biodiversity Youth Ambassadors at the Biodiversity Festival of the 2016 NPS/National Geographic National Parks BioBlitz at Constitution Gardens on the National Mall. NPS photo.

Biodiversity Youth Ambassador Program

In association with BioBlitz and other Biodiversity Discovery initiatives of the NPS, the Foundation competed in a microfunding initiative, Give For Youth, to garner travel support for the participation of NPS Biodiversity Youth Ambassadors in the May 2014 BioBlitz. The Foundation also sponsored an internship for a UNC Institute of the Environment student to help mentor and support existing and future Biodiversity Youth Ambassadors through progressive communication strategies. In addition, the EOWBF engaged Duke's Nicholas School of the Environment Program Management class in a Group Masters Project to create a strategic plan for development of the program so that: 1) Youth Ambassadors are more effective at communicating and raising awareness of biodiversity in their home communities, 2) Youth Ambassadors have greater awareness of how to use available biodiversity-related technological resources, and 3) to encourage momentum around and between BioBlitz events and sustain the growth of a youth network into the future.

In August 2013, the Foundation was invited by the NPS to attend an NPS summer workshop in Ft. Collins, Colorado to: 1) consult on the role of the NPS Biodiversity Youth Ambassadors in furthering biodiversity awareness among their peers, 2) assist in preparation of an NPS Biodiversity Youth Ambassador Support and Development plan, and 3) consult on best practices in engaging the Biodiversity Youth Ambassadors and other students during the NPS/NGS BioBlitzes. The projects of the UNC intern and Nicholas School grad students were presented and discussed. The Foundation helped to create handbooks for the program using components of the Nicholas School Group Project deliverables.

Biodiversity Discovery

"We should preserve every scrap of biodiversity as priceless while we learn to use it and come to understand what it means to humanity." —E.O. Wilson

The EOWBF seeks to actively contribute to research infrastructure that fosters an understanding about the importance of biodiversity to a knowing stewardship of our world, and has consequently created the All Taxa Biodiversity Inventory (ATBI)/BioBlitz SWAT Team. ATBI/BioBlitz SWAT Teams are graduate students who survey gaps in

biodiversity understanding on vital public and private lands, design field research that narrows those gaps and create media about their work that fosters public understanding and inspires better care of our planet. The ATBI/BioBlitz SWAT Team has worked in Rocky Mountain National Park and the Great Smoky Mountains National Park, and we seek to expand the program onto additional parks and private lands, including the Turner family's Ladder Ranch in New Mexico.

The ATBI/BioBlitz SWAT Team projects are executed in cooperation with the NPS, Discover Life in America and Turner Endangered Species Fund. The SWAT Team catalyzes biodiversity inventory and research on some of the most important public and private lands in the country while cultivating awareness of the importance of biodiversity and environmental conservation on a local and national level. Through ongoing annual support of this project we are creating a perpetual team of graduate student experts, and future ATBI advisors that can be dispatched to national parks and other vital habitats to support the collection, interpretation and dissemination of species data critical to the ecosystems that form the fabric our lives. More information about the 2014, 2015, and 2016 projects can be found here: http://eowilsonfoundation.org/atbibioblitz-swat-team/

Profiles of Youth Engagement - National Park Service Biodiversity Youth Ambassador Program

(Kelly Coy)

Overview

The National Park Service (NPS) initiated the Biodiversity Youth Ambassador Program to engage youth in science activities in national parks and local communities. The program was inspired by youth participating in the annual BioBlitz hosted by NPS and the National Geographic Society (NGS). The mission of the Biodiversity Youth Ambassador Program is to cultivate youth leadership that inspires the next generation of stewards in our schools and communities.

The NPS has a team of eight Biodiversity Youth Ambassadors (ages 10-25) from California, Colorado, Connecticut, Florida, Hawaii, Texas, Louisiana and Washington, D.C. This geographical distribution allows for diverse cultural and ecological perspectives on issues of mutual interest such as biodiversity conservation and empowerment of the next generation—their generation. The wide age range promotes mentorship within the program.

Through ongoing mentoring and activities, Biodiversity Youth Ambassadors are given opportunities to develop skills such as: leadership, public speaking, communication, analytical reasoning, and scientific literacy. Many Biodiversity Youth Ambassadors are also provided an opportunity to serve as an intern at their host parks to work on biodiversity conservation and citizen science projects. The Ambassadors have monthly meetings to share ideas and learn from each other as they pursue their individual goals and projects.

From 2010 to 2016 the Biodiversity Youth Ambassadors gathered at the annual NPS/NGS BioBlitz to talk to kids about their experiences, why biodiversity is important, and what kids can do to make a difference in their communities. Prior to the BioBlitz they participated in a workshop to hone their leadership, communication, and science literacy skills. During the BioBlitz, the Ambassadors hosted an exhibit to help teach youth about biodiversity and participated on inventories as citizen scientists to explore the biodiversity at each new park.

Profiles of the Ambassadors

Katherine Hagan, 21, is the Biodiversity Youth Ambassador for National Capital Parks East and Kenilworth Park and Aquatic Gardens. Growing up on a farm in Western Kentucky inspired a deep appreciation of the natural world and encouraged her responsibility in conservation. During the summer of 2015, Katherine was a camp counselor at Nature Camp in Vesuvius, Virginia teaching principles of wildlife conservation to children ages nine to sixteen. This experience introduced Katherine to the importance of conservation education and environmental stewardship. An environmental science major at Centre College in Danville, Kentucky, combines Katherine's interest in conservation education and entomology, particularly the study of bees, and the relationship that humans play in their decline. Katherine spent the month of January interning at the Entomology Department at the University of Kentucky identifying bee genus from the Ohio Valley Region and measuring species richness in the area. The following spring semester was spent in Mérida, Mexico, working with a stingless tropical bee of cultural and ecological importance to the Maya. As a current senior, Katherine hopes to promote conservation through education

programs while furthering her degree in graduate school.

Katherine is an intern at Kenilworth Park and Aquatic Gardens for the summer of 2016. She is assisting resource management staff with processing of data from the May 2016 BioBlitz and other biological inventory efforts. She is also helping to coordinate outreach events such as the Lotus and Lilly Festival to engage youth and the local community with park biodiversity and resources.

Mikaila Ulmer, 12, is the National Park Service Biodiversity Youth Ambassador representing the Pollinator Conservation Initiative. Born and raised in Austin, Texas she is currently in the 5th grade. Mikaila is also the founder and Chief Executive Officer of Me & the Bees Lemonade, an award-winning natural lemonade made with flaxseed and sweetened with natural honey. She got the idea for the lemonade after she was stung by a bee at age 4. Although at first afraid, she started doing research and found that bees play a vital role in ecosystems and her own life. Around that same time Mikaila also received an old family recipe for Flaxseed Lemonade. She entered her lemonade in the Acton Children's Business Fair and Austin Lemonade Day and it quickly became clear that her idea was going to be a huge success. Me & the Bees Lemonade is now sold at Whole Foods Market stores in the United States Southwest region and Mikaila's story has been featured on Shark Tank, CBS News, NBC News and countless print sources. In October 2016, Mikaila received the Eleanor Roosevelt Val-Kill Achievement Award. As a Youth Ambassador, Mikaila hopes to further promote pollinator conservation and spread the sweet message of her lemonade far and wide!

Julia Espaniola, 20, is the 2015 Youth Ambassador representing Hawai'i Volcanoes National Park. Born and raised on the island of Hawai'i, she is a graduate of Ka'ū High School and is now a student at Hilo Community College. Julia started with the National Park Service in 2011 as a summer Youth Ranger. In this role, she gained skills to provide walks, talks and programs for park visitors. While in high school, she joined the NPS Pathways program in the park's Kahuku Unit. Her passion for working with children has been extended to working at the education center and providing ranger-led programs for school groups. As a Youth Ambassador, Julia's goal is to encourage other youth to visit, discover and love the park enough to want to share it with their family and friends. Julia will graduate this fall with an associate's degree in liberal arts and will transfer to the University of Hawai'i-Hilo to pursue a double major in English and environmental studies.

As a Biodiversity Youth Ambassador, Julia has given developed several youth programs for young children focusing on Hawaiian Biodiversity. She has worked with 3rd – 5th graders at three local elementary schools (Pahala Elementary, Pahoa Elementary, Volcano School of Arts and Sciences). Julia gives a 1-2 hour presentation to the students focused on the unique native flora that were present on their school campus. Following the presentation, she takes the students on a

mini-bioblitz as they walk around the school campus and count and identify as many plants as they can. Julia does follow up visits with the students to reinforce what they learned.

Julia is also working diligently to create a subcommittee for the Friends of Hawai'i Volcanoes National Park aimed at engaging youth of the island to do service and conservation projects. Julia has also planned activities such as guided hikes to teach participants about native biodiversity, and threats to biodiversity. She has coordinated trash clean-up efforts and community outreach events such as community presentations and potlucks to inform the local community about biodiversity and conservation.

Lurleen Frazier, 19, is the Biodiversity Youth Ambassador from the 2014 BioBlitz at Golden Gate National Recreation Area. Lurleen got involved with the National Park Service through an internship with the Inspiring Young Emerging Leaders Program (I-YEL) at the Crissy Field Center. Through her work with I-YEL and as a NPS Biodiversity Youth Ambassador, she has been able to appreciate the Golden Gate National Recreation Area, contribute ideas to park programming and take an active role in her community through advocacy and leadership. She loves helping people and teaching people how they can make a difference. Currently, she is a sophomore at California State University in Los Angeles, majoring in anthropology.

In 2015, Lurleen organized an activity promoting biodiversity and pollinator awareness and conservation at Backyard Bound, an annual youth-led summit for over 100 bay-area youth. In 2016, Lurleen organized a field trip for youth in her home community (San Francisco area) to teach kids about biodiversity. She worked with a local church to plan a full day event during the 2016 spring break for neighborhood children (ages 5-12). The day was full of learning activities and games with biodiversity walk along the Bay Area Ridge Trail. The focus of the program was to explain the importance of biodiversity, why the species should be conserved, and how to be more aware of the biodiversity around them.

Ben Clark, 16, is the National Park Service Biodiversity Youth Ambassador for the Natural Resource Stewardship and Science Directorate (NRSS). He lives in Bridgeport, Connecticut. His favorite subject is science because he loves to learn about the way the natural world works. His inspiration is Dr. Edward O. Wilson. Ben believes biodiversity affects the world we live in because "it literally is the world we live in." Ben wants to protect the Earth's natural resources and inspire other youth to do the same. He believes that if children today care about biodiversity, then future generations will work to preserve it. When Ben is not outside in nature, he enjoys creating art, running competitively and studying cultural diversity, global geography and anthropology. Ben has worked with students, teachers and administrators to start Biodiversity Friends Clubs at three

elementary schools in his community. He has organized school BioBlitzes at a nearby wetland three years in a row, and also organized the preparation and planting of a pollinator garden at his school last spring. In 2014, Ben was selected as an "Everyday Young Hero" by Youth Service America for his work as a Biodiversity Youth Ambassador raising biodiversity stewardship and awareness among his peers. In October of 2014, Ben presented at the National Park Service Biodiversity Summit on his work as a Biodiversity Youth Ambassador to notable attendees including the Science Advisor to the NPS Director, Associate Director of the NPS Natural Resource Stewardship and Science Directorate, President of NatureServe, President and CEO of E.O. Wilson Biodiversity Foundation, and his lifelong hero, Dr. E.O. Wilson.

In spring of 2016 Ben hosted a leadership course at his previous middle school and coordinate a school yard BioBlitz with 8th graders as a Biology lab. Ben also worked with his old teachers to design inventories and create species guides and data sheets for the event. His leadership workshop included topics such as coordinating community events, pursuing your goals, and how kids can be leaders among their peers and in their communities.

Caleb Ezelle, 18, lives in the backyard of the Barataria section of the Jean Lafitte National Historical Park and Preserve in southeast Louisiana, site of the 2013 BioBlitz. As a lifelong resident of the area, he has had the opportunity to experience the park as it has changed over the years. Caleb interned at Jean Lafitte National Historical Park and Preserved for two summers where he worked alongside park staff. Caleb organized eight park clean up days to allow students from surrounding schools to achieve required service hours. He aided resource management division with salvinia research and developed an interpretive program for visitors about the biodiversity of the Barataria Preserve. He also leads visitors on bird walks, worked in the Visitor Center, and gave presentations on Birds' of Prey for Cub Scouts.

Beyond his internships, Caleb has been an ongoing volunteer at the park since 2013. In May 2016 Caleb was awarded the Hartzog Regional Youth Volunteer Award in recognition of his volunteer service. Among the highlights of Caleb's volunteering include serving as an inventory lead at the March 2016 Jean Lafitte Bug Blitz, accompanying NPS Director Jarvis to commemorate events for Black History Month in February 2016, the 200th anniversary of the Battle of New Orleans in January 2015 and assisting with annual events such as the Better Health Bayou Festival, National Public Lands Cleanup Day, and the Spring in the Swamp festival.

In 2015 Caleb hosted a booth at the Swamp Festival at the Barataria Preserve about native hummingbirds and how community members could create hummingbird habitat and food sources in their own backyards. In 2016 Caleb did extensive research on edible plants of the gulf south region and how they have been traditionally used and contemporary uses to demonstrate cultural associations with biodiversity. Caleb will develop learning materials based on his research that he will share with Jean Lafitte National Historical Park and Preserve and local summer camp programs. Students will be able to learn about uses of these native plants and learn how to identify them in the wild.

Parker Hopkins, 19, was nominated as the National Park Service Biodiversity Youth Ambassador for Rocky Mountain National Park in 2012 and is now a freshman at the University of Colorado in Boulder Colorado majoring in Environmental Studies, with a minor in Atmospheric and Oceanic Sciences. For the last two summers, Parker worked with the Continental Divide Research Learning Center in Rocky Mountain National Park to spread biodiversity awareness through citizen science. In addition to his work with NPS, Parker is an intern with NOAA measuring trace gases in the atmosphere, which helped him understand the extent of abiotic factors on the Earth's ecology. As an active member of his high school Environmental Club, Parker promoted biodiversity awareness by organizing school assemblies, posting fliers about biodiversity issues, and encouraging his peers to volunteer in local bioblitzes.

In 2015 helped coordinate volunteer restoration efforts to re-vegetate riparian areas with native willow species following a devastating flood in the Big Thompson Canyon.

In 2016 Parker initiated a project to help conserve wild pollinators (including bees and/or butterflies) in and around Boulder's urban environment. Parker engaged his residence hall, Baker Hall, which is part of an interdisciplinary curriculum emphasizing environmental science and sustainability, entomology professors from CU and a small group of students to help coordinate the event which is took place in April 2016. Student volunteers and CU faculty helped to plan native pollinator friendly plants in garden boxes and planters and distributed them around the CU campus after learning about the role of pollinators, their current state in North America, and contributing factors of pollinator decline from CU entomology professors.

Parker is also part of the 3D Naturalist Pollinator Hot Shot team which was funded by the National Science Foundation to engage diverse youth in the rigorous science and taxonomy the behind biological inventories conducted at BioBlitzes with a focus on pollinators.

Dara Reyes, 17, was the first National Park Service Biodiversity Youth Ambassador, nominated at the 2010 BioBlitz at Biscayne National Park in Florida. Dara presented at the 2011 Discover Life in America conference, where she had the honor of meeting Dr. Edward O. Wilson. Her curiosity in nature drives her to learn about the environment, and she inspires others to do the same. For her efforts and contributions to youth, Dara was been honored as a Hero for Change at the 2012 Radio Disney Music Awards.

After attending the 2010 BioBlitz, Dara returned to her middle school and promoted biodiversity awareness and conservation to her peers. With the support of her teachers and school administrators, this enthusiasm ignited the entire school and led to the development of a Biodiversity Friends Club.

Dara interned at Canaveral National Seashore from 2014-2015 where she worked in the visitor center and assisted resource management staff with sea turtle monitoring and conservation efforts. Dara worked with

park staff and local partners to promote monarch conservation through an 'Adopt a (native) Milkweed' program.

In 2016, Dara worked with her high school Environmental Club to build a monarch garden on school grounds, including a sign with information about monarch migration, native milkweeds, and pollinator decline. Dara views studying biodiversity as important for all youth, because, as future leaders, it will be their job to preserve and conserve the natural world.

Dominque Ashe observing birds at Yellowstone National Park as part of the 3dNaturalist. Photo courtesy of Gillian Bowser.

Profiles of Youth Engagement - 3dNaturalists and the Pollinator Hotshot Team

Broadening the participation of minority undergraduate students in the sciences

(Gillian Bowser and John Moore Colorado State University, Diane Husic, Moravian College, Joseph Kerski, Esri Corporation; Teresa Mourad, Ecological Society of America, Anna Monfils, Central Michigan University)

Project Summary

The 3dNaturalist is a project funded through collaboration with the National Park Service, Ecological Society of America and through a National Science Foundation grant to Colorado State University, Central Michigan University, Ecological Society of America, Moravian College and Esri Corporation. The 3dNaturalist project was part of an effort to introduce diverse students to science using the NPS BioBlitzes, and citizen science apps. The addition of science parameters to the citizen science tool coupled with team learning activities was designed to both engage students in science and discovery while promoting the quality and accuracy of taxonomic data collected during the BioBlitzes themselves. Twenty seven students participated in a two-part workshop where they first learned associated science skills and team leadership (first week), followed by a week-long event around the actual bioblitz itself. Over 80 percent of the participating students were from diverse backgrounds and for many of the students, the BioBlitz was their first park experience.

Background

Citizen science, where individuals participate in collecting, transcribing or analyzing scientific data is the new big data approach that brings public participants into contact with scientists while generating taxonomic lists (Bonney, et al., 2014, Holden, 2015). At a recent meeting on citizen science held at the White House, the science advisor to the president, Dr. John Holdren called for federal agencies to tap into the use of citizen science to address societal and science challenges (Holdren, 2015). Dr. Holdren went on to suggest that three tenants needed to be met for citizen science to recognize the full untapped potential of millions of volunteer scientists: (1) data quality; (2) openness and data access; and (3) public participation (Holdren, 2015; See also Leong & Kyle, 2014; Hochachka et al., 2012; Silvertown, 2009;). Citizen science and the associated new technological ability to crowd source data may be the gateway for engaging the general public in the science needed for the management, protection and stewardship of parks (Leong & Kyle, 2014). While the practice of amateur scientists studying biological phenomena is not new and certainly the rich datasets on birds attest to the power of public participation; new

technology and internet crowd sourcing approaches has led to an explosion of data collected by the public with estimates of over 1 million participants in citizen science projects worldwide (Citizen Science Organization, http://staging.citizenscience.org; Bonney et al. 2014; Franzoni & Sauermman, 2015).

Data apps and smartphone platforms change the accessibility to science, especially for ecological sciences where observations of organisms large or small can be documented by smartphone cameras and placed on a digital map (Kerski, 2015). Data apps can be loaded onto smartphones so the ability to take -a picture of an organism and post it into a dataset is as easy as taking a selfie and posting it on a social media site. The ease of data uploads from a smartphone into a species database connects the public to the science as participant researchers, and the many crowdsourcing applications where species identification can be "crowd-sourced out" to a global network of other citizen scientist makes the science of taxonomy accessible to all and socially engaging (Hochachka et al., 2012). Crowd-sourcing and access to a community with shared interests appears to be one attraction to citizen science activities such as BioBlitz, yet can these activities also attract new audiences or encourage new participation in environmental activities? Citizen science, smartphone technology, social media and the connections to diverse urban communities may provide an innovative path to address the currently paradigm of the extremely low participation and poor retention of minority students in the ecological sciences (Koeing, 2009; Lauwerijssen et al. 2015).

3dNaturalist uses citizen science approaches to engage youth in science and in national park Citizen science and crowd sourcing approaches represent an enormous and mostly untapped potential to generate data (Franzoni & Sauermann, 2014), for such data to be an integral part of science and policy, the data must be robust, credible and useable and meet criteria such as data quality (including data management and evaluation), openness and accessible datasets, and public participation (Holdren, 2015). Data generated by citizens through smartphone apps and other online platforms, are messy yet rich with not only ecological issues (Silverton, 2009; Follett & Strezov, 2015) but also with a window on the average citizen's willingness to participate and observe such issues. Such data, however, provides an important bridge between science and the public where management and scientific observations can be combined with citizen science data to answer large scale geospatial questions (Bonney et al, 2014; Kerski, 2015). Citizens participating in the creation of robust datasets are more engaged, tend to gain scientific literacy, can follow scientific advancements, discriminate between facts and fallacy, and make informed decisions that impact their daily lives (Follett & Strezov, 2015). Citizens with this level of understanding are better at analyzing the validity of any type of information and can more meaningfully engaged in the political process. In 2010, Labov stated "…new biology…needs to attract students to science who want to solve real-world problems… with deep knowledge in one discipline and a working fluency in several" (Labov, Reid & Yamamoto, 2010). Both the complexity of contemporary global challenges and the ability to analyze these large datasets demand improved quantitative reasoning, new ways of formulating research questions, systems-level thinking, computational skills, and the ability to engage in interdisciplinary approaches.

3dNaturalists refers to creating "new" naturalists who work across three dimensions in science that are all changing how scientist-naturalists apply ecological information: digital data generated by major infrastructure programs and collections; discovery where data collected by the general public can be useful for science and management questions that have broad relevance to societal issues; and diversity where youth traditionally under-represented in science can become engaged in ecology and related sciences (Mace, 2014). The 3d (digital, discovery and diversity) are integrated across the student activities by: (1) identifying a sense of relevance for the students participating in the data collection; (2) assessing how learning experiences as

citizen scientists lead to improvements in science inquiry skills; and (3) identifying strategies for introducing traditionally underserved students to scientific inquiry using geospatial skills and digital maps. Citizen science and the emergence of easily accessible taxonomic inventory applications on smartphones and tablets represent an incredible shift in engaging citizen scientists as an "…emerging technique for collecting large amounts of ecological data while also creating an avenue for outreach..." (Meetemeyer et al., 2015). While such citizen science datasets are often messy with inaccurate species identification; increasingly such data are used for rapid assessments of the abundance and distribution of organisms (Dickinson et al., 2010; Diamond et al., 2014). The growing uses of citizen science in biodiversity conservation calls for a new generation of ecologists who are equally skilled in designing and implementing citizen science participation on digital databases, using mobile technology, and analyzing the results of large datasets.

Methods

Students were selected by competitive applications solicited through universities and colleges across the U.S. Over 100 completed applications were received and reviewed by the lead principal investigators. Twenty-seven students were chosen from that pool to participate in a two phase project with one workshop over spring break at Bandelier National Park and a second workshop during the Bandelier Centennial Bioblitz. Travel, lodging and other costs for the students were covered by the NSF grant. Faculty members were from Utah State University, Ecological Society of America, Colorado State University and Esri Corporation.

National Park Sites

3dNaturalists participated in BioBlitz activities or citizen science projects in three different national park units: Bandelier National Monument, Valles Caldera National Preserve and Yellowstone National Park. In addition, two teams of 3dNaturalists assisted the North Cascades Cluster (North Cascades National Park and San Juan Historic Site). Bandelier and Valle Caldera sites were surveyed as part of the National Park Service Centennial BioBlitz efforts. Yellowstone National Park set up research sites specifically to conduct citizen science data collection on pollinator species.

Equipment

All students used smartphone apps to collect data during the workshop experiences. iNaturalist was used to collect preliminary species data. In addition, data were backed up using google drive and exel into datasheets for further analyze. All students were issued ArcGIS accounts through Colorado State University to access mapping software and spatial databases available through CSU. In addition, secondary data were collected for each observation including temperature and wind speed using a Kestral200; geoposition with a Garmin GPS unit, and soil temperature probes. PH was measured for all water sites. All species identifications were checked for accuracy with the Gillette Museum of Entomology and the Denver Museum by student team members.

iNaturalist ap

The iNaturalist ap was a central tool for the Centennial BioBlitzes as a way to summarize data and generate species lists (http://www.inaturalist.org). The iNaturalist ap creates both an observation summary (recorded by individual users) and a species list for the overall project. iNaturalist was loaded on ipad minis owned by the project for student teams. Individual students with smartphones also loaded personal accounts on iNaturalist.

Story Maps

3dNaturalists uploaded data generated by the BioBlitz in conjunction with geospatial software called Story Maps. The story maps form a framework for communicating the results of the student's project and could include analyzing citizen science datasets for the particular species (e.g. pollinators) and summarizing the available data including spatial, temporal and biological datasets (such as the story map above). The template

provided by the Story Maps becomes an organizing platform for students to apply systems thinking approaches on the spatial and temporal datasets combined with the observed citizen data to tell the story of a group of organisms for one protected area. The end product could include results from searching natural history collections, digital databases or personal stories and pictures. Story maps are part of an online geospatial database that allows users to create "stories" on maps using ArcGIS Online software that places pictures, videos and text in a geospatial context https://storymaps.esri.com/stories/2016/national-park-memories/index.html. Story maps require an ArcGIS license and advanced training so all students participated in a Story map workshop hosted by Dr. Kerski at Colorado State University. All participants received temporary ArcGIS licenses through the GeoCentroid Unit of Colorado State University from Dr. Sophia Linn. All Story maps produced by this project will remain under the license of Colorado State University.

Results

Forty-three students participated in the 3dNaturalists over the course of the project. Twenty-three students (plus ProRanger students) participated in the Bandelier BioBlitz and at Valles Caldera. Those students were in two groups—one group focused on the taxonomy and species collections, the second group focused on outreach (manning two booths) and cultural connections. Twenty-five students (3dNaturalist team leads plus RMSSN students) participated in Yellowstone's pollinator transects. Eight students (3dNaturalist team leads and 3dNaturalist student participants) participated in the North Cascades cluster inventories at San Juan and at North Cascades units. Student participants were selected in April to augment the leadership teams. An additional 10 students were selected from the applicant pool along with 13 students through an associated National Park Service ProRanger program bringing the total team size to 40.

Table 8. Demographics of student participants

Student Affiliations	**Totals**
Gender	
Male	9
Female	14
Race and Ethnicity	
African American	5
Hispanic American	5
Native American/Pacific Islander	3
White American	6
Other (Asian American, mixed race)	4
Institution Type	
Community College	1
Historically Black College and University	3
Hispanic Serving Institution	2
International	2
Public college/university	
Private college/university	1
Major of study	
Science (including pre-med and pre-vet)	17
Liberal Arts	3
Undeclared (or mixed majors	3
TOTAL STUDENT NUMBERS* *Numbers do not reflect participants from the NPS ProRanger Program (13 African American students through the San Antonio ProRanger program).	23

Bandelier and Valle Caldera

Taxonomy team: 3dNaturalists submitted 164 observations for both Bandelier and Valles Caldera (as this one project area in iNaturalist, observations from both Valles Caldera and Bandelier were tagged under the Bandelier project). From the total observation set, 80 were identified to species within iNaturalist as of August 1st with some species ids needing further expertise. Verified species were updated in iNaturalist through the student teams with the help of the Denver and Gilbert Museums. Ten spiders from 8 different genera were preliminary identified and tagged with assistance from the Denver Museum.

Cultural Team: 3dNaturalists hosted two booths (one at the Peaks Environmental Center in Los Alamos and one at the Visitor

Center in Bandelier) during the BioBlitz. Students also conducted and completed 17 video interviews of BioBlitz participants at the Environmental Center as part of an approved project through Colorado State University. No interviews were conducted on parklands. The Cultural team also hosted a booth at the Visitor Center where they met with visitors and talked with BioBlitz participants. The Cultural team final report includes a report on the Photopoints project for Yellowstone as well as the participants from the Bandelier BioBlitz.

Yellowstone National Park and RMSSN

3dNaturalist team members were joined by 10 students as part of the Rocky Mountain Sustainability and Science Network (RMSSN) summer academy and traveled to Yellowstone and Grand Teton National Parks. This team worked on designing and establishing six permanent pollinator transects within Yellowstone under the guidance of the lead biologists for the park. All six transects were surveyed and marked with permanent metal tags. For each transect, photopoints were also established by members of the 3dNaturalist cultural team. At each transect 100meter sampling lines were laid out and flagged at 10 meter intervals. Quadrat frames (one meter square) were used as sampling points where all insects were collected within the quadrat and major flowering species of plants (in flower) were identified. All insect samples were either photographed and released when clear pictures could be taken, or samples were labeled and stored in alcohol. These samples were processed by Gillette Museum or the Denver Museum and specimens were returned when labeled and correctly identified to the park as part of the parks collecting mandate for this project.

In addition to the pollinator transects, the team participated in wolf surveys at Slough Creek, conducted pika surveys with the Youth Conservation Corps staff at Hellroaring Trailhead and taught park staff in iNaturalist and set up a transect on Bunsen Peak.

Science Presentations

Six 3dNaturalists (3 each from the Taxonomy and Cultural teams) presented posters at the 13th Annual Yellowstone Science Conference in Jackson Wyoming, October, 2016. The students presented posters and participated in conference sessions. Three of the students also were able to interview for graduate school study at Colorado State University as part of a program to broaden minority participation in the ecological sciences.

Project Next Steps

The 3dNaturalist project is funded by the National Science Foundation to continue until 2020 with students returning to resample transect points in Yellowstone and other participating parks. Student evaluations will continue to complete assessments of student learning, explore differences between minority students and others in science learning, perceptions and motivations through citizen science approaches. In addition, the 3dNaturalist program will be presented at Ecological Society of America as a professional presentation organized and presented by the students themselves.

International Opportunities

As part of the 3dNaturalist program, Colorado State presented six workshops for the U.S. State Department. These workshops were for local community colleges in the Eastern Caribbean Nations of Barbados, St. Lucia, St. Vincent and Dominica. Over 200 participants were at the workshops which included sessions on iNaturalists, geospatial mapping, and taxonomy. During the workshops over 200 observations were uploaded into iNaturalist (final species tally is not currently known) and several community groups indicated interest on how to use citizen science as part of natural areas management.

Profiles of Youth Engagement - Biodiversity Friends

The "Biodiversity Friends," a group of students (grades 1-8) from St. Ann Academy, Bridgeport, Connecticut became interested in biodiversity in the national parks through the efforts of a teacher and through learning about the experiences of their schoolmates in the 2012 NPS/NGS BioBlitz at Rocky Mountain National Park. The students began corresponding with National Park Staff in the NPS Biological Resources Division, in an effort to learn more about species diversity varied between their home state and that of Colorado. Several students organized a "Biodiversity Friends" group and hosted regular meetings in their school to discuss biodiversity and raise funds to attend the 2013 NPS/NGS BioBlitz at Jean Lafitte National Historical Park and Preserve.

The students' enthusiasm and participation during this BioBlitz caught the eye of both the National Geographic Society and the E. O. Wilson Biodiversity Foundation, leading to the creation of short videos from both organizations, featuring several of the Biodiversity Friends, "Imani's BioBlitz," http://education.nationalgeographic.com/education/media/imani-bioblitz/?ar_a and "Inspired by Nature" http://eowilsonfoundation.org/inspired-by-nature/, respectively.

Upon returning to their home community, the students organized a school-wide BioBlitz at a nearby estuary, drawing upon local expertise for species identification and featuring a school festival with every student in the school preparing posters of the biodiversity in a different national park. They also prepared a hands-on biology related demonstrations, attended a demonstration by the local Audubon Society, toured the entomology collection of the Peabody Museum at Yale University. During the course of their field inventory, they discovered 92 different species.

Enthusiasm and awareness of biodiversity continued to grow throughout the school. In one striking observation, a teacher at the school reported students on detention, sent to weed the school grounds, began hosting an impromptu BioBlitz in the school yard when one of them found a dead bird. In her words, "City kids who are living in some of the most crime-ridden and drug-ridden housing projects in the Northeast and who need to appear "tough" so that they can survive, are now digging for worms and talking about biodiversity!"

Subsequently, the Biodiversity Friends group traveled to NPS NRSS offices in Fort Collins, Colorado to present on their bioblitz experiences to approximately 30 NPS staff and engage in biodiversity activities in the Colorado Front Range and attended the 2014 NPS/NGS BioBlitz at Golden Gate Parks and the 2016 National Parks BioBlitz—Washington, D.C. Two students from the school have become NPS Biodiversity Youth Ambassadors, while a third student has continued to work with National Geographic as a biodiversity spokesperson and youth advocate.

Profiles of Youth Engagement - Advancing Biodiversity Education

Public awareness of what biodiversity is, why it is important, how it is at risk, what issues are posed by species extinctions, and how people can contribute to biodiversity conservation are still widely misunderstood, unknown, or dismissed. In 1998 the Convention on Biological Diversity (CBC) ranked this lack of public awareness as a serious issue. Subsequent studies cite that challenges include defining an approach for biodiversity education, communication to diverse audiences, disconnection between people and nature, and biodiversity as an ill-defined concept (Moramay 2012) all to Action Item 7 planners have theorized that biodiversity education and public involvement may be the single most important measures to accomplishing biodiversity conservation. Between 2011-2016, advances to biodiversity education included:

- Funding (from NPS, National Park Foundation and National Park Trust) to support busing and other transportation needs for underserved students attending the 2013-2016 NPS/NGS BioBlitzes.
- The E.O. Wilson Biodiversity Foundation attended the 2013 NPS/NGS BioBlitzes at Jean Lafitte National Historic Park and Preserve, Golden Gate Parks, and 2016 National Parks BioBlitz, initiating a biodiversity storytelling project, which includes the stories and experiences of school-age participants.
- In 2014-2015, a retired teacher was hired as a Geoscientist in Parks to develop STEM (Science, Technology, Engineering, Mathematics) biodiversity-related curriculum, tied to Next Generation Science Standards for 4-6 grade. The result were nine lesson plans in biodiversity, 3 lesson plans on Invasive Species, a week long curriculum about bees, plans for a week-long residential field camp, “Student as Researcher,” an oceanography curriculum, and plan to create a network of biodiversity clubs in schools across the country.
- Development of public internet sites on biodiversity and pollinators: https://www.nps.gov/subjects/biodiversity/index.htm https://www.nps.gov/subjects/pollinators/index.htm

Attendees of the 2014 premier NPS Biodiversity Summit. NPS photo.

Moving Beyond the Call to Action Biodiversity Education

Advancing NPS Biodiversity Conservation Beyond 2016

A Declaration for Continued Biodiversity Conservation and Discovery

(Call to Action Champion Elaine F. Leslie)

As we come to a close on the National Park Service (NPS) Centennial year, there is much to celebrate—and yet, reason for concern. The diversity of native species, the genetic material they contain, and the processes of which they are critical components, are declining globally at a historically unprecedented rate. We are losing the beauty and richness of our natural environment and de-stabilizing ecological processes, resulting in a rapid decline of natural wealth and a reduction of our nation's ecosystem services. Whether we realize it or not, biodiversity has cultural, historical, and biological connections that we cannot afford to lose.

National parks are becoming critical preserves of biodiversity in the face of increasing global change. Our nation's protected areas are isolated islands. Scientific consensus demands that we plan for extensively connected systems across broad spaces and that we ensure the restoration of keystone species and ecosystems. At the alarming rate we are losing biodiversity on this planet, we must reduce the rate of loss by increasing protected natural areas and the services they provide. Preserving biodiversity—from a beetle to a grizzly bear—allows us to understand how the pieces of an ecosystem fit together and helps us to detect long-term changes in our environment. When we conserve and restore biodiversity, we are preserving our national natural heritage.

Biodiversity conservation has been greatly enhanced through biodiversity discovery efforts which have yielded increased knowledge of species and fostered public education and engagement. The concept of "biodiversity conservation and discovery" has rapidly become a common framework for conservation, education, and action, both in local communities and within the NPS.

The NPS is now speaking the language of biodiversity. Underserved and under-represented park visitors have participated in bioblitzes; a corps of biodiversity youth ambassadors are now employees working in parks; partnerships with National Geographic Society, EO Wilson Biodiversity Foundation, scientists, and universities and others are deepening. Cumulatively, these accomplishments are seen to represent the

slow turning of a rising tide and agency culture shift. The NPS sees the progress with Next Generation of Stewards as a proof of concept case study - and is ready to evaluate how best to advance the future of NPS biodiversity conservation and discovery into the future. Planned is a Community Stewardship Program that will engage youth, Tribes, STEM activities, and that will have a strong nexus to the Urban Initiative. Efforts may include additional park bioblitzes and new All Taxa Biotic Inventories.

The NPS is committed to continuing a national and global leadership role in biodiversity conservation. This decade-long approach has cultivated a support network-a community of practice- amongst our employees, our neighbors, and our partners. This will ensure that parks have the ability to learn from others' experiences and expertise, develop best practices for biodiversity stewardship, ensure high quality data, coordinate data management and sharing, and ultimately magnify and leverage the returns of individual park's sampling and outreach efforts. For these activities to be successful, the education, interpretation, science, and curatorial communities must also work together to leverage support, expertise, and funds from local, regional, national, and international partners.

We must work together to find a persuasive message that educates the American public so that they want to conserve the integral components of Earth's biological portfolio. Our NPS goal is for people to protect and conserve biodiversity-in their parks and in their own backyards- because they want to-not because they have to. The very word 'biodiversity' represents not just a suite of scientific principles, but also our values, our culture, and our emotions.

No matter where our protected areas dot the global map, together we can ensure that the vital components of our natural heritage and legacy remain intact for future generations.

This is reason to celebrate and to keep moving forward into the next 100 years of the National Park Service mission and goals!

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Appendix A: Combined Results of Biodiversity Discovery efforts 2011-2015 and the 2016 National Parks BioBlitz

Table 1. Results of Call to Action #7 Biodiversity Discovery Efforts (2011-2016)	
182	Parks participated in a Biodiversity Discovery effort of multiple levels and scopes, including All Taxa Biodiversity Inventories (ATBI), bioblitzes, and multi-park inventories. This number includes parks that participated in a Service-wide bee inventory in climate sensitive NPS habitats and a multi park project to examine mercury levels in dragonflies.
116,500+	Participants, including professional scientists, educators, students, children, families, NPS staff, and park visitors. Projects ranged from widely in number of participants.
20,395+	Species have been found during the course of Biodiversity Discovery efforts. This number includes species which were previously unknown to have existed in a specific park, as well as species that are new to science.
1,500+ (2011-2015) 2016 results of species new to parks and new to science, are still unknown.	Species have been found during the course of Biodiversity Discovery efforts that are new to the host park's species list. A designation of a species as "new to science" requires extended verification that can take years. The extended All Taxa Biological Inventory at Great Smoky Mountains National Park has yielded 970 such species since 1998. Additionally, at least 7 other species new to science have been reported by participatory parks during the Call to Action years.

Appendix B: 2016 BioBlitz Events

Park Unit	State	Event Name	Date
Acadia National Park	ME	2016 National Parks BioBlitz - Acadia Lepidoptera BioBlitz	Fri. July 22 - Sun. July 24, 2016
Antietam National Battlefield	MD	2016 National Parks BioBlitz - Antietam: Grassland Birds	Sat. May 21, 2016
Appomattox Court House National Historical Park	VA	2016 National Parks BioBlitz - Explore the Natural Side of Appomattox Court House	Sat. May 21, 2016
Apostle Islands National Lakeshore	WI	2016 National Parks BioBlitz - Apostle Islands	Sat. June 4, 2016
Assateague Island National Seashore	MD, VA	2016 National Parks BioBlitz - Assateague Island	Sat. May 21, 2016
Aztec Ruins National Monument	NM	2016 National Parks BioBlitz - Aztec Ruins BugBlitz: May	Wed. May 18 - Thu. May 19, 2016
Aztec Ruins National Monument	NM	2016 National Parks BioBlitz - Aztec Ruins BugBlitz: July	Wed. July 20, 2016
Aztec Ruins National Monument	NM	2016 National Parks BioBlitz - Aztec Ruins BugBlitz: September	Tue. September 20, 2016
Bandelier National Monument	NM	2016 National Parks BioBlitz - Bandelier	Fri. May 20 - Sat. May 21, 2016
Bering Land Bridge National Preserve	AK	2016 National Parks BioBlitz - Bering Land Bridge	Thu. July 7 - Sun. July 10, 2016
Big Thicket National Preserve	TX	2016 National Parks BioBlitz - Big Thicket Mini-BioBlitz	Fri. October 14 - Sun. October 16, 2016
Boston Harbor Islands National Recreation Area	MA	2016 National Parks BioBlitz - Boston Harbor Islands	Sat. September 24, 2016
Buffalo National River	AR	2016 National Parks BioBlitz - Caddisflies of Buffalo National River	Fri. May 20 - Sat. May 21, 2016
Cabrillo National Monument	CA	2016 National Parks BioBlitz - Cabrillo Intertidal BioBlitz	Sun. March 6, 2016
Cabrillo National Monument	CA	2016 National Parks BioBlitz - Cabrillo: Urban Island BioBlitz	Sat. May 21 - Sun. May 22, 2016
Capulin Volcano National Monument	NM	2017 National Parks BioBlitz - Capulin Volcano	Sat. July 30, 2016
Carl Sandburg Home National Historic Site	NC	2016 National Parks BioBlitz - Carl Sandburg Scientists	Sat. July 23, 2016
Carl Sandburg Home National Historic Site	NC	2016 National Parks BioBlitz - Carl Sandburg Home	Fri. May 20, 2016
Catoctin Mountain Park	MD	2016 National Parks BioBlitz - Catoctin Insect BioBlitz	Fri. May 20 - Sat. May 21, 2016
Cedar Breaks National Monument	UT	2016 National Parks BioBlitz - Cedar Breaks: Bats, Birds, and Bugs	Fri. June 24 - Sun. June 26, 2016
Cesar E. Chavez National Monument	CA	2016 National Parks BioBlitz - Cesar E. Chavez	Sat. April 16, 2016
Chickasaw National Recreation Area	OK	2016 National Parks BioBlitz - Chickasaw PaleoBlitz	Fri. May 20 - Sat. May 21, 2016
Chiricahua National Monument	AZ	2016 National Parks BioBlitz - Chiricahua: Birds, Bugs and Botany	Sat. May 14, 2016
Channel Islands National Park	CA	2016 National Parks BioBlitz - Channel Islands	Mon. May 16 - Sat. May 21, 2016
Chesapeake & Ohio Canal National Historic Park	DC	2016 National Parks BioBlitz - C&O Canal Biodiversity Celebration	Fri. May 20 - Sat. May 21, 2016
Charles Pinckney National Historic Site	SC	2016 National Parks BioBlitz - Charles Pinckney	Fri. May 20 - Sat. May 21, 2016

Park Unit	State	Event Name	Date
City of Rocks National Reserve	ID	2016 National Parks BioBlitz - City of Rocks: Birds and Blooms	Sat. May 21, 2016
Colonial National Historical Park	VA	2016 National Parks BioBlitz - Colonial ButterflyBlitz	Sat. September 24, 2016
Congaree National Park	SC	2016 National Parks BioBlitz - Congaree	Fri. May 20 - Sat. May 21, 2016
Coronado National Memorial	AZ	2016 National Parks BioBlitz - Coronado: Birds, Bugs and Botany	Sat. May 21, 2016
Cowpens National Battlefield	SC	2016 National Parks BioBlitz - Cowpens	Fri. May 20 - Sat. May 21, 2016
Crater Lake National Park	OR	2016 National Parks BioBlitz - Crater Lake: Meet the Beetles	Sat. July 23, 2016
Craters of the Moon National Monument and Preserve	ID	2016 National Parks BioBlitz - Craters of the Moon: Lichen Blitz	Fri. May 13 - Sat. May 14, 2016
Cuyahoga Valley National Park	OH	2016 National Parks BioBlitz - Cuyahoga Valley	Fri. May 20 - Sat. May 21, 2016
Denali National Park and Preserve	AK	2016 National Parks BioBlitz - Denali - Arthropod Inventory	Wed. June 15 - Tue. August 30, 2016
Devils Tower National Monument	WY	2016 National Parks BioBlitz - Devils Tower Porcupine BioBlitz	Sat. April 30, 2016
Death Valley National Park	CA	2016 National Parks BioBlitz - Death Valley: Discovering Life on the Edge	Sat. March 12, 2016
Dinosaur National Monument	CO	2016 National Parks BioBlitz - Dinosaur Wild Life Weekend	Sat. May 21 - Sun. May 22, 2016
Ebey's Landing National Historical Reserve	WA	2016 National Parks BioBlitz - Ebey's Landing	Fri. May 20 - Sun. May 22, 2016
Effigy Mounds National Monument	IA	2016 National Parks BioBlitz - Effigy Mounds: Arthropodapolooza	Fri. July 8 - Sat. July 9, 2016
Fort Bowie National Historic Site	AZ	2016 National Parks BioBlitz - Fort Bowie: Birds, Bugs and Botany	Sat. March 26, 2016
Fort Caroline National Memorial	FL	2016 National Parks BioBlitz - Fort Caroline: Insect BioBlitz	Fri. May 20 - Sat. May 21, 2016
Fort Sumter National Monument	SC	2016 National Parks BioBlitz - Fort Moultrie	Fri. May 20 - Sat. May 21, 2016
Fort Vancouver National Historic Site	WA	2016 National Parks BioBlitz - Fort Vancouver	Fri. May 20 - Sat. May 21, 2016
First State National Historical park	DE	2016 National Parks BioBlitz - First State	Fri. May 20 - Sat. May 21, 2016
Gates of the Arctic National Park & Preserve	AK	2016 National Parks BioBlitz - Gates of the Arctic	Fri. May 20 - Sun. May 22, 2016
George Washington Carver National Monument	MO	2016 National Parks BioBlitz - George Washington Carver: Harkins Woods	Sat. May 21, 2016
George Washington Memorial Parkway	VA	2016 National Parks BioBlitz - George Washington Memorial Parkway	Fri. May 20 - Sat. May 21, 2016
Gateway National Recreation Area	NY	2016 National Parks BioBlitz - Gateway: Jamaica Bay BioBlitz	Fri. June 10 - Sat. June 11, 2016
Gateway National Recreation Area	NY	2016 National Parks BioBlitz - Gateway: Sandy Hook BioBlitz	Fri. September 23 - Sat. September 24, 2016
Gettysburg National Military Park	PA	2016 National Parks BioBlitz - Gettysburg	Fri. May 20, 2016
Glacier National Park	MT	2016 National Parks BioBlitz - Glacier Alpine Aquatic Insect Blitz	Fri. August 26 - Sun. August 28, 2016
Glacier National Park	MT	2016 National Parks BioBlitz - Glacier Weed Blitz	Tue. July 19, 2016
Glacier National Park	MT	2016 National Parks BioBlitz - Glacier Lake Ecology Blitz	Wed. May 25 - Sat. May 28, 2016

Park Unit	State	Event Name	Date
Glacier National Park	MT	2016 National Parks BioBlitz - Glacier Wildlife Observations	Sun. May 1 - Fri. September 30, 2016
Golden Gate National Recreation Area	CA	2016 National Parks BioBlitz - Golden Gate with Farallone View Elementary	Fri. April 1, 2016
Grand Canyon National Park		AZ	2016 National Parks BioBlitz - Grand Canyon Birds
Great Basin National Park	NV	2016 National Parks BioBlitz - Great Basin Bird BioBlitz	Fri. May 20 - Sun. May 22, 2016
Great Smoky Mountains NP	NC	2016 National Parks BioBlitz - Great Smoky Mountains: North Carolina	Fri. April 22, 2016
Great Smoky Mountains NP	TN	2016 National Parks BioBlitz - Great Smoky Mountains: Tennessee	Thu. May 12, 2016
Gulf Islands National Seashore	FL	2016 National Parks BioBlitz - Gulf Islands	Sat. May 21, 2016
Guilford Courthouse National Military Park	NC	2016 National Parks BioBlitz - Guilford Courthouse: Environmental Inventory	Sat. September 24, 2016
Harpers Ferry National Historical Park	WV	2016 National Parks BioBlitz - Harpers Ferry	Fri. May 20 - Sat. May 21, 2016
Hawaii Volcanoes National Park	HI	2016 National Parks BioBlitz - Hawai'i Volcanoes: E Ho'omau...To perpetuate	Sat. August 27, 2016
Hopewell Furnace NHS	PA	2016 National Parks BioBlitz - Hopewell Furnace	Fri. May 20 - Sat. May 21, 2016
Homestead National Monument of America	NE	2016 National Parks BioBlitz - Homestead Critter Count	Sat. May 21, 2016
Homestead National Monument of America	NE	2016 National Parks BioBlitz - Homestead Bee BioBlitz	Sun. October 2, 2016
Hot Springs National Park	AR	2016 National Parks BioBlitz - Hot Springs: Reptilian Roundup and Fungus Find	Fri. May 20 - Sat. May 21, 2016
Hubbell Trading Post National Historic Site	AZ	2016 National Parks BioBlitz - Hubbell Trading Post	Fri. May 20 - Sat. May 21, 2016
Indiana Dunes National Lakeshore	IN	2016 National Parks BioBlitz - Indiana Dunes: Miller Woods BioBlitz	Fri. May 20 - Sat. May 21, 2016
Jean Lafitte National Historical Park and Preserve	LA	2016 National Parks BioBlitz - Jean Lafitte BugBlitz	Fri. May 6, 2016
John Muir National Historic Site	CA	2016 National Parks BioBlitz - John Muir	Fri. May 20 - Sat. May 21, 2016
Joshua Tree National Park	CA	2016 National Parks BioBlitz - Joshua Tree Ethno-Bot-Blitz	Sat. May 21, 2016
Kenai Fjords National Park	AK	2016 National Parks BioBlitz - Kenai Fjords Pollinators	Mon. July 25 - Fri. July 29, 2016
Kenilworth Aquatic Gardens	DC	2016 National Parks BioBlitz - Kenilworth	Fri. May 20 - Sat. May 21, 2016
Kings Mountain National Military Park	SC	2016 National Parks BioBlitz - Kings Mountain	Fri. May 20 - Sat. May 21, 2016
Klondike Gold Rush National Historic Park	AK	2016 National Parks BioBlitz - Klondike Gold Rush	Thu. May 12 - Fri. May 13, 2016
Klondike Gold Rush: Seattle Unit	WA	2016 National Parks BioBlitz - Klondike Gold Rush: Seattle Unit	Sat. May 21, 2016
Knife River Indian Villages National Historic Site	ND	2016 National Parks BioBlitz - Knife River Indian Villages ArcheoBlitz	Thu. May 5 - Sat. May 7, 2016
Lava Beds National Monument	CA	2016 National Parks BioBlitz - Lava Beds Bug-Blitz	Sat. May 21, 2016
Lake Mead National Recreation Area	NV	2016 National Parks BioBlitz - Lake Mead	Sat. March 19, 2016
Lake Roosevelt National Recreation Area	WA	2016 National Parks BioBlitz - Lake Roosevelt BugBlitz	Sat. September 24, 2016
Lassen Volcanic National Park	CA	2016 National Parks BioBlitz - Lassen Volcanic Bird Banding BioBlitz	Sun. July 17, 2016

Park Unit	State	Event Name	Date
Lassen Volcanic National Park	CA	2016 National Parks BioBlitz - Lassen Volcanic Butterfly BioBlitz	Sat. July 23, 2016
Lewis & Clark National Historic Trail	WA	2016 National Parks BioBlitz - Lewis and Clark	Fri. May 20 - Sat. May 21, 2016
Little River Canyon National Preserve	AL	2016 National Parks BioBlitz - Little River Canyon	Fri. May 20 - Sun. May 22, 2016
Marsh-Billings-Rockefeller National Historic Park	VT	2016 National Parks BioBlitz - Marsh-Billings-Rockefeller	Sun. May 22, 2016
Manassas National Battlefield Park	VA	2016 National Parks BioBlitz - Manassas	Fri. May 20 - Sat. May 21, 2016
Mississippi National River and Recreation Area	MN	2016 National Parks BioBlitz - Mississippi River Coldwater BioBlitz	Fri. July 15 - Sat. July 16, 2016
Missouri National Recreational River	SD	2016 National Parks BioBlitz - Missouri National Recreational River	Sat. May 21, 2016
Montezuma Castle National Monument	AZ	2016 National Parks BioBlitz - Montezuma Castle Invertebrate BioBlitz	Sat. May 21, 2016
Monocacy National Battlefield	MD	2016 National Parks BioBlitz - Monocacy	Fri. May 20 - Sat. May 21, 2016
Mount Rainier National Park	WA	2016 National Parks BioBlitz - Mount Rainier	Fri. May 20 - Sun. May 22, 2016
National Mall & Memorial Parks	DC	2016 National Parks BioBlitz - National Mall	Fri. May 20 - Sat. May 21, 2016
Natchez Trace Parkway	MS	2016 National Parks BioBlitz - Natchez Trace BioBlitz and Wildlife Weekend	Sat. April 16, 2016
Ninety Six National Historic Site	SC	2016 National Parks BioBlitz - Ninety Six	Fri. May 20 - Sat. May 21, 2016
North Cascades National Park	WA	2016 National Parks BioBlitz - North Cascades	Fri. May 20 - Sun. May 22, 2016
National Park of American Samoa	AS	2016 National Parks BioBlitz - American Samoa	Sun. May 15 - Sun. May 22, 2016
Ocmulgee National Monument	GA	2016 National Parks BioBlitz - Ocmulgee Butterfly BioBlitz	Fri. August 19 - Sat. August 20, 2016
Olympic National Park	WA	2016 National Parks BioBlitz - Olympic	Fri. May 20 - Sat. May 21, 2016
Oregon Caves National Monument and Preserve	OR	2016 National Parks BioBlitz - Oregon Caves Millipede BioBlitz	Fri. May 20 - Sat. May 21, 2016
Oregon Caves National Monument and Preserve	OR	2016 National Parks BioBlitz - Oregon Caves Butterfly BioBlitz	Sat. July 2, 2016
Oregon Caves National Monument and Preserve	OR	2016 National Parks BioBlitz - Oregon Caves Dragonfly BioBlitz	Sat. August 13, 2016
Padre Island National Seashore	TX	2016 National Parks BioBlitz - Padre Island: Dragonfly BioBlitz	Mon. July 25 - Mon. August 15, 2016
Petrified Forest National Park	AZ	2016 National Parks BioBlitz - Petrified Forest Nocturnal ReptileBlitz	Wed. August 10 - Wed. August 17, 2016
Pinnacles National Park	CA	2016 National Parks BioBlitz - Pinnacles	Sat. May 21, 2016
Pipestone National Monument	MN	2016 National Parks BioBlitz - Pipestone	Sat. May 21, 2016
Piscataway Park	MD	2016 National Parks BioBlitz - Piscataway	Fri. May 20 - Sat. May 21, 2016
Point Reyes National Seashore	CA	2016 National Parks BioBlitz - Point Reyes: Mudflat & Terrestrial Invertebrates	Fri. May 20, 2016
President's Park	DC	2016 National Parks BioBlitz - President's Park	Fri. May 20 - Sat. May 21, 2016
Prince William Forest Park	VA	2016 National Parks BioBlitz - Prince William Forest	Fri. May 20 - Sat. May 21, 2016
Pullman National Monument	IL	2016 National Parks BioBlitz - Pullman	Sat. May 21, 2016
Redwood National and State Parks	CA	2016 National Parks BioBlitz - Redwood Waterbird BioBlitz	Wed. May 25, 2016
Richmond National Battlefield Park	VA	2016 National Parks BioBlitz - Richmond Battlefield Biota	Mon. September 26 - Sun. October 2, 2016
Rock Creek Park	DC	2016 National Parks BioBlitz - Rock Creek Park	Fri. May 20 - Sat. May 21, 2016

Park Unit	State	Event Name	Date
Rocky Mountain National Park	CO	2016 National Parks BioBlitz - Rocky Mountain: Dragonfly BioBlitz	Tue. May 24 - Fri. June 10, 2016
Saint Croix National Scenic Riverway	WI	2016 National Parks BioBlitz - Saint Croix	Fri. May 20 - Sat. May 21, 2016
Saint-Gaudens National Historic Site	NH	2016 National Parks BioBlitz - Saint-Gaudens	Fri. May 20 - Sun. May 22, 2016
Saguaro National Park	AZ	2016 National Parks BioBlitz - Saguaro Schoolyard BioBlitz	Fri. January 1 - Sat. December 31, 2016
Salinas Pueblo Missions National Monument	NM	2016 National Parks BioBlitz - Salinas Pueblo Missions BirdBlitz	Sat. May 14, 2016
Salinas Pueblo Missions National Monument	NM	2016 National Parks BioBlitz - Salinas Pueblo Missions Star Party	Sat. September 3, 2016
San Antonio Missions National Historical Park	TX	2016 National Parks BioBlitz - San Antonio Missions	Fri. October 28 - Sat. October 29, 2016
Saguaro National Park	AZ	2016 National Parks BioBlitz - Saguaro Queen of the Night	TBA
Sagamore Hill National Historic Site	NY	2016 National Parks BioBlitz - Sagamore Hill BirdBlitz	Sun. May 29, 2016
San Juan Island National Historical Park	WA	2016 National Parks BioBlitz - San Juan Island	Mon. May 16 - Sat. May 21, 2016
Santa Monica Mountains National Recreation Area	CA	2016 National Parks BioBlitz - Santa Monica Mountains	Mon. May 16 - Sat. May 21, 2016
Sequoia and Kings Canyon National Parks	CA	2016 National Parks BioBlitz - Sequoia and Kings Canyon	Fri. May 20 - Sat. May 21, 2016
Sequoia and Kings Canyon National Parks	CA	2016 National Parks BioBlitz - Sequoia and Kings Canyon: Newt Blitz	Sat. March 5, 2016
Shenandoah National Park	VA	2016 National Parks BioBlitz - Shenandoah: Mycological Foray	Thu. September 8 - Sun. September 11, 2016
Sleeping Bear Dunes National Lakeshore	MI	2016 National Parks BioBlitz - Sleeping Bear Dunes	Fri. September 16 - Sat. September 17, 2016
Tallgrass Prairie National Preserve	KS	2016 National Parks BioBlitz - Tallgrass Prairie Pollinators: Wildflowers and Butterflies	Sat. June 18 - Sun. June 19, 2016
Theodore Roosevelt National Park	ND	2016 National Parks BioBlitz - Theodore Roosevelt	Fri. June 24 - Sat. June 25, 2016
Timpanogos Cave National Monument	UT	2016 National Parks BioBlitz - Timpanogos Cave	Wed. June 8, 2016
Tumacacori National Historical Park	AZ	2016 National Parks BioBlitz - Tumacacori Pollinator BioBlitz	Sat. August 20, 2016
Upper Delaware Scenic and Recreational River	PA	2016 National Parks BioBlitz - Upper Delaware	Fri. June 24 - Sat. June 25, 2016
Valley Forge NHP	PA	2016 National Parks BioBlitz - Valley Forge: Wildlife Watchers PhotoBlitz	Mon. May 16 - Sun. May 22, 2016
Valles Caldera National Preserve	NM	2016 National Parks BioBlitz - Valles Caldera	Sat. August 27, 2016
Voyageurs National Park	MN	2016 National Parks BioBlitz - Voyageurs	Fri. October 7 - Sat. October 8, 2016
Weir Farm National Historic Site	CT	2016 National Parks BioBlitz - Weir Farm	Fri. May 20 - Sat. May 21, 2016
Whiskeytown National Recreation Area	CA	2016 National Parks BioBlitz - Whiskeytown: Birds, Bees, and Butterflies BioBlitz	Fri. May 13 - Sat. May 14, 2016
Wind Cave National Park	SD	2016 National Parks BioBlitz - Wind Cave Bird Blitz	Sat. May 21, 2016
Wolf Trap National Park for the Performing Arts	VA	2016 National Parks BioBlitz - Wolf Trap	Sat. May 21, 2016

Park Unit	State	Event Name	Date
Yellowstone National Park	WY	2016 National Parks BioBlitz - Yellowstone Dragonfly Hg	Sun. May 15 - Mon. August 15, 2016
Yosemite National Park	CA	2016 National Parks BioBlitz - Yosemite BloomBlitz	Sun. May 22, 2016
Zion National Park	UT	2016 National Parks BioBlitz - Zion Dragonfly BioBlitz	Wed. July 13, 2016

Appendix C: 2016 BioBlitz Results to Date

Park Unit	Number of inventories	Number of inventory leads	Estimated number of participants	Estimated number of K-12 students	Estimated number of 4th graders
George Washington Memorial Parkway	7	9	100	200	-
Chickasaw National Recreation Area	1	6	80	40	4
Gates of the Arctic National Park and Preserve	9	11	45	20	2
George Washington Carver National Monument	3	3	350	100	25
Missouri National Recreation River	2	3	54	-	-
Chesapeake and Ohio Canal National Historical Park	4	18	21	120	60
Indiana Dunes National Lakeshore	50	30	950	600	0
Whiskeytown-Shasta-Trinity National Recreation Area	15	15	500	345	100
Jean Lafitte National Historical Park and Preserve	29	23	595	376	25
Cabrillo National Monument	7	32	5,000	2,500	1,000
Yosemite National Park	640	12	55	-	-
Wind Cave National Park	1	6	275	-	-
Channel Islands National Park	0	0	1470	200	100
Cuyahoga Valley National Park	110	70	415	484	0
Timpanogos Cave National Monument	250	16	55	40	0
Bandelier National Monument	800	20	800	200	60
Sagamore Hill National Historic Site	1	2	120	80	10
City of Rocks National Reserve	2	2	9	0	0
Saguaro National Park	12	2	554	554	70
Lewis and Clark National Historical Park	11	7	270	60	10
Fort Bowie National Historic Site	5	2	12	2	0

Park Unit	Number of inventories	Number of inventory leads	Estimated number of participants	Estimated number of K-12 students	Estimated number of 4th graders
Chiricahua National Monument	5	4	11	2	0
Coronado National Memorial	5	4	83	71	0
First State National Historical Park	7	9	300	200	10
San Juan Island National Historical Park	6	4	260	80	20
Glacier National Park	2	2	65	45	0
Point Reyes National Seashore	8	12	107	91	15
Bering Land Bridge National Preserve	4	3	20	10	0
National Park of American Samoa National Park	104	4	127	21	53
Kenai Fjords National Park	1	1	45	35	12
Klondike Gold Rush National Historical Park	3	5	70	50	0

Appendix D: Social Media Template Examples

Example 1. Social media signage

Example 2. Social Media Hashtag Cards (front and back)

Appendix E: Call to Action Item 7 Presentations, Webinars, Publications and Websites

Call to Action Item 7 "Next Generation Stewards" Presentations

- Presentation. "To seek out new life: biodiversity discovery in the national parks," All-Hands Meeting, NPS Natural Resource Stewardship and Science Directorate, August 2011.
- Webinar. "Call to action #7: next generation stewards: two steps forward and one look back," January 2011.
- Presentation, "Two steps forward and one look back: biodiversity discovery in the National Park Service parks," Discover Life in America Conference, March 2012.
- Webinar, "Biodiversity Discovery: Creating New Generation Stewards," Department of Education Greenstrides Webinar Series, June 2013.
- Poster. "Serving nature through biodiscovery," NatureServe Conference, New Orleans, April 2014.
- Presentation: "Seeking out new life: biodiversity discovery in the national parks," National Association for Interpretation, November, 2014.
- Poster. "How the National Park Service is utilizing citizen science to contribute to biological resource conservation and inspire the next generation of stewards." Citizen Science 2015 Conference, Citizen Science Association, February, 2015.
- Roundtable Discussion. "Advancing NPS biodiversity discovery beyond the Call to Action." 2015 George Wright Society Conference on Parks, Protected Areas, and Cultural Sites. March, 2015.
- Webinar Series. Planning for the 2016 National Parks BioBlitz. Available at: https://sites.google.com/a/nps.gov/centennialbioblitz/webinarseries

Biodiversity Discovery Publications

- Chandler, Donald S., et al. 2012. Biodiversity of the Schoodic Peninsula: Results of the Insect and Arachnid Bioblitzes at the Schoodic District of Acadia National Park, Maine. Technical Bulletin 206. Maine Agricultural and Forest Experiment Station, University of Maine), http://www.umaine.edu/mafes/elec_pubs/techbulletins/tb206.pdf
- Rykken JJ and Farrell BD. 2013. Boston Harbor Islands all taxa biodiversity inventory: Discovering the "microwilderness" of an urban island park. Natural Resource Technical Report. NPS/BOHA/NRTR—2013/746. National Park Service. Fort Collins, Colorado. Published Report-2195282 https://irma.nps.gov/App/Reference/Profile/2195282
- Park Science, special issue. Biological Diversity: Discovery, Science, and Management. National Park Service. Volume 31, Number 1. 2014.
- Hinsey, Janice A. and Theresa M. Johnson. Planning and Conducting a BioBlitz Event at a National Park Service Unit. Natural Resource Report NPS/HTLN/NRR—2015/935. March, 2015.

Biodiversity Websites

- National Park Service. Google Site. 2015. National Parks BioBlitz Planning Site. Available at: https//sites.google.com/a/nps.gov/centennialbioblitz/?pli+1
- National Park Service. Website. 2014. Pollinators. Available at: http://www.nps.gov/subjects/pollinators/index.htm
- National Park Service. Website. 2016. Biodiversity. Available at: https://www.nps.gov/subjects/biodiversity/index.htm

2016 National Parks BioBlitz Presentations and Resources

General Presentations

National Parks BioBlitz Webinar Series

- Presented overview of the 2016 National Parks BioBlitz twice on January 12 and 14
- Audience was NPS Servicewide
- Recording available: go.nps.gov/bioblitzwebinarseries
- Promoted in the NRSS weekly and monthly
- Promoted on InsideNPS: http://inside.nps.gov/index.cfm?handler=viewnpsnewsarticle&type=Announcements&id=18208

NRSS Monthly Webinar Series

- Presented overview of the 2016 National Parks BioBlitz on March 22
- Audience was NPS Servicewide but mostly targeted for NRSS staff
- Promoted in the NRSS weekly and monthly
- https://sites.google.com/a/nps.gov/nrss-webinar/past-webinars/specialmarch2016

Director's Webchat

- Presented overview of the 2016 National Parks BioBlitz on May 4
- Audience was NPS Servicewide
- Recording available: http://livestream.com/usinterior/events/5316710/videos/121938581 and http://inside.nps.gov/webchat/chats/2016-05-04-Director-Jarvis.cfm

Centennial Office Webinar Series

- Presented overview of the 2016 National Parks BioBlitz on May 5
- Audience was NPS Servicewide
- Recording available: Alexa Viets is posting shortly

Targeted Presentations

Presentation for NRSS Leadership

- Presented overview of the 2016 National Parks BioBlitz on February 22

Presentation for Director and NPS Leadership

- Presented overview of the 2016 National Parks BioBlitz on April 8

Presentation at NRSS BioBlitz Workshop

- Presented overview of the 2016 National Parks BioBlitz in addition to other roles and project needs on April 28-29
- Audience was all NRSS staff (across the various divisions) involved in BioBlitz

Presentation at BRD All Hands Meetings

- Presented overview of the 2016 National Parks BioBlitz on October 14
- Presented update on the 2016 National Parks BioBlitz on March 2

Presentation at NRSS Leads Workshop

- Presented overview of the 2016 National Parks BioBlitz on October 26
- Audience was the selected BioBlitz NRSS Leads

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

NPS 999/135563, December 2016

National Park Service
U.S. Department of the Interior

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