

Developing a Model for a Taxonomists-in-Parks Program

As more and more national park units become involved in biodiversity discovery activities such as Bioblitzes and All Taxa Biodiversity Inventories (ATBI's), the need for taxonomists, especially those specializing in traditionally under-surveyed taxa (e.g., most invertebrates, microbes, fungi, non-vascular plants) is increasing significantly. Given that morphology-based taxonomy is becoming something of a lost skill and science, and fewer and fewer trained taxonomists have the time or resources to assist parks in what has often been a volunteer capacity, there is an urgent need for the National Park Service to develop a program that encourages amateur and professional taxonomists to participate in biodiversity discovery activities, and also creates rewarding opportunities for beginning and advanced students of taxonomy in some of the most naturally diverse ecosystems in the country. Parks, in turn, will benefit from this expertise by exponentially increasing their knowledge of the biodiversity on their lands, disseminating this information to visitors, and using it to guide their management actions. A fundamental goal of the program will be to forge collaboration between taxonomists and national parks that will also encourage the training of a new generation of taxonomists to lead the quest for biodiversity discovery in the future.

Examples of biodiversity discovery activities in the national parks:

Biodiversity discovery activities take many forms: they can last a weekend or multiple years, might focus on one group or "All Taxa," might put a strong emphasis on public participation or be mostly scientist-driven, can take place in a small urban park or a vast, remote, wilderness. For example:

- i. Great Smoky Mountains NP All Taxa Biodiversity Inventory (ATBI)—Large, remote and naturally diverse park with multi-year project that encompasses All Taxa. Taxonomists specializing in a wide array of taxa come to the park to collect specimens, and often take specimens back to their home institutions to make identifications. Public outreach and education are usually led by the park and their non-profit partner organization, but also by scientists.
- ii. Boston Harbor Islands NRA ATBI—Multi-year effort in a small, urban park, focused on arthropods. One lead scientist at a local university organizes and implements a structured sampling scheme (i.e., many trapping stations sampled regularly), and sends specimens out to various taxonomists for identification. Most taxonomists do not come to the park. The lead scientist and park education staff collaborate on education and outreach materials/activities.
- iii. Yosemite NP targeted taxonomic studies—Longer-term scientist-led projects focusing on particular taxa (e.g., lichens) and/or habitats (e.g., cave arthropods, alpine butterflies). Taxonomists may come to collect, or may be sent specimens after they are collected by others (including park staff, volunteers). Public participation and education are less emphasized.
- iv. Acadia NP Bioblitz—Annual event. Taxonomists focus on one arthropod order (or several minor orders) and come to the park for a weekend to collect specimens with up to 100 other registered participants (including park staff, entomological society members), and try to identify as many species as possible on site. The bioblitz generally focuses on a different arthropod order each year.
- v. National Geographic-sponsored Bioblitz—Annual event for the ten years leading up to the NPS 2016 Centennial. A different park, always near a major urban center (e.g., Indiana Dunes NL, Santa Monica Mountains NRA, Biscayne NP, Saguaro NP), hosts the event. During one weekend, taxonomists and other biologists specializing in a wide array of taxa document as many species as possible on site. The event is highly publicized and draws thousands of public participants, including children.

The Taxonomists-in-Parks (TIP) program will need to be structured to accommodate the full spectrum of biodiversity discovery activities while addressing the many issues common to all biodiversity projects and creating novel opportunities for promoting taxonomy in parks:

I. Parks need to find taxonomists.

Parks need a way to advertise opportunities to taxonomists. Currently within NPS, there exists a “Geoscientists-in-the-Parks” program that matches geologists with particular projects in parks for three-month to year-long positions. These are competitive positions, and applications are processed through the Geological Society of America, which also advertises the positions to its members. It is possible that a Taxonomists-in-Parks program could follow this model by forming a partnership with a national organization such as the American Institute for Biological Sciences (AIBS), that could then promote and advertise opportunities in different parks to taxonomists through its 160 member societies and natural science collections. Additionally or alternatively, such an organization might keep a register of taxonomists, perhaps organized into taxonomic working groups (TWGs), who are interested in participating in biodiversity discovery activities, and to which parks could go directly when they have a need for expertise in a particular group.

II. Who makes up the taxonomist pool.

Taxonomists-in-Parks will likely include academic systematists, ecologists, and their graduate students; other professional taxonomists; skilled amateur taxonomists; and retired taxonomists and professionals on sabbatical leave who might be able to reside in a park for several months. There must be a process for assessing each taxonomist’s qualifications, especially important for skilled amateurs who may have no professional credentials, publications, memberships (e.g., references from other taxonomists in the same or a related specialty, entomological societies etc.). The TIP program will also provide opportunities for younger high school and undergraduate students to participate in biodiversity projects in supporting roles (see section VIII below).

III. Compensation for taxonomists.

The National Park Service is in a position to support and invigorate the field of taxonomy by sponsoring scientifically rewarding opportunities for taxonomists across NPS lands. One important role of the TIP program will be to generate a competitive taxonomy funding source to which parks and/or taxonomists could apply for project grants, similar to grants offered by Great Smoky Mountain NP, in partnership with its non-profit partner, Discover Life in America. Other funding opportunities might include competitive scholarships for graduate students of taxonomy working in national parks (similar to The Canon National Parks Science Scholars Program, initially a collaboration between NPS, Canon, and AAAS). For some projects, payment-in-kind to taxonomists may be appropriate. For instance, where extensive field work is required, taxonomists might receive free lodging in the park. Although a common form of compensation among taxonomists is the acquisition of duplicate specimens collected during a study, relinquishing ownership of specimens collected on NPS lands is currently precluded by NPS Director’s Orders (see section V below).

IV. Rigorous science.

In order for the TIP program to attract funding from scientifically-focused sources such as the National Science Foundation, it will be critical that the scientific merit and rigor of taxonomist-led biodiversity discovery activities are robust, and that proposals are subject to peer review in the scientific community. This does not preclude or diminish related emphases on outreach and education in biodiversity discovery activities, but the science must be able to stand on its own merit. As part of this process, study proposals and work plans must include clear objectives and methods, and details such as the duration and extent of

field surveys, the expected or actual numbers of specimens to be identified, the responsibility and format for data entry, the ultimate repository for specimens, outreach and/or education commitments, timelines, and budgets.

V. The fate of specimens collected during a biodiversity discovery activity.

Many taxonomists, especially if working in a park with unusual species, are keen to keep series of interesting specimens for their institutional collections. In fact, for projects not on federal lands, specimens are often considered to be appropriate compensation for taxonomists' participation in biodiversity projects. Most parks have no collection facilities to store the vast numbers of specimens often collected in biodiversity discovery activities, and so must rely on university museums and other institutional collections to house their specimens. This would appear to be a mutually beneficial situation: taxonomists desire specimens, and parks need places to deposit specimens. However, because all specimens collected on park lands are considered "resources that are part of the natural and cultural heritage of the country and are collected, preserved, and interpreted for public benefit" (Director's Order #24, NPS Museum Collections Management), the NPS always retains ownership of specimens, and gives them to institutions only on permanent loan. Annual audits and reports for the loaned specimens are required by NPS, and many collection managers feel these to be an unreasonable burden, and are unwilling to keep NPS specimens in their permanent collections. As biodiversity discovery activities across the country generate more and more millions of specimens, this is an issue that will come up repeatedly, and will need to be addressed at a national level. The development of a TIP program will help guide this discussion.

VI. Data transfer from taxonomists to parks.

In every biodiversity discovery project, identified specimens are ultimately entered into a NPS-maintained database and so become useable information for the park. Because a single project can generate hundreds of thousands of specimens, it is critical that data input and transfer are as seamless as possible. Parks have consistently had problems on two fronts: choosing/modifying/creating a biodiversity database that will be useful for their own purposes and allow access to other parks and the public, and receiving data from taxonomists in various formats that can be tedious or impossible to import directly into their own databases. Oftentimes, parks receive identified specimens back from taxonomists with no electronic specimen records at all, and it is then up to park staff to enter the data from scratch. Ideally, the TIP program will require that parks have a database in place that meets their needs and will accept the type of information that biodiversity discovery activities will likely generate (e.g., taxonomic, locality, and specimen information, images, sounds, DNA barcodes) and taxonomists will be required to submit specimen data in a pre-specified electronic format to the park.

VII. Emphasis on outreach and education.

One unique aspect of conducting biodiversity discovery activities in a national park versus other federal lands, is that national parks have a legal mandate to accommodate and educate park visitors. Therefore, outreach and education are typically important components of any biodiversity discovery activity. Because many of the taxa being discovered are little-known to the public and, most likely, to park staff, it is important that taxonomists contribute something more about their organisms of interest than just species lists. There are many ways for taxonomists to share information and/or enthusiasm about less-appreciated species. Examples include *activities* such as leading a field walk with the public, giving a public presentation at the park, or mentoring students (see section VIII), and *educational materials* such as high resolution images, a display of pinned or wet specimens, or accessible natural history information (e.g., species pages for the web, accounts of interesting species that can be highlighted by park interpreters, etc.). The TIP program will require taxonomists to include some component of outreach/education in their work plan.

VIII. Engaging high school and undergraduate students in the process of biodiversity discovery.

Although younger students will not possess the taxonomic expertise to provide species level specimen identifications, there are many opportunities for students in the biodiversity discovery process that can directly support taxonomic efforts. For instance, one bottleneck in biodiversity inventories focusing on invertebrate taxa is the tremendous number of specimens that are collected with traps, and which must be processed before species identifications can be made. Processing includes countless hours of work emptying traps and separating specimens from debris, separating and identifying specimens to order (or family) level, pinning or point mounting insects, making and attaching locality labels to specimens, etc. With some training and oversight, these tasks can easily be performed by students with no previous taxonomic experience. The TIP program proposes to include support for “student taxonomists.” Parks with active projects could partner with local colleges and/or high schools to bring students to parks to assist in sampling or on-site processing, as well as setting up programs within school science labs. Appropriate mentoring (including training and guidance for mentors) will be critical to assure that student taxonomists perform high quality work.

IX. Training future taxonomists.

One practical way for the NPS to have access to more skilled taxonomists in the future is to promote and support the training of taxonomists in national parks. A network of Research Learning Centers in different eco-regions of the country could provide physical sites for hosting regional taxonomy field courses. The TIP Program would equip lab spaces with microscopes and other necessary equipment, and hire taxonomists to teach intensive, taxon-focused classes to upper level students, amateurs, and professionals. Ideally, courses would be held in conjunction with proposed or ongoing biodiversity discovery activities in the park network, and would contribute data to these inventories. This type of place-based learning would also facilitate further collaboration between taxonomists, taxonomists-in-training, and parks within different regions.

X. Virtual taxonomy.

Increasingly accessible technology allows amateur photographers to produce high resolution images of even very small insects, and these digital photos may provide valid documentation of species if they can be reliably identified by experts. Websites like BugGuide.net, to which amateur photographers and entomologists upload images of arthropods in the hopes of having them identified, are also appreciated by experts who regularly peruse the site and make taxonomic determinations (where possible), because the images can provide new information on species ranges or natural history. Additionally, many researchers now have access to imaging hardware and software that produces high-resolution images of preserved specimens, often allowing species level identifications to be made. The TIP Program could facilitate the creation of a NPS website similar to BugGuide but serving a broader range of taxa. Images might come from bioblitz participants, park staff, or other researchers, and taxonomists would be invited to visit the website on a regular basis to make determinations where possible. Alternatively, NPS might be able to partner up with existing sites like BugGuide or the Encyclopedia of Life (EOL), with similar objectives.

XI. Field guides and taxonomic keys.

The combination of taxonomists spending more time conducting inventories in national parks, an emphasis on training future taxonomists in parks, and increased access to high quality images of park flora and fauna will set the stage for the creation of regional field guides and taxonomic keys. This presents another opportunity for collaboration with the Research Learning Centers, and an excellent means of transferring biodiversity information to park visitors and staff, citizen scientists, and others.