



## TOWARDS A COORDINATED APPROACH TO NATIONAL BIODIVERSITY MONITORING AND MANAGEMENT

By Anne Bowser and William Alexander Long

*“If it cannot be measured, it cannot be managed.”*

- Aphorism shared by Steve Osofsky, Director of Health Policy at the Wildlife Conservation Society and Coordinator of the Health & Ecosystems: Analysis of Linkages (HEAL) Consortium.<sup>1</sup>

### Why Biodiversity, Why Now?

From the Grizzly Bears in Denali National Park to the Swamp Rose Mallow flower in the Adirondacks, biodiversity is a unique national asset. Biological diversity, or biodiversity, refers to the variety of life on Earth in terrestrial, marine, and freshwater; the genetic variation among different life forms; and, the communities and ecosystems that life is part of and sustains.<sup>2</sup>

Biodiversity and supporting ecosystems provide humans with many important services.<sup>3</sup> Provisioning services guarantee access to resources including clean water, wild species for food, raw materials including lumber, and medicine. Regulatory services keep our natural environment in balance. Local biodiversity can help mitigate invasive species, responsible for over \$120 billion in damages each

year,<sup>4</sup> while ecosystems like wetlands act as buffers against extreme weather events and natural disasters. Supporting services, such as soil formation, offer the building blocks for life and enable a healthy agricultural industry. Cultural services include the aesthetic, spiritual, and recreational benefits that biodiversity offers Americans, including Native American Tribes. These cultural services have both

intrinsic and financial value – recreational hunting and fishing alone generate \$144 billion in revenue, and support 480,000 American jobs, each year.<sup>5</sup> The benefits of biodiversity and ecosystems are significant on the national level, but as one of only 17 countries designated as megadiverse, the U.S. also has a global stewardship responsibility.

Concept	Definition
<b>Biodiversity</b>	The variety of life on Earth in terrestrial, marine, and freshwater ecosystems; the genetic variation among these; and, the complex assemblages of communities and ecosystems that life is part of and sustains.
<b>Ecosystem</b>	A complex biological network of organisms interacting with their physical environment and each other.
<b>Ecosystem Services</b>	The benefits that flow from nature to people, including nature's contributions to the production of food and timber; life-support processes; and, life-fulfilling benefits.
<b>Conservation</b>	The management of human use of organisms or ecosystems to ensure that such use is sustainable.
<b>Monitoring</b>	The consistent and sustained process of documenting living or non-living factors in a defined region.
<b>Assessment</b>	The analysis of data, usually for the purpose of evaluating the efficacy of a program, a policy, or assessing the needs of a certain environment.
<b>Essential Biodiversity Variables (EBVs)</b>	The derived measurements required to study, report, and manage biodiversity change.
<b>Group on Earth Observations (GEO)</b>	An intergovernmental partnership working to improve the discoverability, accessibility, and use of Earth observations for the benefit of society.
<b>Biodiversity Observation Network (BON)</b>	Networks, accredited by the GEO BON community, that monitor biodiversity trends and changes within a nation, region, or across thematic areas (e.g. marine systems), following and applying GEO BON principles, not only for a greater understanding of the region it oversees, but also to allow for the development of an interoperable international network for more powerful biodiversity observations.

One early global assessment concluded that current demands on ecosystems are causing unprecedented rates of change, suggesting that 60% of ecosystem services are being depleted or used unsustainably.<sup>6</sup> Impacts on biodiversity are broad and far-reaching. The 2016 State of North America's Birds Report, jointly financed by governments of the United States, Canada, and Mexico, concluded that more than one-third (37%) of North American avian species are "*at risk of extinction without significant conservation action*."<sup>7</sup> Further, many endangered species lack effective management strategies. Researchers from the U.S. Geological Survey (USGS) studying 35 endangered amphibian species found that delays between endangered listings and the development of recovery plans ranged from two to 29 years.<sup>8</sup>

Understanding biodiversity requires studying a species of interest while considering complex relationships with a wide range of biotic and abiotic factors that support healthy ecosystems or drive change. Factors that drive biodiversity change unfold on local to global scales, requiring different stakeholders with a range of monitoring capabilities and management mandates to work together.<sup>9</sup> Monitoring and managing our national biodiversity through conservation is, therefore, an urgent challenge that requires domestic coordination and global cooperation to meet.

Department of the Interior (DOI) Secretary Ryan Zinke highlighted the value of biodiversity while promoting public land hunting and game use, but more should be done to increase government and public knowledge on biodiversity loss, especially as ecosystem services are under threat. The U.S. needs to establish biodiversity as a national asset and take concrete steps towards establishing a coordinated approach to biodiversity monitoring. A national strategy should be developed specifically for the United States, must consider the balance of power and responsibility between Federal, State, and Tribal authorities, and should promote multi-sector partnerships. It should leverage existing capacity to help coordinate and mobilize activities around clearly defined policy objectives identified with support from national and international authorities. A national strategy could also leverage and build upon innovations including the Essential Biodiversity (EBV) framework and the Group on Earth Observations Biodiversity Observation Network (GEO BON) network structure. Such a plan, and coordinated monitoring approach, would enable the U.S. to monitor and manage critical national resources and more effectively contribute to global assessments.





## The Policy Context

### *Global Biodiversity Policy*

Several international treaties support biodiversity and establish conservation goals. The broadest and most important is the Convention on Biological Diversity (CBD), an agreement with objectives including “*conservation of biological diversity, the sustainable use of its components, and the fair and equitable sharing of the benefits arising from commercial and other utilization of genetic resources.*” After several years drafting global legislation to support CBD, then-President George H.W. Bush declined to sign the legislation at the Rio Earth Summit in 1992. President Clinton signed the CBD in 1993 and the Senate Foreign Relations Committee endorsed ratification by a vote of 16 to 4, but a hold was put on the vote and no action to ratify the Convention has occurred. Outside of the U.S., 196 parties including 195 countries and the European Union are party to this convention. Critics argue

that failing to ratify the CBD signals a lack of commitment to the global environment that undermines historic U.S. leadership. Legal scholars paint a more complex picture, noting that while some provisions of the CBD – including enacting national legislation – are compatible with U.S. policy, other provisions – including those around financial allocation, technology transfer, and biotechnology – either benefited developing countries at the expense of the U.S. or are inconsistent with other policy platforms.<sup>10</sup> The U.S. also contributes to the Global Environment Facility which includes funding for biodiversity conservation efforts worldwide but does not support monitoring activities.

Beyond the CBD, several multilateral treaties offer different protections. The Convention on International Trade of Endangered Species of Wild Fauna



and Flora (CITES) is an important treaty initially agreed to at a 1973 meeting of 80 countries held in Washington. Other multilateral agreements, including the Convention on the Conservation of Migratory Species of Wild Animals, protect certain taxa. Still others, such as the Convention on Wetlands or Ramsar Convention, protect wetland ecosystems and ecosystem resources. The U.S. has ratified and is active in the implementation of both these and several other biodiversity related Conventions.

Perhaps most importantly, in September 2015, the 193 countries of the United Nations (UN) General Assembly adopted a 2030 development agenda with a set of 17 goals known as the Sustainable Development Goals (SDGs). Among these are goals numbered 6, 14, and 15, which aim to work towards sustainable and healthy life on land and in the water. Among the agreements in these goals are objectives to halt biodiversity loss and sustainably manage global ecosystems for the benefit of societies.

## *U.S. Policy: The Legislative Branch*

Conservation of biodiversity, ecosystems, and the environment are long-standing federal policy priorities

with bipartisan support.<sup>11</sup> Early conservation laws include the Lacey Act of 1900, which guides U.S. wildlife imports and exports, and the Federal Aid in Wildlife Restoration Act of 1937,

which allocates an 11% excise tax on firearms and ammunition to conservation and restoration. The Endangered Species Act of 1973 (ESA) outlines provisions for

protecting threatened and endangered species and their habitats and is linked to our international commitments through the CITES treaty. Targeted laws complementing these broad guidelines include the Bald and Golden Eagle Protection Act of 1940, the Marine Mammal Protection Act of 1972, and the Wild Bird Conservation Act of 1992.

Many conservation laws tap a federal agency to lead implementation. With the Department of Interior

---

Early conservation laws include the Lacey Act of 1900, which guides U.S. wildlife imports and exports, and the Federal Aid in Wildlife Restoration Act of 1937.

---





(DOI) acting as the scientific authority, the U.S. Fish and Wildlife Service (USFWS) is charged with implementing the ESA. The Marine Mammal Protection Act established a new agency, the Marine Mammal Commission, to work with the National Oceanic and Atmospheric Administration (NOAA) on implementation.

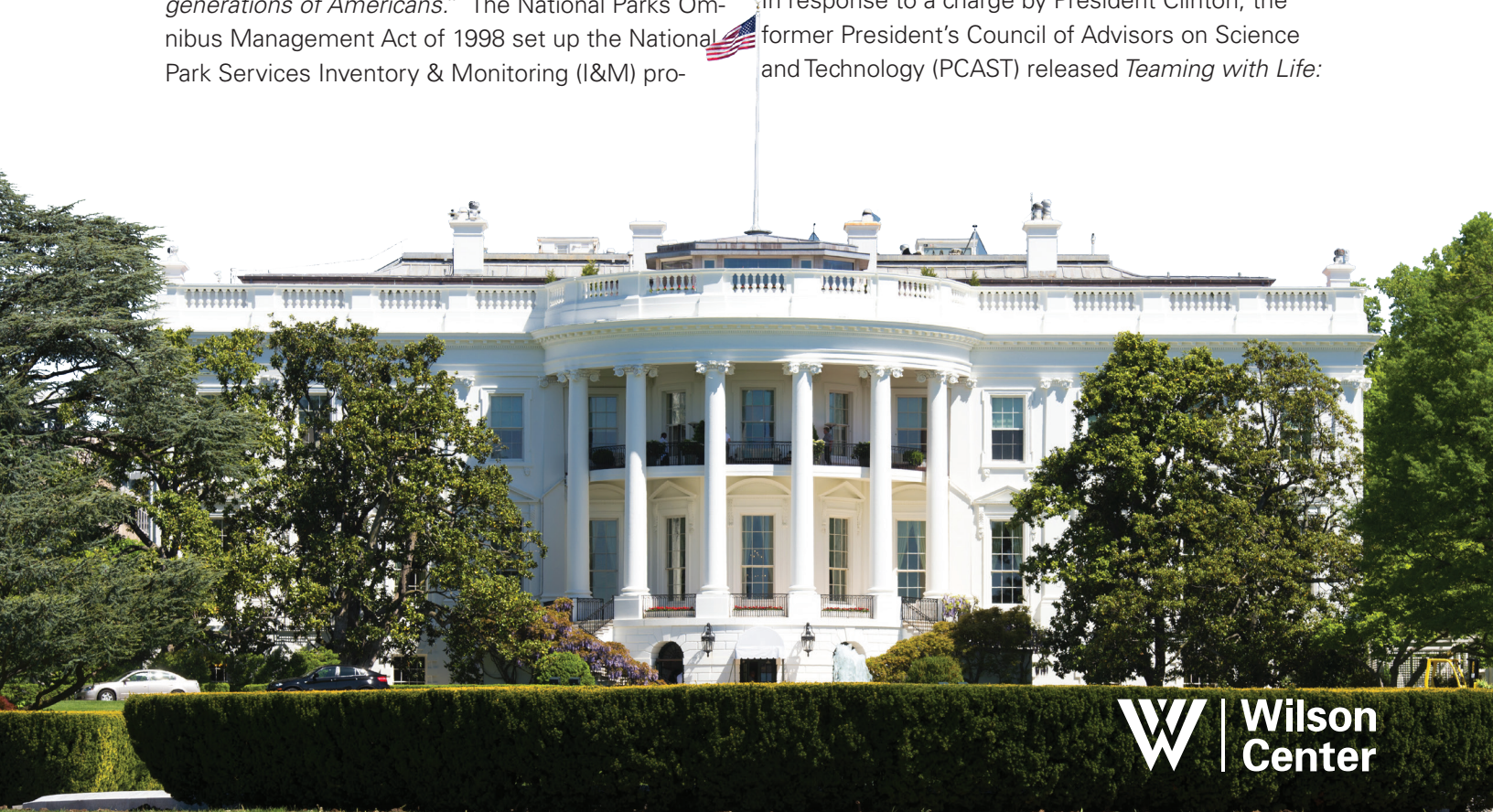
In addition to conservation, Congress also issues guidance on biodiversity monitoring. The National Forest Management Act of 1976 directs the U.S. Forest Service (USFS) to use monitoring and assessment to evaluate the effects of management on forested lands. The National Wildlife Refuge System Improvement Act of 1997 gave USFWS management power over the Refuge system, a network of lands and waters specifically designated for conservation and monitoring, and requires the Secretary of the Interior to *“ensure that the biological integrity, diversity, and environmental health of the System are maintained for the benefit of present and future generations of Americans.”* The National Parks Omnibus Management Act of 1998 set up the National Park Services Inventory & Monitoring (I&M) pro-

gram to provide information on long-term trends.

Other conservation laws hold the states responsible. The Federal Aid in Wildlife Restoration Act of 1937 set a precedent for federal-state cooperation by mandating that DOI allocates proceeds from the excise tax directly to the States. This law has been amended numerous times, including in 2000, when Congress created the State Wildlife Fund (SWG) program to help the states conserve sensitive species not traditionally hunted or fished. The 2000 amendment also ordered states to maintain and approve State Wildlife Action Plans (SWAP)s that identify and help protect the most vulnerable species.

## *U.S. Policy: The Executive Branch*

Over the last few decades, both Democrat and Republican-led administrations have enacted policies to support biodiversity and ecosystem conservation. In response to a charge by President Clinton, the former President’s Council of Advisors on Science and Technology (PCAST) released *Teaming with Life:*



*Investing in Science to Understand and Use America's Living Capital* in 1998.<sup>12</sup> This report established the “essential linkage between the economy and the environment” and recommended increased federal investment in biodiversity research and monitoring.

In 2004, the second Bush Administration released an executive order on *Facilitation of Cooperative Conservation* that called for agencies to work together and with the private sector to achieve conservation outcomes. A second PCAST report, released in 2011 under the Obama Administration, identified priorities including the establishment of a national biodiversity and ecosystems services assessment; support for the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES); expanded agency activities; identification and prioritization of monitoring gaps; and the establishment of a new open data resources including the EcoINFORMA platforms and hubs.<sup>13</sup> The Obama Administration also offered guidance on *Safeguarding the Nation from the Impacts of Invasive Species and Incorporating Ecosystem Services into Federal Decision Making*, though guidance on ecosystem services failed to link these services to biodiversity.

Progress towards these and similar policy objectives has been mixed. The range of legislative mandates relevant to conservation and biodiversity monitoring shows that these are critical priorities with bipartisan support. The executive order *Facilitation of Cooperative Conservation* led to a workshop that convened private and public sector stakeholders, and a report describing 152 profiles of cooperative conservation efforts.<sup>14</sup> The U.S. now participates in IPBES. Data.gov hosts the EcoINFORMA platform, which links to the USGS database Biodiversity Information Serving Our Nation (BISON), the Envi-

ronmental Protection Agency (EPA)'s EnviroAtlas, and a Land Cover database maintained by multiple agencies.<sup>15</sup> But despite calls from government, university, NGO, and private sector researchers,<sup>16</sup> there is currently no national biodiversity strategy, no agreed-upon framework for systematic biodiversity monitoring, and no governance structure to lead implementation. Further, some (but not all) policy guidance establishes the value of biodiversity via links to ecosystem services, and some (but not all) effectively connects the outputs of biodiversity monitoring to assessments of conservation goals and outcomes.

## Biodiversity Monitoring in 2018

Monitoring should, and often does, begin with the development of management goals or objectives. On a global scale, the Aichi Targets are one set of objectives that the CBD has advanced to help prioritize monitoring through 2020.<sup>17</sup> The UN-SDGs

are a second set of international objectives linked to the Aichi Targets. While the U.S. lacks a set of national biodiversity objectives, different agencies have advanced various priorities. For example, the United States Agency for International Development (USAID) has a comprehensive biodiversity monitoring policy with objectives including “integrate conservation and development for improved biodiversity and development outcomes” and “influence key international policies in support of biodiversity conservation.”<sup>18</sup>

---

But despite calls from government, university, NGO, and private sector researchers, there is currently no national biodiversity strategy...

---



## Who is Responsible?

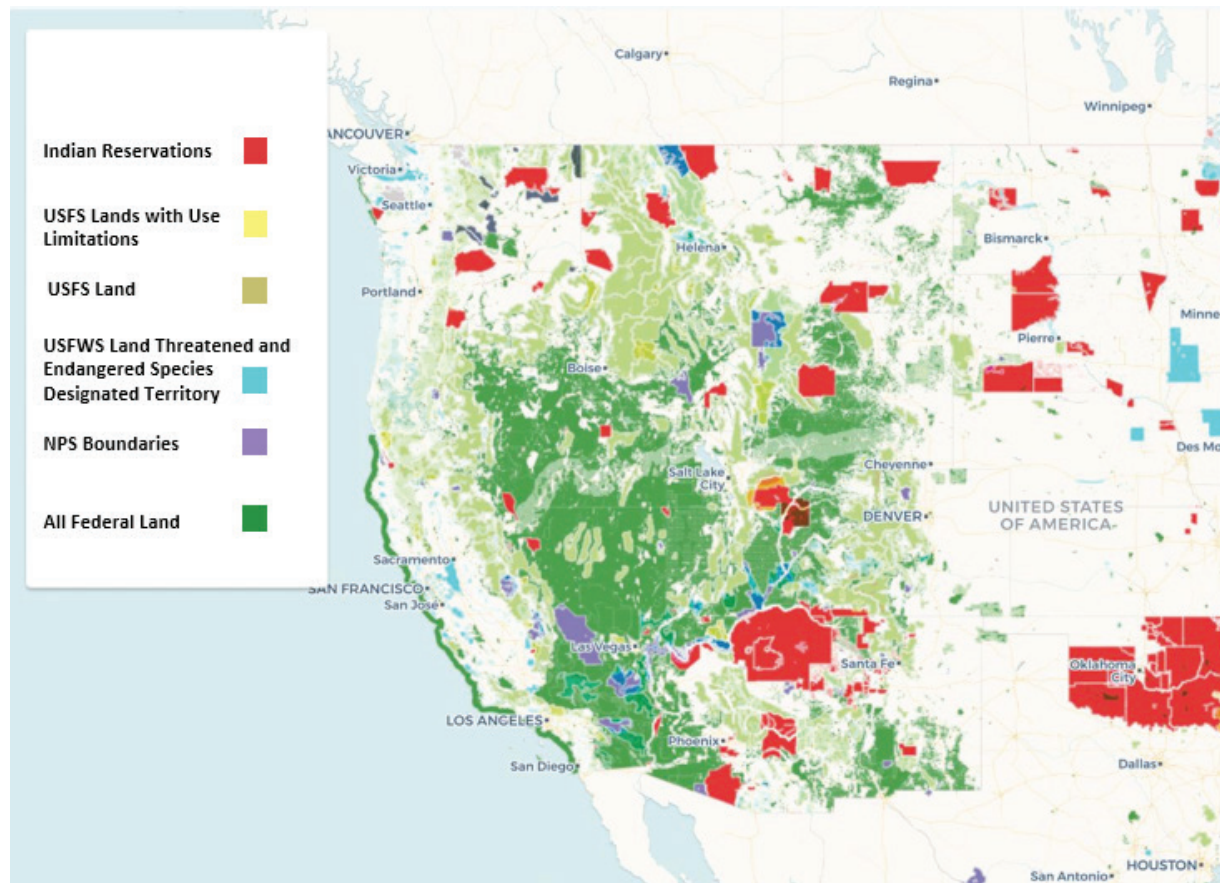
Legislative and Executive branch policies have resulted in a patchwork quilt of responsibilities. Federal Agencies that monitor biodiversity or oversee conservation on public lands include the Bureau of Land Management (BLM), EPA, the National Parks Service (NPS), NOAA, USGS, USFS, USFWS, and others. Some agencies conduct comprehensive monitoring, typically in response to legislative mandates. In addition to the USFS and USFWS programs described earlier, NOAA conducts comprehensive marine sanctuary monitoring through their Office of National Marine Sanctuaries (ONMS). BLM conducts an Assessment, Inventory, and Monitoring program informed by continuing scientific research and development of methods and protocols. Some small-scale coordination already exists. NPS and USFWS work together on the operation of Park and Refuge Inventory and Monitoring (I&M) networks. Non-governmental organizations (NGOs) like NatureServe also contribute through National Heritage Programs across the U.S. which help create a coordinated network for biodiversity monitoring and assessments at the state level.

Many government programs are under evaluation. A 2016 report offering guiding principles and recommendations for excellent science in the NPS I&M division identified outreach to the scientific community as a growth opportunity, and suggested that two NPS databases – IRMA and NPSpecies – should be “*modified to be more useful and usable [to scientific researches], or... dropped altogether.*”<sup>19</sup> In addition to comprehensive monitoring, efforts also focus on monitoring and protecting threatened or endangered species, like through BLM’s monitoring and protection of the Greater Sage-grouse.

While monitoring is a key priority for land management agencies, other authorities are also involved. Obama’s memorandum on *Safeguarding the Impacts of Invasive Species*, with continued support from the Trump administration, strengthened an interagency National Invasive Species Council and tasked the Department of Health and Human Services (HHS) with issuing a report on the public health impacts of invasive species. USAID considers biodiversity conservation a priority for sustainable development, the Smithsonian Institution (SI) promotes biodiversity research, and granting agencies such as the National Aeronautics and Space Administration (NASA) and the National Science Foundation (NSF) fund research to advance the science behind biodiversity monitoring, including through NSF’s network of 28 Long Term Ecological Research (LTER) sites.

In addition, as mandated by the Federal Aid in Wildlife Restoration Act, states are responsible for monitoring and managing threatened species not protected under the ESA. Local governments, particularly in areas where biodiversity is linked to tourism, also take an active interest. Further, while biodiversity and ecosystems are often considered public goods subject to government jurisdiction, monitoring and managing public lands is necessary but not sufficient for achieving a comprehensive understanding of biodiversity and holistic conservation outcomes.

Private sector interest in biodiversity is growing. Businesses rely on the provisioning and regulatory services that healthy biodiversity and ecosystems offer and are incentivized by access to new biotechnology markets, consumer preferences, and corporate responsibility goals. Individual citizens also have an important role to play. Sixty percent of the U.S.’s



Land ownership and management in the Western United States. Map designed on CARTO.<sup>20</sup>

Due to the mosaic structure of land management, species and supporting ecosystems often fall under the jurisdiction of multiple authorities. For example, territory designated for the conservation of threatened and endangered species – illustrated by blue boundaries in the map above – can cover land held by multiple federal authorities as well as private landowners. The structure of land ownership and management is evidence to support the argument that any monitoring framework should recognize a range of responsible parties, emphasizing coordination and data sharing between existing authorities.

land is privately held, and there are numerous ways to emphasize biodiversity conservation on private land without regulation. Members of the public also support research and monitoring through citizen science, a process where public volunteers contribute to scientific research to meet real-world goals. In biodiversity, citizen science contributions are valued as highly as \$2.5 billion each year<sup>21</sup> and are used to inform research and policy through assessments like the State of North America's Birds Report.

Conservation Reserve Enhancement Programs are one example of successful partnerships between federal agencies, state governments, and NGOs that also offer private landowners financial incentives for voluntarily committing to conservation. The ESA's Safe Harbor clause also asks landowners to voluntarily protect endangered species, promising non-intervention in return. These are important examples to draw on when designing newer multi-stakeholder approaches.

## Piecing Together a Patchwork Quilt

In general, species-specific monitoring and conservation programs are well-coordinated, although some overlap is inevitable due to the complex nature of land jurisdiction. But without a coordinated national approach to biodiversity monitoring, it is unclear how broader state, federal, and NGO initiatives relate to each other. The lack of a coordinated monitoring strategy also limits the ability of authorities operating on different levels – such as state governments, private companies, and public citizens – to effectively share information. Silos limit the

contributions that information collected at local or regional scales can make to national or global data sets. But knowledge sharing networks also help researchers operating on smaller scales to understand how the trends they observe relate to larger trends, for example in the case of Alaskan seabirds responding to broader sub-Arctic and Arctic changes in sea surface temperature.<sup>22</sup> Finally, the absence of a coordinated national approach hampers our ability to report on progress towards international goals and commitments.

Working towards a coordinated national approach to biodiversity monitoring requires making progress on three fronts. First, high-level policy guidance should concretely recognize the value of biodiversity and ecosystem services and charge stakeholders to work together to monitor and, when necessary, help mitigate change. Second, there needs to be a unified framework for data collection and interoperability that can meet local, state, national, and international monitoring and assessment needs. The Essential Biodiversity Variables (EBVs) framework is one recent innovation that can help fill this gap.<sup>27</sup> Finally, a networked governance structure must recognize contributions from federal and state agencies along with the private sector, NGOs, and the general public. As one starting point, the Group on Earth Observations Biodiversity Observation Network (GEO BON) published a nine-step BON formation process that illustrates one networked approach to monitoring and assessment that ensures local needs are met while maximizing broader utility.<sup>28</sup>



## The Sage Grouse, a Political Football



Photo courtesy of: Bob Wick / U.S. Bureau of Land Management

The Sage Grouse, often called the bald eagle of the west, is only found within the Sagebrush ecosystem of 11 Western states from Washington to Nevada. This environment is constantly under threat from wildfire, agricultural conversion, and disruption by oil, gas, and other energy industries. Environmental loss has led to the steep decline in Sage Grouse populations from millions to a recent estimate of 500,000. More than half of Sage Grouse habitat lies on public land under the jurisdiction of BLM, which has a conservation plan. In addition, the United States Department of Agriculture (USDA)'s Natural Resources Conservation Service launched the Sage Grouse Initiative in 2010, encouraging more than 1,474 ranchers to conserve 5.6 million acres of vulnerable habitat.<sup>23</sup>

The effectiveness of these strategies was jointly called into question in 2015, as USFWS updated their list of endangered species in consultation with stakeholders including private ranchers, energy companies, and states. Listing an animal as “endangered” leads to strict regulations and makes its habitat virtually untouchable to new developments. Because the Sage Grouse’s habitat is in 11 different states, an endangered listing would impact 11 different state economies, and many states pushed back on the designation. Rhetoric highlighting economic concerns was countered by conservationist groups who cited the dwindling numbers of Sage Grouse as a call to action before impending extinction.

USFWS did not list the Sage Grouse as an endangered species in 2015, but did implement a more collaborative set of goals and restrictions by brokering mutually beneficial agreements with private landowners, tribal groups, and corporations. These included strategies for private ranchers to restructure grazing systems and to remove invasives that disrupt the sagebrush. These were designed to reach conservation outcomes without evoking the endangered species designation; DOI Secretary Sally Jewel praised the effort.<sup>24</sup> Many wildlife groups were disappointed, but the prominent Audubon Society came out in support of the decision, citing “*unprecedented cooperation by private landowners, states, and the federal government.*”<sup>25</sup>

But as the current administration began its process of systematic deregulation, DOI Secretary Ryan Zinke opened up a review of the program, concluding that management of the Sage Grouse conservation should be decided by the states to allow for benefits to industry and to promote energy acquisition. On its face, this seems like a win for the states. However, the model that Zinke’s team implemented raised concern among many Western governors, who worried that too much deregulation could lead to drastic decreases in Sage Grouse populations which would then compel the USFWS to step in and evoke the Endangered Species listing.

The Legislative branch has also attempted to influence the future of Sage Grouse conservation. House Committee Chairman Rob Bishop (R-Utah) recently submitted an amendment to the 2019 National Defense Act (H.R. 5515) which would revoke the ability for the Sage Grouse to be placed under the protection of the Endangered Species Act for the next 10 years.<sup>26</sup>

This case study illustrates the wide range of stakeholders engaged in conservation issues and outcomes. Any effective approach to conservation must take into account federal, state, industry, NGO, public, and private perspectives. Assessing conservation outcomes through biodiversity monitoring similarly requires a coordinated, multi-stakeholder approach.

## *Innovations in Research: Essential Biodiversity Variables (EBVs)*

Biodiversity data are collected on a range of scales and resolutions, resulting in a scattered knowledge base that can be difficult to piece together. In 2013, researchers advanced the concept of Essential Biodiversity Variables (EBVs) as a collection of measurements required for the study, reporting, and management of global biodiversity change.<sup>28</sup> EBVs recognize and build on the earlier Essential Climate Variables (ECV) framework. Together, six classes of EBVs have been proposed as the key variables for understanding biodiversity change: genetic composition, species populations, species traits, community composition, ecosystem structure, and ecosystem function.

The identification of EBV classes can help structure the objectives, with specific species or ecosystem functions determined based on stakeholder needs, to underpin monitoring and assessment activities. In addition to creating a holistic framework to structure the process of setting objectives, designing monitoring strategies, and selecting indicators, work on individual EBVs such as Species Abundance and Distribution can outline exactly how to collect, process, and store certain types of biodiversity data to make this information interoperable with other data and usable in policy tools (e.g. indicators) and assessments.<sup>29</sup> Data standards and processes for data sharing and integration are developed collaboratively with the international Taxonomic Data Working Group (TDWG), which provides a framework and tools for effective data management, access, and use. Therefore, when researchers working on local, national, or global scales collect, process, and store biodiversity data in line with the EBV frame-

work, this information can meet an immediate need – such as the monitoring and conservation of a vulnerable species as identified through a State Wildlife Action Plan (SWAP) – and can also be re-used in national or global assessments of biodiversity change.

Some federal agencies are already investing in helping to develop the EBV framework. In October 2017, NASA announced 8 new awards designed to help the U.S. government make major contributions to biodiversity, including by supporting work on Earth Observation EBVs, as part of a larger initiative jointly supported by NOAA and the Bureau of Ocean Energy Management (BOEM).<sup>30</sup> NSF has also supported work on EBVs that leverages the capacity of the National Ecological Observatory Network (NEON)<sup>31</sup> and leads the U.S. delegation with funding support for the Global Biodiversity Information Facility (GBIF), an international network of biodiversity data providers. The USGS and NOAA, through the Intergovernmental Oceanographic Commission, support the research and development of the Essential Ocean Variables (EOVs) for biodiversity and the data sharing platform the Ocean Biographic Information System. But despite the potential of the EBV framework to support biodiversity monitoring that meets local, national, and global needs, the framework is still largely conceptual, with a limited number of case studies demonstrating the potential for implementation. Additional investments would help researchers and policymakers evaluate the viability of the EBV framework as a structural basis driving all future monitoring and assessment needs.

## *Innovations in Governance: The Group on Earth Observations Biodiversity Observation Network (GEO BON)*

The Group on Earth Observations (GEO) is an intergovernmental consortium created at a meeting of the Group of Eight Industrialized Nations (G8) that currently counts 108 governments including the U.S. as members. As appropriate to its mission of harmonizing Earth Observations globally, GEO draws open data contributions from a range of U.S. organizations including NASA as well as private sector partners. Under the GEO umbrella, the Group on Earth Observations Biodiversity Observation Network (GEO BON) seeks to improve the acquisition, coordination, and delivery of biodiversity observations and related services to users including decision makers and the scientific community.<sup>32</sup>

GEO BON currently focuses on three primary tasks: Developing the EBV framework, building the BON in a Box toolkit,<sup>33</sup> and facilitating the development of national, regional and thematic Biodiversity Observation Networks (BONs). National BONs, currently being implemented in China, Colombia, and France, are typically government-sponsored initiatives that are approved by the GEO BON governing consortium. Regional BONs currently exist for the Arctic (Circumpolar Biodiversity Monitoring Program)<sup>34</sup> and Asia-Pacific (AP BON). Thematic BONs target Marine (MBON) and Freshwater (FWBON) realms. Of course, there are a great number of biodiversity monitoring initiatives underway around the world that have not been officially endorsed by GEO BON and do not receive the network's assistance.

The U.S. took a strong leadership role in establishing the US MBON, primarily through the work and investment of agencies including NASA, NOAA, and the Bureau of Ocean Energy Management (BOEM).

US MBON supporting infrastructure includes the U.S. Integrated Ocean Observing System and the Ocean Biogeographic Information System (OBIS). The U.S. also participates in the Circumpolar Biodiversity Monitoring Program through federal agencies including NOAA, the Department of State, USFWS, USGS, and NPS. State authorities, including the Bureau of Land Management's Alaska State Office and the Alaska Department of Fish and Game, also contribute to CBMP activities.

National BONs can be linked to EBVs, to regional and thematic BONs, and to each other. As with EBVs, one primary innovation of BONs is implementing biodiversity research or monitoring programs that can meet immediate and contextual needs while also being suitable for coordination with complementary activities through common underlying standards and via a flexibly applied design process. Some implementations of the BON model, for example the French BON, demonstrate how BON governance can encourage different authorities within a country to work together to advance research and policy outcomes. The BON model can also help authorities coordinate different types of information, and have been described as a *"first attempt by national governments to jointly coordinate satellite, airborne, and in situ observations across biodiversity elements through genes, species, and ecosystems."*<sup>32</sup>

Through EBVs, a US BON would provide the underlying data framework for ensuring that monitoring efforts conducted by state, federal, NGO, and private authorities using a range of methods and techniques are interoperable. A US BON could also provide the high-level governance framework for a coordinated approach to national biodiversity monitoring, bringing together existing programs



to support more efficient, more economical, and faster monitoring and assessment cycles while also promoting additional types of knowledge exchange. Finally, a US BON would be the logical authority to coordinate with international authorities in assessments. But there are currently no public plans to expand U.S. involvement beyond the existing

MBON to create a US BON with broader coverage and including terrestrial and freshwater realms. Fortunately, ample groundwork exists through numerous monitoring and conservation mandates and supporting infrastructure.



Photo courtesy of - David Cornwell - Kesling Wetland and Farmstead

Merry Lea is a nature sanctuary located near Wolf Lake, Indiana. Most of the habitats found in northeastern Indiana are present in the 1,189 acres of Merry Lea. Unique geological features such as peat bogs, a marl pit, and glacial gravel formations are present. Observable management practices include wetland, prairie, and savanna restorations, as well as sustainable agriculture. A vigorous educational program interprets the significant biological and geological features.

## Early Coordination: Invasive Species

One success story of small-scale government coordination may be found in the response by federal agencies to Executive Order 13112, issued in 1999 by President Clinton, and the follow up Executive Order 13751 issued in 2016 by President Obama. The first order set up the coordinating body known as the National Invasive Species Council (NISC). The NISC is composed of executive agency heads united *“to prevent the introduction of invasive species and provide for their control and to minimize the economic, ecological, and human health impacts that invasive species cause.”* In 2016, President Obama refocused the group’s efforts by amending 13112 writing that the new order

*“...directs actions to continue coordinated Federal prevention and control efforts related to invasive species. This order maintains the National Invasive Species Council (Council) and the Invasive Species Advisory Committee; expands the membership of the Council; clarifies the opera-*

*tions of the Council; incorporates considerations of human and environmental health, climate change, technological innovation, and other emerging priorities into Federal efforts to address invasive species; and strengthens coordinated, cost-efficient Federal action.”<sup>33</sup>*

In 2016, the NISC published a national strategy 2016-2018.<sup>34</sup> Accountability is ensured through an itemized report card measuring progress against stated goals and timelines. One of the action items the Strategy set forth (2.4) called for a common data standard to quantify and qualify invasive species presence across the U.S. In 2018, the Council followed up with a report identifying a number of priority actions with the unifying theme of standardizing and openly publicizing invasive species data for public consumption. The same report affirmed inter-agency interoperability in monitoring and mitigating the impacts of invasives.<sup>35</sup>

## Policy Recommendations

There is currently a massive overlap between the monitoring mandates of various federal and state authorities. This is both a strength, resulting in significant capacity for monitoring activities, and a weakness, due to the massive challenges that coordination can pose. Executive and legislative branch policymakers can take a leadership role through concrete steps to move the U.S. towards a coordinated approach to national biodiversity monitoring.

***Establish biodiversity as a national asset and critical priority.*** Biodiversity and ecosystems provide valuable provisioning, regulatory, and cultural services that are under threat. High-level policy guidance should acknowledge the economic and intangible value of biodiversity, concretely link biodiversity monitoring and conservation assessment, and establish biodiversity conservation as a critical national priority. Early recognition could include, or simply lay the groundwork for, subsequent and detailed guidance designed to drive action.

***A leading authority, such as the Office of the President of the United States, could form a Biodiversity Conservation and Monitoring Task Force for the eventual publication of a National Strategy on Biodiversity Conservation and Monitoring in the United States.*** The Biodiversity Conservation and Monitoring task force should include agencies that have a vested interest in biodiversity through land and resource management, including BLM, NPS, USFS, USFWS, and USDA, as well as other agencies with a vested interest such as NOAA, EPA, SI, and USAID. Participation from the private sector, NGOs, and the general public in developing priorities and in monitoring and analysis should be encouraged. A task force could conduct

research, interviews, and case studies to inform the eventual publication of a National Strategy that highlights the current state of biodiversity in the United States and future conservation priorities. Beginning with articulated policy needs, the National Strategy should define clear, measurable targets, questions, and objectives for monitoring and conservation to structure coordinated monitoring around.

***Identify the relevant authorities capable of coordinating biodiversity monitoring and conservation within the U.S. government.*** No single agency has the full perspective to lead an effort alone, though an authority like the White House Office of Science and Technology (OSTP) could take a strong leadership role in offering coordination and guidance. A commission co-led by higher level agency officials, perhaps including leadership from the U.S. Group on Earth Observations (GEO), could also bring the right mix of skills and perspectives. Regardless, an actionable National Strategy will likely hold one or more authorities responsible for leading implementation and ensuring accountability.

***Invest in research on Essential Biodiversity Variables (EBVs) that align with national and agency-specific priorities.*** The EBV framework identifies six separate classes, each with a subset of more specific variables. Agencies should be encouraged to evaluate the applicability of different classes and EBVs to their biodiversity monitoring and assessment needs and invest in the EBV framework in line with relevant policy priorities. For example, USGS's Natural Phenology Network (USA-NPN) – the nation's predominant resource for supporting the study of cyclic and seasonal natural phenomena – would be uniquely qualified to lead the development of a



phenology EBV that could be implemented in the U.S. and globally. Agencies should be encouraged to advance the EBV framework through concrete actions and activities, as well as through funded extramural research. EBVs have provided an underlying structure to organize and help focus GEO BON activities and could serve a similar value for advancing cross-agency coordination.

***Align a national biodiversity strategy and action plan with the network approach of GEO BON.***

By using an already established governance structure and BON design process, GEO BON offers a compelling starting point for bringing disparate contributions together within and beyond the United States. Creating a National BON would help link a coordinated monitoring assessment leveraging the EBV framework with thematic assessments such as those driven by the MBON. By joining a handful of other early adopters, the creation of a National BON would also help the U.S. demonstrate global leadership in biodiversity monitoring.

***Invest in and maintain a research infrastructure including open data platforms and other knowledge sharing resources.***

Supported by Data.gov, the EcoINFORMA platform provides a common point of access to three agency-specific open data portals. The EcoINFORMA and hubs including BISON and EnviroAtlas should be supported and, when possible, modernized in conjunction with larger agency-specific efforts taken to ensure the integrity and availability of government data and information systems. Additional hubs, such as the Smithsonian's growing database of digitized biodiversity records in cooperation with the Biodiversity Heritage Library (BHL), are or could be linked at no additional cost to federal agencies. State-specific biodiversity monitoring databases could be linked

as well, especially the Natural Heritage Information Systems that are set up state by state and collect rare species data specific to each state's environments. Where global research infrastructure such as GBIF and OBIS support objectives of the national strategy, these should be incorporated directly to take advantage of a broader knowledge base and multilateral sustained research investments.

***Re-evaluate our relationship to international policy frameworks.***

The CBD's current Strategic Plan for Biodiversity runs from 2011-2020, and the next decade of planning is underway. This could become an opportunity for the U.S. to contribute to international negotiations on biodiversity in order to prioritize and re-visit various points of contention that have discouraged ratification in the past. The UN-SDGs also present a compelling high-level policy framework for aligning national biodiversity and conservation efforts with international goals and assessments.

## Endnotes

1. Holzman, David C. "Accounting for Nature's Benefits: The Dollar Value of Ecosystem Services." *Environmental Health Perspectives* 120, no. 4 (April 1, 2012): A 152-7. <https://doi.org/10.1289/ehp.120-a152>.
2. Mace, Georgina M., Ken Norris, and Alastair H. Fitter. "Biodiversity and Ecosystem Services: A Multilayered Relationship." *Trends in Ecology & Evolution* 27, no. 1 (January 1, 2012): 19–26. <https://doi.org/10.1016/j.tree.2011.08.006>.
3. U.S. Fish & Wildlife Service. "The Cost of Invasive Species," January 2012. <https://www.fws.gov/verobeach/Python-PDF/CostofInvasivesFactSheet.pdf>.
4. USGS. "President Proposes \$860 Million USGS Budget for FY2019," February 12, 2018. <https://www.usgs.gov/news/president-proposes-860-million-fy19-budget-usgs>.
5. Millennium Ecosystem Assessment. *Ecosystems and Human Well-Being: Current State and Trends: Findings of the Condition and Trends Working Group*. Washington, DC: Island Press, 2005.
6. North American Bird Conservation Initiative. "The State of North America's Birds 2016." Ottawa, Ontario: Environment and Climate Change Canada, 2016. <http://www.stateofthebirds.org/2016/wp-content/uploads/2016/05/SoN-AB-ENGLISH-web.pdf>.
7. Walls, Susan C., Lianne C. Ball, William J. Barichivich, C. Kenneth Dodd, Kevin M. Enge, Thomas A. Gorman, Katherine M. O'Donnell, John G. Palis, and Raymond D. Semlitsch. "Overcoming Challenges to the Recovery of Declining Amphibian Populations in the United States." *BioScience* 67, no. 2 (February 1, 2017): 156–65. <https://doi.org/10.1093/biosci/biw153>.
8. Scholes, Robert J., Michael J. Gill, Mark J. Costello, Georgios Sarantakos, and Michele Walters. "Working in Networks to Make Biodiversity Data More Available." In *The GEO Handbook on Biodiversity Observation Networks*, 1–17. Springer, Cham, 2017. [https://doi.org/10.1007/978-3-319-27288-7\\_1](https://doi.org/10.1007/978-3-319-27288-7_1).
9. U.S. Department of the Interior. "Secretary Zinke Promotes Hunting, Fishing, and Wildlife Conservation with Employee 'Showdown' at Department of the Interior," September 19, 2017. <https://www.doi.gov/pressreleases/secretary-zinke-promotes-hunting-fishing-and-wildlife-conservation-employee-showdown>.
10. "Convention on Biological Diversity." United Nations, 1992. <https://www.cbd.int/doc/legal/cbd-en.pdf>.
11. Blomquist, Robert F. "Ratification Resisted: Understanding America's Response to the Convention on Biological Diversity, 1989-2002." *Golden Gate University Law Review* 32, no. 4 (January 2002): 493-586.
12. *National Wildlife Refuge System Improvement Act of 1997*, Public Law 105-57, *U.S. Statutes at Large* 111 (1997): 1252.
13. *National Parks Omnibus Management Act of 1998*, Public Law 105-391, *U.S. Statutes at Large* 112 (1998): 3497.
14. President's Committee of Advisors on Science and Technology. "Teaming with Life: Investing in Science to Understand and Use America's Living Capital." Washington, DC: National Science and Technology Council, March 1998. <https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/pcast-teamingwithlife.pdf>.
15. President's Committee of Advisors on Science and Technology. "Sustaining Environmental Capital: Protecting Society and the Economy." Washington, DC: National Science and Technology Council, July 2011. [https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/pcast\\_sustaining\\_environmental\\_capital\\_report.pdf](https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/pcast_sustaining_environmental_capital_report.pdf).

16. Council on Environmental Quality. "Faces and Places of Cooperative Conservation." St. Louis, Missouri, 2005. <https://govinfo.library.unt.edu/whccc/team/FacesPlacesPartOne.pdf>.
17. Jackson, Stephen T., Clifford S. Duke, Stephanie E. Hampton, Katharine L. Jacobs, Lucas N. Joppa, Karim-Aly S. Kassam, Harold A. Mooney, Laura A. Ogden, Mary Ruckelshaus, and Jason F. Shogren. "Toward a National, Sustained U.S. Ecosystem Assessment." *Science* 354, no. 6314 (November 18, 2016): 838-9. <https://doi.org/10.1126/science.aah5750>.
18. U.S. Agency for International Development. "USAID BIODIVERSITY POLICY." Washington, DC, March 2014. <https://www.usaid.gov/sites/default/files/documents/1865/USAID%20Biodiversity%20Policy%20-%20June%202015.pdf>.
19. "Excellent Science in the National Park Service Inventory and Monitoring Division: Guiding Principles and Recommendations." Fort Collins, Colorado: National Park Service, May 2016. <https://irma.nps.gov/DataStore/Download-File/550658>.
20. **Data sources:** Department of the Interior. *Protected Areas Database of the United States (PAD-US)*. March 29, 2018. Distributed by Data.gov. <https://catalog.data.gov/dataset/protected-areas-database-of-the-united-states-pad-us>; Department of Transportation. *National Parks*. March 29, 2018. Distributed by Data.gov. <https://catalog.data.gov/dataset/national-parks>; Federal Geographic Data Committee. *BIA Indian Lands Dataset (Indian Lands of the United States)*. March 29, 2018. Distributed by Data.gov. <https://catalog.data.gov/dataset/bia-indian-lands-dataset-indian-lands-of-the-united-states>; United States Forest Service. *Forest Service Regional Boundaries*. March 29, 2018. Distributed by USDA. [https://data.fs.usda.gov/geodata/edw/edw\\_resources/meta/S\\_USA.AdministrativeForest.xml](https://data.fs.usda.gov/geodata/edw/edw_resources/meta/S_USA.AdministrativeForest.xml); United States Forest Service. *National Forest Lands with Nationally Designated Management or Use Limitations*. March 29, 2018. Distributed by USDA. [https://data.fs.usda.gov/geodata/edw/edw\\_resources/meta/S\\_USA.OtherNationalDesignatedArea.xml](https://data.fs.usda.gov/geodata/edw/edw_resources/meta/S_USA.OtherNationalDesignatedArea.xml); United States Forest Service. *Public Land Survey Cover*. March 29, 2018. Distributed by USDA. [https://data.fs.usda.gov/geodata/edw/edw\\_resources/meta/S\\_USA.Cover.xml](https://data.fs.usda.gov/geodata/edw/edw_resources/meta/S_USA.Cover.xml)
21. Theobald, E. J., A. K. Ettinger, H. K. Burgess, L. B. DeBey, N. R. Schmidt, H. E. Froehlich, C. Wagner, et al. "Global Change and Local Solutions: Tapping the Unrealized Potential of Citizen Science for Biodiversity Research." *Biological Conservation* 181 (January 1, 2015): 236–44. <https://doi.org/10.1016/j.biocon.2014.10.021>.
22. Irons, David B., Tycho Anker-Nilssen, Anthony J. Gaston, G. Vernon Byrd, Knud Falk, Grant Gilchrist, Martti Hario, et al. "Fluctuations in Circumpolar Seabird Populations Linked to Climate Oscillations." *Global Change Biology* 14, no. 7 (July 1, 2008): 1455–63. <https://doi.org/10.1111/j.1365-2486.2008.01581.x>.
23. "New Paradigm." Sage Grouse Initiative. Accessed July 19, 2018. <https://www.sagegrouseinitiative.com/about/new-paradigm/>
24. Fears, Darryl. "Decision Not to List Sage Grouse as Endangered Is Called Life Saver by Some, Death Knell by Others." *Washington Post*, September 22, 2015. <https://www.washingtonpost.com/news/energy-environment/wp/2015/09/22/fewer-than-500000-sage-grouse-are-left-the-obama-administration-says-they-dont-merit-federal-protection/>.
25. Opar, Alisa. "Unprecedented Conservation Efforts Keep Greater Sage-Grouse Off Endangered Species List." *Audubon*, September 22, 2015. <https://www.audubon.org/news/unprecedented-conservation-efforts-keep-greater-sage-grouse-endangered-species>.
26. Jarman, Madilyn. "Riders Remain in 2019 National Defense Authorization Act." THE WILDLIFE SOCIETY, May 22, 2018. <http://wildlife.org/riders-remain-in-2019-national-defense-authorization-act/>.

27. Navarro, Laetitia M., Néstor Fernández, Carlos Guerra, Rob Guralnick, W. D. Kissling, Maria Cecilia Londoño, Frank Muller-Karger, et al. "Monitoring Biodiversity Change through Effective Global Coordination." *Current Opinion in Environmental Sustainability* 29 (December 1, 2017): 158–69. <https://doi.org/10.1016/j.cosust.2018.02.005>.
28. Pereira, H. M., S. Ferrier, M. Walters, G. N. Geller, R. H. G. Jongman, R. J. Scholes, M. W. Bruford, et al. "Essential Biodiversity Variables." *Science* 339, no. 6117 (January 18, 2013): 277–78. <https://doi.org/10.1126/science.1229931>.
29. Kissling, W. Daniel, Jorge A. Ahumada, Anne Bowser, Miguel Fernandez, Néstor Fernández, Enrique Alonso García, Robert P. Guralnick, et al. "Building Essential Biodiversity Variables (EBVs) of Species Distribution and Abundance at a Global Scale." *Biological Reviews* 93, no. 1 (February 1, 2018): 600–625. <https://doi.org/10.1111/brv.12359>.
30. GEO BON Secretariat. "NASA Announces New Funding for GEO BON Activities." GEO BON (blog), November 29, 2017. <https://geobon.org/nasa-announces-new-funding-for-geo-bon-activities/>.
31. "MSB-ECA: Leveraging NEON Data to Investigate Remote Sensing of Biodiversity Variables and Scaling Implications." National Science Foundation. Accessed July 19, 2018. [https://www.nsf.gov/awardsearch/showAward?AWD\\_ID=1703062](https://www.nsf.gov/awardsearch/showAward?AWD_ID=1703062).
32. Turner, Woody. "Sensing Biodiversity." *Science* 346, no. 6207 (October 17, 2014): 301–2. <https://doi.org/10.1126/science.1256014>.
33. "Executive Order 13751 of December 5, 2016, Safeguarding the Nation From the Impacts of Invasive Species." *Code of Federal Regulations*, title 3 (2016): 88609-14, <https://www.gpo.gov/fdsys/pkg/FR-2016-12-08/pdf/2016-29519.pdf>
34. Sarri, Kristen J., Robert Bonnie, and Christine Blackburn. "Management Plan 2016-2018." Washington, DC: National Invasive Species Council Secretariat, July 11, 2016. <https://www.doi.gov/sites/doi.gov/files/uploads/2016-2018-nisc-management-plan.pdf>.
35. "Enabling Decisions That Make a Difference: Guidance for Improving Access to and Analysis of Invasive Species Information." Washington, DC: National Invasive Species Council Secretariat, March 26, 2018. [https://www.doi.gov/sites/doi.gov/files/uploads/isim\\_guidance.pdf](https://www.doi.gov/sites/doi.gov/files/uploads/isim_guidance.pdf).





## Dr. Anne Bowser

Dr. Anne Bowser is the Director of Innovation at the Woodrow Wilson International Center for Scholars, a quasi-government think tank in Washington, DC. Her work focuses

on understanding and mobilizing public participation in science, technology, and policy while helping the Wilson Center leverage technologically innovative programming to reach new audiences.

Taking the concepts of public participation and open innovation as unifying themes, Anne's research and practical work focuses on topics including how technological interfaces can be designed to motivate participation; the role that standards and interoperability play in facilitating data collection and data sharing (or not); and how citizen science technologies are appropriated from one context for use in another. Her Ph.D., awarded by the University of Maryland's iSchool, explored a cooperative approach to designing Floracaching, a geocaching mobile app for biodiversity data collection.



## William "Alex" Long





William "Alex" Long is a Program Assistant for the Innovation Initiative within the Science and Technology Innovation Program at the Wilson Center. Alex is currently

working with the Citizen Science program on how to promote citizen science projects with a focus on biodiversity monitoring and the One Health framework. He is specifically interested in the crossroads between the environment and human health and how citizen science, AI, and ethically constructed algorithms could be vehicles for a healthier world and stronger policy.

Alex earned an M.S. in Biomedical Science Policy & Advocacy program at Georgetown University in May 2018 and graduated from the University of Richmond in May 2017 with a B.S. in Biology where he conducted extensive research on South American frog cryptic speciation.

**Thank you to Mike Gill Director, Biodiversity Indicators Program at NatureServe & GEO BON Co-Chair for his helpful review.**

## The Wilson Center

-  [wilsoncenter.org](http://wilsoncenter.org)
-  [facebook.com/WoodrowWilsonCenter](https://facebook.com/WoodrowWilsonCenter)
-  [@TheWilsonCenter](https://twitter.com/TheWilsonCenter)
-  202.691.4000

## Science and Technology Innovation Program

-  [wilsoncenter.org/program/science-and-technology-innovation-program](http://wilsoncenter.org/program/science-and-technology-innovation-program)
-  [stip@wilsoncenter.org](mailto:stip@wilsoncenter.org)
-  [facebook.com/WilsonSTIP](https://facebook.com/WilsonSTIP)
-  [@WilsonSTIP](https://twitter.com/WilsonSTIP)
-  202.691.4002

Woodrow Wilson International Center for Scholars  
One Woodrow Wilson Plaza  
1300 Pennsylvania Avenue NW  
Washington, DC 20004-3027