Four Challenges to an Effective National Nature Assessment

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Abstract

Comprehensive biodiversity assessments play an essential role in strengthening global and national conservation strategies. The recently announced first US National Nature Assessment provides a unparalleled opportunity to comprehensively review status and trends of biodiversity at all levels;

this broad context can then help coordinate actions to conserve individual species and ecosystems. The scientific assessments informing the Global Biodiversity Framework adopted at the 2022 Convention on Biological Diversity (CBD) conference of parties provide models for synthesizing information on trends at multiple levels of biodiversity, including decline in abundance and distribution of species, loss of populations and genetic diversity, and degradation and loss of ecosystems and their services, along with data on drivers of biodiversity loss and pathways to their mitigation. The US national assessment can augment such global analyses and avoid the pitfalls encountered by previous US efforts by ensuring policy-relevant design, data accessibility, and inclusivity in both process and product, and by incorporating spatial data relevant to both national and subnational audiences. Although the US is not formally a CBD party, an effective NNA should take full advantage of the global context by including targets and indicators adopted at the 2022 meeting and incorporating an independent review mechanism that supports periodic stocktaking and ratcheting up of ambition in response to any identified shortfalls in stemming biodiversity loss. The challenges to design of an effective US assessment are also relevant globally as nations develop assessments and reporting to support the post-2020 global biodiversity targets. By considering and incorporating the diverse ways in which society values and benefits from nature, such assessments can help bridge the gap between research and conservation practice and communicate the extent of the biodiversity crisis to the public, fostering broad-based support for transformative change in humanity's relationship to the natural world.

Introduction

Sustainability of human society requires a healthy biosphere as the context for all life (IPBES, 2019). The recent conference of parties (COP15) to the primary global biodiversity treaty (the Convention on Biological Diversity; CBD) forged new commitments to reverse the decline of biodiversity at all levels by means of transformative societal action (CBD, 2022). Improvements in

biodiversity monitoring and assessment will be a fundamental component of this effort (CBD, 2022; Gonzalez et al., 2022). At the national level where most biodiversity policy is implemented, comprehensive biodiversity assessments are a key tool for coordinating actions to conserve species and ecosystems (Jackson et al., 2016). However, many countries including the US lack a clear and consistent picture of national biodiversity status and trends to provide scale-appropriate guidance.

In 2022, the US Administration announced a new initiative called the National Nature Assessment (NNA; White House, 2022), which aims to "create a holistic picture of America's lands, waters, wildlife, ecosystems and the benefits they provide to our economy, health, the climate, environmental justice, and even our national security" (Lubchenco et al., 2022). The NNA builds on earlier proposals for US national assessments of biodiversity and ecosystem services (Lubchenco, 1995; PCAST, 2011; Jackson et al., 2016; Gerber at al., 2020).

Development of the first NNA provides an unparalleled opportunity to advance biodiversity science and conservation practice. However, the history of previous US biodiversity and climate change assessments (Fig. 1) demonstrates the many potential hurdles in achieving these goals (NRC, 2007). In many ways, the barriers to an effective national nature assessment are even greater than those faced by national climate assessments. Biodiversity itself is complex and multi-faceted yet represents only one framing for valuation of nature's contributions to people (IPBES, 2022). The nexus between global and US biodiversity policy is even more complex than is the case with climate change because the US is not a party to the CBD. And as with climate policy, an entrenched economic and bureaucratic status quo presents barriers to completing a rigorous assessment and stocktaking that identifies shortcomings in society's response to the biodiversity crisis (Obura et al., 2022).

Here we discuss how lessons on best practice drawn from previous national science assessments can inform design of the NNA (NRC, 2007)(Table 1). We also examine several challenges that have particular resonance for the NNA effort. We begin by examining two issues that are clearly of concern to NNA planners (OSTP, 2022) but are far from resolved: the challenge of designing an inclusive assessment process, and one that effectively synthesizes information across levels of biodiversity and approaches to valuing nature (e.g., biodiversity and ecosystem services). Next, we examine two challenges that have received less focus to date: linking assessments across scales of governance (global, national, and subnational), and enabling an independent review component that ensures an honest stocktaking of success and shortfalls in halting and reversing nature loss, a component highlighted as essential in the recent CBD COP15 agreement (CBD, 2022).

Although involved in the creation of previous US biodiversity reports (Fig. 1), none of the authors is directly involved in planning of the NNA. This independence allows us a wider scope to stimulate discussion within the broad community of scientists and practitioners. As with the CBD COP15 process, public scientific discussion and debate is an essential complement to internal planning and negotiations in ensuring the NNA will effectively support a coherent and policy-relevant response to the biodiversity crisis. Although grounded in the specifics of US policy, the questions we consider (Table 2) are also highly relevant for other nations as they develop national ecosystem assessments and reporting on progress towards global biodiversity targets (CBD, 2022)(Fig. 2).

Common challenges evident from previous national science assessments

Previous "assessments of assessments" have not surprisingly identified factors such as strong leadership, a well-articulated organizational structure, and adequate funding as essential to a successful assessment process (NRC, 2007). The NNA will be carried out under the Global Change Research Act (15 U.S.C. §§ 2921-61) which established the periodic US National Climate Assessments (NCA; see Fig. 2 legend for list of acronyms)(Wuebbles et al., 2017). Although led by the Global Change Research Program, the NNA's budget and personnel are drawn from 13 federal agencies, a structure that facilitates broad buy-in but is vulnerable to budgetary cutbacks and interagency disputes. The NNA is likely vulnerable to many of the same organizational challenges faced by the NCA (Moss et al., 2019).

Several previous US national biodiversity assessments serve as precursors (and cautionary tales) to the NNA, ranging from efforts sponsored by the short-lived US National Biological Survey (Noss et al., 1995) and the US Geological Survey (Mac et al., 1998), to reports sponsored by major US NGOs (Heinz Center, 2008; Stein et al., 2000)(Fig. 1). Although valuable, these documents demonstrate the issue of a supply-side vs demand-side model for data development: without a specific "client" or program-related requirement creating a demand for the information, even rigorous and comprehensive assessments can have little direct impact on conservation decisions (Enquist et al., 2017).

Strong support from executive leadership and budgetary continuity across administrations will be key to the NNA's success. This will be challenging given the level of political polarization around biodiversity issues in the US (Weiss, 2022). Unlike the NNA, the NCA is mandated by law to be produced at four-year intervals. However, the number of years between successive NCA has

varied widely among US administrations in part due to polarization concerning the validity of climate change science (Wuebbles et al., 2017).

Although only the initial product (to be delivered by 2026) has been authorized, the NNA will be most useful if it is established as a periodically updated assessment (e.g., via a new legislative mandate), as tracking of biodiversity change over long periods is necessary to discern clear trends. The first assessment provides a critical opportunity to develop standardized approaches and methods that can be consistently employed in future iterations. Because there can be a long hiatus between successive assessments, especially under less-supportive administrations, some have advocated a shift from a periodic report format to a "sustained" assessment, which would be updated in sections rather than all at once (Jackson et al., 2016; Moss et al., 2019). The shift to a sustained format, along with the strategic use of case studies, can help address the inevitable challenge of balancing comprehensiveness and timeliness of reporting.

Weaving together knowledge based on diverse valuation systems in an inclusive process

In addition to common issues evident from previous national science assessments, several challenges are unique or especially resonant to the NNA effort. Use of the term 'nature' in naming the new assessment indicates a broad scope that will "synthesize knowledge of…connections between nature, climate, economy, and society" (Young & Nelson, 2022), building on previous calls for a national ecosystem services assessment (PCAST, 2011; Jackson, 2016) and recent work at the global level on ecosystems services and other methods of valuation of nature's contributions to people (IPBES, 2019, 2022). The administration also intends to link the NNA to related initiatives such as to the system of natural capital accounts and reports on nature-based climate solutions (White House, 2021, 2022; Lubchenco et al., 2022; CEQ, 2022; OSTP, 2022).

Existing initiatives in the UK (Grafton, 2017) and China (Ouyang et al., 2016) provide models for a unified assessment that addresses the multiple ways in which the natural world is valued by humans (Table 2)(IPBES, 2022). Nonetheless, best practice in synthesizing reporting on status and trends in biodiversity with information on ecosystem services and metrics related to human well-being is still an area of active development (UNEP-WCMC, 2022). Public information to date suggests that the NNA's elements related to natural capital accounting are being developed on a shorter timeline than are its biodiversity-related elements (Lubchenco et al., 2022). It is important that that these diverse elements are synthesized into a whole greater than the parts, and that the NNA elements focused on status and trends of biodiversity are not shortchanged due to being one of several foci.

Recent iterations of the NCA have emphasized the need to further "engage diverse authors and stakeholders [and] value and integrate…different knowledge systems" (Table 2)(Roesch-McNally et al., 2020). The most recently completed (fourth) NCA involved the participation of over 300 scientists, with half from outside government (Wuebbles et al., 2017). Such a model can be a strength in incorporating diverse perspectives and expertise, but the work of volunteer experts must be adequately supported by program staff to avoid slowing progress and excluding those without adequate resources for participation.

More generally, we support efforts to make inclusivity in process and products a fundamental guiding principle for the NNA (OSTP, 2022). The NNA can benefit from recent advances in developing inclusive models for scientific assessments, including integration of Traditional Ecological Knowledge (TEK), to facilitate broader societal engagement with the process (Hill et al., 2020; McElwee et al., 2020). As McElwee et al. (2020) noted, inclusivity "requires a deliberate framework and approach from the start that facilitates recognition of different knowledge systems,

identifies questions relevant at various scales, mobilizes funding and recognizes time required and engages networks of stakeholders with diverse worldviews".

This inclusive model is relevant to the role of the NNA in informing environmental justice priorities, e.g., resolving injustice done to communities with limited nature access (White House, 2022), as well as building the ecosystem monitoring and management capacity of Indigenous communities (Hill et al., 2020). The NNA could also enhance inclusivity if it can be designed to both benefit from and stimulate capacity for community science surrounding biodiversity monitoring (Soroye et al., 2022).

Synthesizing insights across levels of biological organization

An effective response to the biodiversity crisis must address drivers of loss at all levels of biological organization (Leadley et al., 2022). In contrast to global climate negotiations that focus on a single topline goal based on global mean temperature increase, the CBD's biodiversity goals and targets include elements focused on conservation of ecosystems, species, and genetic diversity, and emphasizes the importance of monitoring and assessment at all three levels (CBD, 2022). US agencies, with some exceptions, have historically emphasized species-focused assessments over monitoring of ecosystems or intraspecific diversity (Noss et al., 1997). The NNA can be a much-needed stimulus for the evolution of US biodiversity assessment towards a geographically and taxonomically comprehensive review of the status and trends of biodiversity at all levels, offering a broad context for addressing decline in abundance and distribution of species, loss of populations and genetic diversity, and degradation and loss of ecosystems and their services. Perhaps the greatest contribution the NNA can make to understanding of US biodiversity will be to provide an updated summary of the status and integrity of US ecosystems and the level of threat that they face. Although challenging, comprehensive ecosystem assessment has been made more feasible by recent

advances in classification, mapping, and risk assessment of ecosystems globally (Nicholson et al., 2021). Although completion of the NNA will require significant resources, it will be facilitated by a design that leverages existing data and expertise. At the species level of biodiversity, the NNA can build on data on species' status and trends developed by federal, state, tribal, academic, and non-profit organizations. This includes including public-private collaborations (e.g., NatureServe and the state Natural Heritage Programs) that assess and track the status and distribution of US species and ecosystems (Hamilton et al., 2022; Comer et al., 2022), and which can be synthesized and reported out at a national scale (Stein et al., 2000). There is also a need to better incorporate US biodiversity into global assessment protocols and programs; the IUCN Red List of Threatened Species, for example, includes assessments for <15% of plant species in the continental US and Canada (Knapp et al., 2021). The IUCN Red List of Ecosystems provides analogous information on the decline and protection status of ecosystem types (Comer et al., 2022; Keith et al., 2015).

Recent reviews have highlighted the importance of more comprehensive tracking of population abundance and trends to complement (and contribute to) indicators of species extinction risk and intraspecific diversity (Carroll et al., 2022; Cavender-Bares et al., 2022). The NNA should incorporate existing datasets on population trends, such as the North American Breeding Bird Survey and state breeding bird atlases (Cavender-Bares et al., 2022). The US Gap Analysis Program was a pioneer in developing a comprehensive database of habitat distribution models for vertebrates, butterflies, and some other taxa, as well as the ecosystems and vegetation types with which these taxa are associated (Scott et al., 1993). More recent efforts have resulted in data with increased spatial resolution and taxonomic breadth (Jetz et al., 2022; Hamilton et al., 2022).

Comprehensive biodiversity strategies aim not only to conserve species, but also genetic diversity within and among populations (Hoban et al., 2022; CBD, 2022). Although explicit quantitative targets for intraspecific genetic diversity are a recent development in conservation

policy, US conservation statutes acknowledge the importance of retaining multiple abundant populations located across a range of ecological settings, which facilitates retention of genetic diversity (Stein et al., 2000; Carroll et al., 2022). By incorporating data on species' distribution and abundance, the NNA could track proxies for intraspecific diversity (e.g., number of ecoregions within historic range with extant populations of a species), in addition to incorporating recent research on delineating units for conserving genetic diversity (Hoban et al., 2022), and existing agency policy for assessment of species' resilience, redundancy, and representation (the '3R' framework; Stein et al., 2000). A comprehensive NNA should not only address the levels of biodiversity (ecosystems, species, genetic diversity) individually but also analyze interactions across levels (e.g., effects of species loss on ecosystem integrity) and interlinked responses to drivers of biodiversity loss, including via use of case studies (Table 2)(Leadley et al., 2022).

Coordinating assessment from local to global extents

Two primary pathways provide the impetus for the NNA. The first consists of the NNA's historical predecessors at the national level (Noss et al., 1995; Mac et al., 1998; Heinz Center, 2008; Stein et al., 2000; Fig. 1), combined with more recent calls for a comprehensive national assessment of biodiversity and ecosystem services (Lubchenco, 1995; Jackson et al., 2016; PCAST, 2011). The second impetus stems from international science-policy processes.

At the 2022 CBD COP15 meeting in Montreal, the world's nations agreed on a comprehensive Global Biodiversity Framework (GBF) to guide and incentivize global and national biodiversity policy (CBD, 2022). The GBF consists of a set of goals, targets, and indicators informed by recent assessments by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). The goals reflect major desired outcomes, such as halting anthropogenic species extinctions; the associated targets correspond to categories of conservation actions (e.g.,

protection of 30% of land and waters, the "30x30" target) that address major drivers of biodiversity loss. The GBF's indicators are designed to track biodiversity status and better understand the effectiveness of conservation actions and linkages between drivers of biodiversity loss (Leadley et al., 2022).

As the only nation besides the Vatican that is not a party to the CBD, the US has lacked the impetus that formal treaty commitments provide for development of national biodiversity assessments and associated indicators. The current (Biden) administration has participated as an observer in CBD meetings and endorsed CBD-related goals as part of the High Ambition Coalition for People and Nature (UNEP, 2020). However, even supportive administrations are aware that political opposition to assessments that could lead to conservation actions on public and private lands has been an enduring theme of US politics, and that such action is often demonized as originating from international mandates (Weiss, 2022).

Two examples demonstrate the relevance of this political context to the NNA. In 1994, the Clinton administration formed a new agency, the National Biological Survey (NBS), designed to provide decisionmakers and the public with biodiversity-related information (Pulliam, 1998)(Fig. 1). The NBS's creation unfortunately coincided with a rise in influence of so-called "wise use" groups that misconstrued the "survey" name as an indication that the agency planned to trespass on private property to gather information (e.g., on presence of threatened species) to support government restrictions on land use. As a result of this political opposition along with resistance within existing agencies, the NBS was renamed and ultimately merged into the US Geological Survey, leaving much of its original mandate unfulfilled (Pulliam, 1998). The long hiatus in US national biodiversity assessments over the last two decades (Fig. 1) is in part due to this loss.

The GBF's Target 3 commits nations to conserving 30% of land and marine areas by 2030 (CBD, 2022). The US administration recently endorsed the 30x30 target via Executive Order (White House, 2021) and as part of membership in the High Ambition Coalition for People and Nature (UNEP, 2020). However, the target is already being attacked as both a federal government "land grab" and part of an international conspiracy (Weiss, 2022). In response, the administration has re-named its 30x30 initiative as "America the Beautiful" and avoided any mention of the global context in its reporting on the initiative (USDOI, 2021). The NNA has recently begun to be attacked in the same manner as was the NBS and 30x30 (Weiss, 2022). Caught between a desire to fulfill long-sought proposals for a national assessment and minimize political blowback, the US national administration has downplayed the nexus between its international commitments and national biodiversity policy.

This less-than-coherent posture towards global biodiversity science-policy processes comes at a cost. A major potential advantage to the timing of the current NNA initiative as compared to previous US biodiversity assessments is that the NNA can make use of guidance coming out of recent global processes (Fig. 1, 2). One of the major advances of the GBF over previous CBD agreements is its emphasis on monitoring and assessment via National Ecosystem Assessments and National Reports (UNEP-WCMC, 2021)(Fig. 2). The effectiveness of the NNA will be weakened if it does not take full advantage of this global guidance due to political concerns. For example, scientific organizations have proposed a set of Essential Biodiversity Variables for use in assessments (Pereira et al., 2013), and many of these have been adopted as "headline" indicators in the GBF (CBD, 2022). The NNA would ideally include a subset of these indicators to ensure that the US assessment can both support and make use of data from global efforts (Xu et al., 2021). The use of globally standardized biodiversity datasets, such as Key Biodiversity Areas and the IUCN Red Lists, would also facilitate these linkages (Keith et al., 2015; Smith et al., 2019).

The NNA's planners are already focused on the need to maximize policy relevance and management applicability for key subnational audiences, including state, municipal, and tribal governments, in part by ensuring the scoping phase of the assessment elicits relevant information from these potential users (OSTP, 2022). Support and uptake of the national climate assessments has been successively enhanced by an increasing emphasis on detailed regional and sectoral assessments which have strengthened the rationale for how national assessments augment the value of global analyses (Wuebbles et al., 2017).

Although the US is not a CBD party, US subnational governments such as the state of California have participated in CBD meetings and have developed assessments and policies reflecting the global framework and targets including 30x30 (CNRA, 2022). Even in states that are not CBD participants, State Wildlife Action Plans provide a subnational approach to biodiversity assessment and conservation priority setting, which in many states has recently broadened beyond vertebrate taxa to include invertebrate groups and plants (Meretsky et al., 2012). Such subnational programs increase local support and allow the assessment process to be adapted to different biogeographic and political settings, but can be challenging to synthesize into a consistent national assessment (Stein et al., 2000).

Place-based conservation actions are a critical facet of strategies to protect most elements of biodiversity (Carroll & Noss, 2021). The GBF's Target 1 commits nations to an expansion of biodiversity-focused spatial planning processes (CBD, 2022). Mapped data on priority habitats and ecosystems for conservation and restoration should be a key element of the NNA so that the status of biodiversity elements (species, ecosystems) can be linked to the status (e.g., landcover, management) of and threats to specific sites and landscapes (Jetz et al., 2022). The NNA could summarize these spatial data to evaluate the potential role of public and private lands in conservation of different taxa, and the potential of different areas to support ecosystem-based

carbon mitigation, building on ongoing work such as the Natural Capital database and mapping of ecosystem carbon and old-growth and mature forest on US federal forestlands (Vilsack, 2022).

Incorporation of spatial data will also make the NNA more useful in supporting 30x30 efforts at national and subnational levels by helping assess not only the amount of area conserved, but also resulting conservation impact (CNRA, 2022). The availability of a non-proprietary portal that allows access to multiple biodiversity databases could be an important benefit stemming from the NNA, building on proposals for open-data initiatives linked to national ecosystem services assessment (EcoINFORMA; PCAST 2011), or the model of national biodiversity data hubs being developed in other nations (Schulman et al., 2021).

Coordinating biodiversity assessment and policy among international, national, and subnational levels is a challenge both within the US and for other nations. In many nations, spatial planning decisions are primarily made at a local and subnational level, creating a tension with what may be perceived as "top-down" national and global commitments (Carroll et al., 2022). Successfully linking assessment processes at the global, national, and subnational levels can help bridge the gap between research and applications build a more robust "network of networks" of scientists and practitioners (Ruckelshaus et al., 2019).

Enhancing policy relevance and enabling independent review

Although the NNA is not in itself a policy document, it must be designed to effectively inform subsequent biodiversity policy development. Global climate assessments such as the IPCC reports address this science-policy distinction by including multiple contrasting scenarios or socioeconomic pathways to explore the impacts of alternate policies without being prescriptive (IPCC, 2014). IPCC and IPBES reports also always include a "Summary for Policymakers" that presents a distillation of technical information in the context of key policy questions. Similarly, CBD guidance on development

of national assessments states that they should provide a critical synthesis of knowledge framed around key policy questions (UNEP-WCMC, 2021).

Recent reports from IPBES and CBD have emphasized that, in addition to summarizing status and trends of biodiversity itself, it is essential to include within biodiversity assessments data tracking direct and indirect drivers of biodiversity loss (IPBES, 2019; CBD, 2022). Similarly, IPCC Working Group reports begin by examining the physical science of climate change, followed by information on climate impacts and adaptation, and finally pathways for climate mitigation, i.e., the relative feasibility and effectiveness of alternative pathways to emissions reduction via economic and policy changes (IPCC, 2014).

To date, the US National Climate Assessments have primarily focused on the physical science of climate change and its impacts, analogous to the first two of the three IPCC reports, with limited discussion of the topic of reducing risks through emissions mitigation. To be effective, the NNA should follow the IPCC and IPBES models by incorporating detailed information on pathways for reversing biodiversity loss and restoring ecosystem function. The NNA should include analysis of patterns and trends in direct drivers (e.g., landuse and climate change, pollution, overexploitation, invasive species) and indirect drivers (e.g., demographic processes such as urbanization, economic policies that disincentivize conservation actions) of loss of biodiversity and ecosystem services (IPBES, 2019). Such analysis will also allow the NNA to better support parallel assessments of biodiversity impacts by the financial and business community (e.g., nature-related financial disclosures and risk reporting (CBD, 2022; OSTP, 2022).

The GBF, unlike previous CBD agreements, takes a lesson from climate accords in incorporating a “present, review, ratchet” mechanism that supports periodic stocktaking and ratcheting up of ambition in response to any identified shortfalls (CBD, 2022). There is an inevitable

temptation for government-led assessments to celebrate successes rather than publicize shortfalls in policy or implementation. Previous studies have found that a robust independent review process is an essential element in successful assessments (NRC, 2007), and recent reviews have also noted the importance of independent auditing and validation of progress towards biodiversity targets (Watson et al., 2021). The NNA could benefit from involvement of the National Research Council (e.g., via a dedicated standing committee) and professional scientific societies in biodiversity-related fields as a source of expertise in both planning and review of the assessment.

Several alternative models for such review have also been proposed or developed in other nations. Canada's environment minister recently proposed that a new law should establish and support periodic reviews of national progress and shortfalls in reversing biodiversity loss by an expert advisory body, analogous to the system in place for Canada's international climate commitments (Geselbracht and Hazell, 2021). The Australian government recently funded an independent Biodiversity Council (https://biodiversitycouncil.org.au/) to apply scientific expertise to assess the adequacy of current biodiversity policy. Ireland's government used a more inclusive model in 2022 when it convened a Citizens' Assembly on Biodiversity Loss (www.citizensassembly.ie/en/assembly-on-biodiversity-loss/) drawn from the general population to advise on biodiversity policy solutions. Whatever the model used, it is clear that as Ruckelshaus et al. (2020) concluded, "effective scaling of science-policy efforts, driven by global and national assessments…will require unprecedented commitment by scientists to engage with communities of policy and practice". The national nature assessment process entails development of not only an information resource but also a vehicle for broader engagement of researchers, practitioners, and society with strategies for reversing biodiversity loss.

Conclusion

Both the National Climate and Nature Assessments play a dual role in providing "a means for connecting the scientific and management communities" and "a more general educational resource about what's at stake for society" as a result of climate change and biodiversity loss, respectively (Wuebbles et al., 2017). At the global scale, recent IPBES reports and other research supporting development of the CBD COP15 agreements have led to substantial advances in knowledge regarding patterns of biodiversity and interlinked drivers of biodiversity loss (Leadley et al., 2022). The first NNA provides a similar opportunity to advance the linkage between conservation research and practice by stimulating and coordinating efforts to develop an analogous understanding at national and subnational extents.

The field of biodiversity research is also chronically underfunded; the NNA can help identify priorities for filling key data gaps within existing biodiversity inventories and invest in long-term infrastructure to maintain and provide access to biodiversity data (OSTP, 2022; Schulman et al., 2021). In coordination with related efforts such as the American the Beautiful (30x30) initiative's Conservation and Stewardship Atlas (USDOI, 2021), the NNA can support spatial planning for biodiversity conservation and climate solutions, both within land management agencies' regional assessments and at smaller extents, helping ensure that proposed nature-based climate solutions do not undermine biodiversity goals (Lubchenco et al., 2022; Carroll et al., 2022; CEQ, 2022).

The NNA's second and equally important role is to broadly communicate "what's at stake" if loss of nature continues unabated. The NCA has had served as an authoritative summary of climate change and its impacts; the NNA's government imprimatur similarly has the potential to elevate understanding of the importance of biodiversity loss in the wider arena of public opinion and the

media. In a promising sign, the US recently enacted substantive climate legislation (the Inflation Reduction Act of 2022) after decades of failed proposals. If the evolution of US biodiversity policy is analogous to climate policy, increased momentum for addressing the biodiversity crisis will allow the NNA to succeed where previous assessment efforts such as the NBS have fallen short. This context underscores the importance of developing the NNA through an inclusive process that clearly communicates the assessment's value to the public via a diversity of channels that are accessible to non-specialists (Table 2). Such broad-based engagement by the scientific community and civil society is also necessary to ensure continued support for the NNA under future administrations.

A recent joint statement by chief science advisors from dozens of countries (including the US) attending the COP15 meeting highlighted the universality of the challenges describe above: weaving together information from diverse knowledge and valuation systems, across scales of biological organization from genes to ecosystems, and across spatial scales from local to global (Office of the Chief Science Advisor, 2022). Each of the challenges we highlight in regard to the NNA (Table 2) will also be relevant globally as nations develop assessments and reporting to support the measuring progress towards commitments made at COP15 (CBD, 2022). Although the political context for national biodiversity assessments will differ among nations, the need for creative and inclusive outreach and communication that empower locally led conservation efforts is universal. Building on a comprehensive assessment of biodiversity to incorporate the diverse ways in which society values and benefits from nature (IPBES, 2022) is a key step in developing the broad-based support necessary to secure transformative change in humanity's relationship to the natural world.

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FIGURE LEGENDS

Figure 1. Timeline of development of biodiversity assessments that serve as precursors to the US National Nature Assessment both within the US and internationally, as well as the policy initiatives that impelled development of the assessments. Two milestones for climate-related assessments are included for context. See reference section for full citations for assessment reports, including Noss et al., (1995)'s *Endangered Ecosystems of the US*, Mac et al., (1998)'s *Status and Trends of the Nation's Biological Resources*, Stein et al., (2000)'s *Precious Heritage: the Status of Biodiversity in the United States*, and Heinz Center (2008)'s *State of the Nation's Ecosystems*.

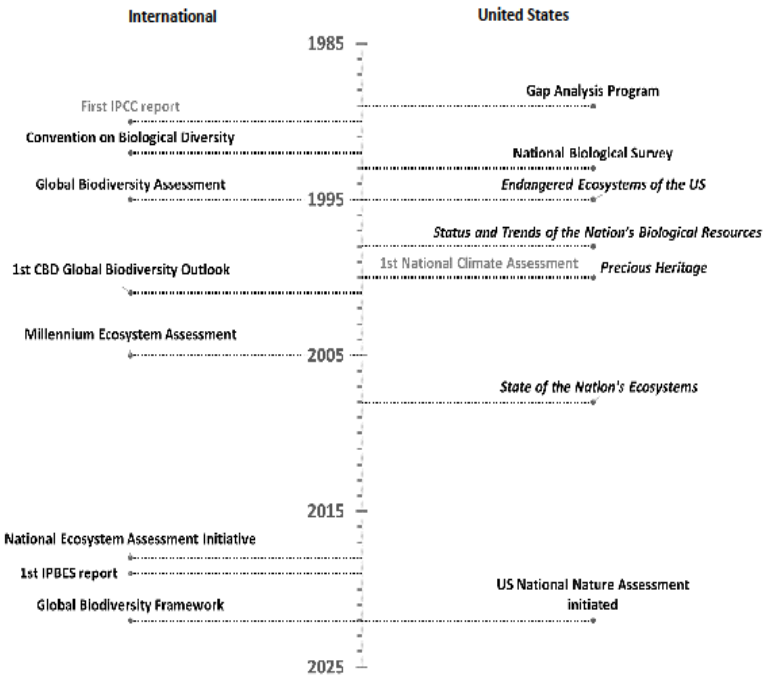

Figure 2. Diagram of (a) linkages between biodiversity assessments at national, subnational, and global scales (shown in grey), with policy processes (CBD) and agreements (GBF) informed by such assessments shown in white. Analogous climate assessments and policy processes are shown in (b). Note that while some linkages (such as those between the CBD, GBF, and NBSAPs, or between the IPCC, UNFCCC, and NDCs) are well established (solid arrows), other linkages (such as between science products at various scales) are still poorly defined (dashed arrows), especially for the US, which is a member of IPBES but not a formal party to the CBD. Acronyms used are here and in text are as follows CBD, Convention on Biological Diversity; GBF, Global Biodiversity Framework; IPBES, Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services; IPCC, Intergovernmental Panel on Climate Change; NBSAP, National Biodiversity Strategy and Action Plan; NCA, National Climate Assessment; NDC, Nationally Determined Contribution; NEA, National Ecosystem Assessment; NR, National Report; UNFCCC, United Nations Framework Convention on Climate Change. See also Ruckelshaus et al. (2020) for a detailed depiction of similar linkages.

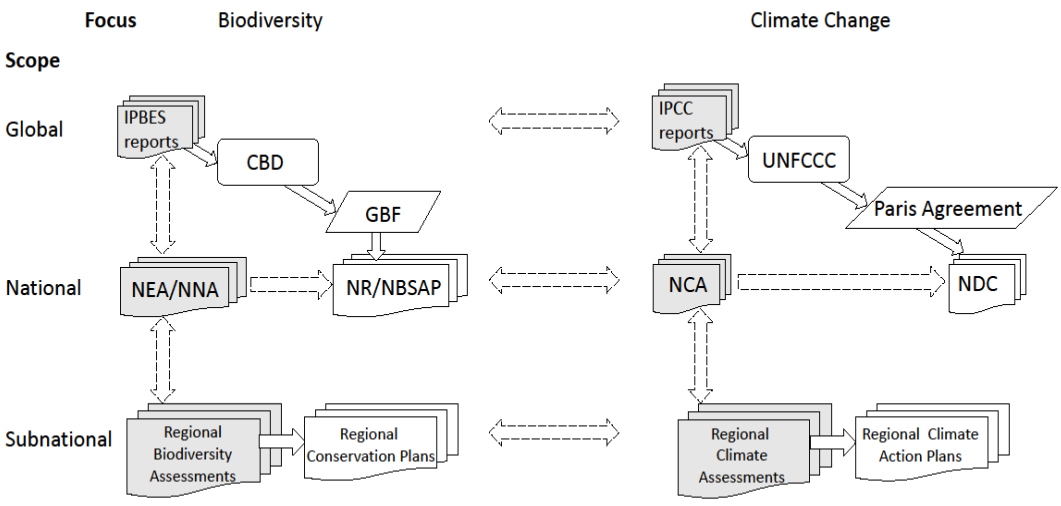

Table 1. Ten suggested elements of an effective national nature assessment.

Content

1. Learn from the strengths and limitations of previous assessments

2. Create a comprehensive summary of status and trends at multiple levels of biodiversity

3. Synthesize data on drivers of biodiversity loss and pathways to their mitigation

4. Link place-based and element-based data

5. Ensure policy-relevant design

Process

6. Ensure broad involvement to overcome organizational barriers

7. Enhance continuity and comparability between successive assessments

8. Prioritize data accessibility

9. Ensure inclusivity in process and product

10. Anticipate and address misrepresentation of assessment goals

Table 2. Key questions and challenges in the design of a national nature assessment.

1. How can a national assessment inform and be informed by assessments at global and subnational scales?

2. How can interactions between trends across multiple levels of biodiversity (ecosystems, species, genetic diversity) be understood and communicated?

3. How can information based on disparate forms of valuation of the natural world (biodiversity, ecosystem services, etc.) be assembled into a coherent synthesis?

4. How can an assessment meet the information needs of specific audiences and agencies while also retaining generality and relevance for the broader public?

5. How can an assessment best meet expectations for an authoritative government science product while also benefiting from an inclusive process and a diversity of perspectives?

6. How can independent review of the assessment and auditing of subsequent progress towards stemming biodiversity loss be organized and supported?

7. How does a national assessment fit within the broader context of science communication and dialogue concerning societal valuation of the natural world?