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Forum

Agreeing that maps can disagree: Moving away from map confusion in conservation

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Abstract

Deciding where to implement actions for biodiversity conservation remains challenging for many reasons, including the increase in maps aimed at prioritizing locations for conservation efforts. Although a growing numbers of maps can create the perception of uncertainty and competing science, a shared set of principles underlie many mapping initiatives. We overlaid the priority areas identified by a subset of maps to assess the extent to which they agree. The comparison suggests that when maps are used without understanding their origin, confusion seems justified: The union of all maps covers 73% of the contiguous United States, whereas the intersection of all maps is at least 3.5%. Our findings support the need to place a strong focus on the principles and premises underpinning the maps and the end users' intentions. We recommend developing a science-based guidance to aid scientists, policymakers, and managers in selecting and applying maps for supporting on-the-ground decisions addressing biodiversity loss and its interconnected crises.

Deciding where to focus limited resources aimed at conserving biodiversity remains a challenge for conservationists and environmental policymakers. With improved technologies, the availability of geospatial data and prioritization methods has increased, leading to more maps representing important locations for conservation actions. As of 2023, numerous assessments prioritize national and global biodiversity (e.g., Pouzols et al. 2014, Jenkins et al. 2015, Belote et al. 2021, Jung et al. 2021, Hamilton et al. 2022), connectivity (Belote et al. 2016, Carroll et al. 2018, Brennan et al. 2022), or multiple values (Belote et al. 2017, Lawler et al. 2020, Dreiss and Malcom 2022), including those supporting climate adaptation (Michalak et al. 2018, Dreiss et al. 2022, Anderson et al. 2023). Although these spatial assessments represent the best available science, growing numbers of maps create the perception of uncertainty, confusion, and competing science. Different organizations developing different maps reflecting different scales, different values, and different purposes leave decision-makers asking, "Which map do I use?" Even for the experienced user, map titles, legends, and metadata don't make explicit whether and which maps are appropriate for the intended use, why they were created, and how they should be used to inform what kind of conservation-related decisions. A growing set of available maps could fuel a growing problem in conservation: misguided or confused "strategic" prioritization of limited conservation resources.

Ongoing efforts to support global and national conservation initiatives exemplify the challenge of perceived map confusion. Area-based targets such as conservation of at least 30% of Earth's land and waters by 2030 (30×30; Dinerstein et al. 2019) are meant to be an initial step in addressing biodiversity loss and inseparable issues of climate change and nature equity (2050 Vision for Biodiversity; Secretariat of the Convention on Biological Diversity 2022), but currently don't identify which 30%. Similar goals are embedded in the Biden Administration's Conserving and Restoring America the Beautiful (USDOI et al. 2021). With this initiative, US government agencies have been motivated to invest in land conservation and nongovernmental organization and academic partners have been energized to add to the wealth of maps and data intended to inform the relatively open question of where to invest. There is general consensus that decisions related to where to invest are closely tied to achieving both numerical targets and substantive conservation goals, signifying the potential importance of map selection.

Despite perceptions of uncertainty, a shared set of conservation principles serve as the foundation of many mapping initiatives. These principles have generally been the cornerstone of conservation planning and can be identified on the basis of conservation objectives or associated community values. Focusing on these principles and premises can help clarify the commonalities, agreement, and important differences between these maps before users get lost in the variation created by data set choice, scale, and extent. In addition, these principles rely on a set of assumptions or premises that can help to clarify the benefits and challenges to using or interpreting resulting maps and should help define appropriate usage. In our experience, conservation practitioners generally focus on available maps and ignore the questions, principles, and premises underpinning the spatial assessments. Clear guidance is lacking for how practitioners can connect multiple maps to their planning needs at all scales from national to local planning. Science will continue to produce maps, but it can also set the foundation for more cohesive thinking about what maps are being used and why. More specifically, principles from conservation science can offer a framework to guide purposeful selection and application of maps and improve strategic conservation planning at multiple scales. A science-guided approach can be critical for achieving, measuring, communicating, and

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informing biodiversity conservation success, especially as government agencies are tasked with prioritizing places, allocating resources, implementing actions, and tracking conservation progress.

As spatial ecologists, we work to integrate the best available science into programs of our conservation organizations. Although the missions of these organizations differ, we often address similar conservation issues and use many of the same principles to guide our work. Addressing three interconnected crises—biodiversity loss, climate change, and inequitable access to nature—is the ultimate goal, but we recognize that this will require a larger conversation with a broader segment of the conservation community. Our shared experience and expertise allow us to speak most proficiently to biodiversity conservation. In the present article, we describe shared conservation principles to address biodiversity loss and conduct a simple spatial analysis to highlight the importance of focusing on premises of spatial assessments when comparing maps. Our aim is to demonstrate the potential challenge or confusion and the ultimate need for a clear guidance founded on shared conservation science principles. We use this forum as a starting point for a more comprehensive guide for connecting maps and underlying science with planning needs, focusing on mapping initiatives to address biodiversity loss.

Prioritization mapping exercise

Conservation science principles should serve as the foundation for planning efforts aimed at conserving biodiversity regardless of scale. To illustrate the use of shared principles and the abundance of considerations made in map selection, we identify two commonly mapped principles in biodiversity conservation planning and a subset of the approaches used to map them. We focus on those that directly link to objectives set by the post-2020 Global Biodiversity Framework. Target 3 addresses the global 30×30 objective: to "ensure and enable that, by 2030, at least 30% of terrestrial, inland water, and coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem functions and services, is effectively conserved and managed through ecologically representative, well-connected and equitably governed systems of protected areas and other effective area-based conservation measures."

At least two important principles for biodiversity conservation are captured in this target: representation and connectivity. We use these two widely shared and commonly mapped principles for the general purpose of deepening an understanding of the perceived confusion associated with available data sets for identifying areas in need of conservation action. For each principle, we selected four maps used by the authors in their conservation analyses (total of eight maps; table 1). We discuss these key principles, mapping approaches, and their associated premises below.

Area-based targets such as the conservation of at least 30% of Earth's land and waters by 2030 (30×30) are meant to be an initial step in addressing biodiversity loss, but the targets do not currently address the crucial questions of which lands and waters should be included in the conserved 30% of the country. For each principle above (i.e., representation and connectivity), we identified four maps that share the following characteristics: They were published in peer-reviewed journals, they cover at least the contiguous United States, their resolution is less than or equal to 1 kilometer, and they were developed or used by the authors for the general purpose of deepening an understanding of conservation needs for 30×30 contextualized by respective organizational values. As such, the data sets or methods used in map development were generally selected to highlight organizational interests and maximize specific conservation values. For example, Defenders of Wildlife (DOW) commonly uses imperiled species richness data sets, which is closely tied to the organization's focus on protecting and recovering imperiled species and habitats. Similarly, The National Audubon Society (NAS) makes map selections to help further its goal to protect birds and the places they need, today and tomorrow; The Nature Conservancy (TNC) does the same for conserving the lands and waters on which all life depends, and The Wilderness Society (TWS) does so for uniting people to protect America's wild places.

For each data set, we selected the top 30% of the country on the basis of the distribution of values (e.g., locations with greater species richness). The result is four different maps identifying the 30% of the country that should be prioritized for conservation under 30 × 30 efforts. We then assessed areas of agreement among maps by overlaying the top-ranked 30% of pixels, indicating where one, two, three, and all four methods placed a pixel into the top 30% of priorities. We calculated the proportion of the contiguous United States that fell within overlapping 30% priorities. We report on how much of the contiguous United States is identified as a priority by all (i.e., the intersection of the maps) or by one or more of the mapping approaches (i.e., the union of the maps). We did this for maps within a principle to describe shared areas of overlap or explaining major dissimilarities in resulting priority areas.

Representation

Sustaining biodiversity is a key goal of conservation. Knowing which species are currently in conserved areas—and which are not—is critical to implementing actions in the right places to ensure that all species are *represented* in a conservation plan. Although all levels of biodiversity are important to maintain (from genes to landscapes), most spatial conservation planning is focused on species diversity. The recorded locations of observed species allow scientists to model and map suitable habitat for many species, most commonly terrestrial vertebrates (i.e., mammals, birds, amphibians, and reptiles). However, there are many ways of combining suitable habitat maps together to represent and quantify biodiversity at a location. The result is that there are a number of available maps of biodiversity priorities. Some include different numbers of species representing different taxonomic groups and are based on different methods. One should be very clear about what biodiversity priority maps are being used.

Maps of species richness (i.e., the number of species in a location) alone are useful for understanding where ranges or suitable habitats of the most species overlap and for evaluating coarse patterns of the relationship between protected areas and biodiversity. Measures of raw species richness assume that all species are equally distinct and equally important to ecosystem functioning, proving potentially limited in reflecting many primary goals of conserving biodiversity (e.g., sustaining ecosystem services and resilient populations).

Our respective organizations all used different methods for combining suitable habitat maps together to represent and quantify biodiversity at a location. DOW used maps of rarity-weighted richness (Hamilton et al. 2022) to account for species endemism and threat, assuming that range-restricted species are more vulnerable. This approach can be well suited for identifying hotspots of at-risk species and focusing resources on preventing extinction to conserve the nation's biodiversity (Stein et al. 2000, Jenkins et al. 2015, Hamilton et al. 2022). With this, the user

Table 1a. A list of data sets that were used in the mapping exercise to compare and contrast the locations of the top 30% priority pixels for two common conservation principles; biodiversity representation is shown in the table.

Organization	Source Data set	Objective	Process	Premise
DOW	Dreiss et al. 2022	Conserve areas where the most imperiled species are present.	Rarity-weighted richness	Range-restricted species are vulnerable, fewer options for conservation, higher risk of extinction, overlap important for sustaining biodiversity
NAS	Taylor et al. 2022	Conserve areas that serve to benefit the most bird species today and under climate change.	Stratified optimization of species data	Birds are a diverse and broadly distributed taxonomic group and representative of all species, climate change will alter future species distributions, accounting for places that are both important today and under climate change will provide continuity in conservation.
TNC	Anderson et al. 2023	Conserve places recognized for their current biodiversity value to protect thriving communities and provide source areas for dispersing populations.	Compile data from 104 published assessments representing two main sources: TNC ecoregional assessments and state wildlife action plans	State or ecoregion-based areas of importance serve as quality examples of natural communities, intact habitats or vulnerable species populations, are supported by local politics and economies for more durable conservation
TWS	Belote et al. 2021	Conserve a set of lands that maximizes the total number of vertebrate species represented.	Optimization of habitat suitability	All species are equally important and identifying sites that most efficiently represent all species are priorities for biodiversity

The data sets are associated with an author-affiliated environmental nongovernmental organization—Defenders of Wildlife (DOW), National Audubon Society (NAS), The Nature Conservancy (TNC), The Wilderness Society (TWS)—that developed or used them recently in peer-reviewed science, as well as in guiding the work of the organization. The general method or process used to develop the data set and the premises underlying its use are described.

Table 1b. A list of data sets that were used in the mapping exercise to compare and contrast the locations of the top 30% priority pixels for two common conservation principles; landscape connectivity is shown in the table.

Organization	Source data set	Objective	Process	Premise
DOW	Carroll et al. 2018	Conserve areas connecting current climate types and future analogs to facilitate movement	Passage density or centrality	Species will need to move from current locations to where the climatic conditions they currently inhabit will be in the future—while avoiding areas of human modification.
NAS	DeLuca et al. 2023	Conserve important landscapes for North American migratory birds across their full annual cycle.	Stratified optimization of species data	Migratory birds need a connected network of high-quality habitat to complete their full annual cycles. Often these networks span hemispheres and include a diverse array of habitats.
TNC	Anderson et al. 2023	Conserve connected corridors and zones of natural cover that follow climatic gradients to facilitate movement with changing climate.	Omnidirectional circuit model	Species need to move, human modification impedes movement, concentrations of potential ecological flow along climatic gradients will allow species to disperse in newly suitable habitat now within their climatic envelopes
TWS	Belote et al. 2016	Conserve the most “natural” corridors between large protected areas.	Least cost paths between cores	Species need to move, human modification impedes movement, corridors between protected areas are an important part of a regional conservation plan

The data sets are associated with an author-affiliated environmental nongovernmental organization—Defenders of Wildlife (DOW), National Audubon Society (NAS), The Nature Conservancy (TNC), The Wilderness Society (TWS)—that developed or used them recently in peer-reviewed science, as well as in guiding the work of the organization. The general method or process used to develop the data set and the premises underlying its use are described.

assumes that range-restricted species are more vulnerable to extinction, and given their restrictions, they have fewer options for conservation solutions.

Richness and weighted richness maps will likely fail to identify range-limited species that don't occur in species-rich areas (e.g., the black-footed ferret). A complementarity-based method, such as that used by TWS (Belote et al. 2021) works to maximize the number of species conserved across all sites (Sarkar 2012, Belote et al. 2021). This approach assures that species will be efficiently represented and that no species will be missed. As with raw species richness, all species are assumed to be equally important.

Both DOW's and TWS's approaches are focused on where species are currently found. If conservation goals include consideration of climate-driven shifts in species ranges for future-forward outcomes, planners might consider the approach used by NAS (Taylor et al. 2022), which incorporates climate vulnerability but is focused on a single taxonomic group (birds). However, there are many groups of species for which we have no national inventory of suitable habitat (Anderson and Ferree 2010, Hjort et al. 2015, Carroll et al. 2017). Coarse-scale approaches have been proposed to identify and map ecosystem-level (Aycrigg et al. 2013, Dietz et al. 2015) and geophysical diversity (Anderson and Ferree 2010). Because species diversity is strongly governed by parent material of soils, soil types, topographic settings, latitude, and elevation, scientists suggest that protecting the variety of geophysical conditions is an important proxy for conserving all species in the face of a changing climate. Rather than use species habitat suitability maps, spatial information representing broad vegetation (or ecosystem) groups and geophysical conditions are used. Ecoregions in particular have been a widely used ecological classification system for conservation planning.

Another way to ensure that all ecosystems, ecoregions, or other ecologically important spatial units are represented is to stratify conservation values by those units. By identifying the highest value places within geographical strata, an analyst is assured that some places in every ecoregion, for instance, will be identified as important and will therefore be represented in a broader-scale assessment. Taking additional steps to stratify can aid decision-makers working at multiple scales and may ultimately help increase representation of the unique species assemblages and services they harbor in conservation plans. TNC focused on representing the full spectrum of US habitats and species by targeting places in each of 68 ecoregions (and 38 state wildlife action plans) that are recognized for supporting rare or specialized species and characteristic communities. Representing biodiversity value was one step in a larger goal to identify a network of sites part of well-connected microclimates and recognized for their intact habitats, exemplary natural communities, or viable rare species population.

The areas where all four priority maps intersect cover 3.5% of the contiguous United States. The southern regions tended to have more overlap in higher biodiversity values, including Appalachia, the Ozarks, the Florida panhandle, central Texas, the California coast, and the Sierra Nevada basin. However, overlap also occurs in some northern regions, such as the northern cascades (figure 1).

Over 73% of the contiguous United States was included in the union of the four maps. TNC's map had relatively less coincidence with the others, given its general goals of achieving biodiversity representation at multiple scales and region types. This approach resulted in additional representation in all states and ecoregions. NAS grouped their bird data to achieve a similar stratified approach and to ensure representation of a biogeographical units. This generally led to additions in eastern states. TWS and DOW assessed the national distribution of values, but species richness approaches reflected different taxonomic representation and methodologies; a complementarity-based approach (TWS) led to additional concentration along the southern border, and a rarity-weighted prioritization (DOW) added to the southeast.

Connectivity

Connectivity is a measure of the relative ease with which species can move through the landscape. It can be structural (i.e., focusing on continuity of landscape elements such as forest patches that are independent of species ecology) or functional (i.e., focused on landscape features that facilitate or impede species movement between habitat patches; Taylor et al. 2006). Conserving unimpeded pathways for movement is essential to maintain biodiversity now and into the future.

Connectivity between two points is often evaluated by assigning local features (e.g., roads, powerlines) and land covers (e.g., agriculture, industrial forest) a number reflecting its relative resistance to the movement of species. Connectivity methods can be focused on delineating paths between source and target areas or evaluate paths between pairwise combinations of sites (i.e., centrality). Conservation priorities will depend on the method and strategy. For example, areas where large quantities of connectivity and flow occur may be important in maintaining because they serve as a critical pinch point in a more fragmented landscape. However, more intact landscapes with diffuse flow may be priorities for preventing fragmentation.

Many conservation scientists recommend conserving a connected network of protected areas or sites to maintain biodiversity (Rudnick et al. 2012). Maps of important corridors or connectivity zones have been developed under a variety of assumptions. For example, TWS's map identifies the least human-modified places between protected areas, relying on the assumption that human modification (*sensu* Theobald 2013) to landscapes impedes movement (Belote et al. 2016). However, not all national connectivity maps are species agnostic. NAS focused on identifying locations of high conservation value for North American breeding birds across their full annual cycle to highlight areas that are either important to many species or may be vital to a few species not captured elsewhere (DeLuca et al. 2023).

The spatial configuration of natural lands can also facilitate or impede species' ability to track their optimal climatic conditions under climate change scenarios. Some efforts to identify climate connectivity areas are based on current climate or environmental characteristics. For example, TNC's map identifies connected corridors and areas with environmental characteristics that can facilitate movement as individuals disperse to take advantage of the diversity of microclimates (Anderson et al. 2023). Others, such as that used by DOW, connect current patches projected to be climatically similar under future conditions (McGuire et al. 2016, Littlefield et al. 2017, Carroll et al. 2018), focusing on conserving places where species may need to move to on longer timescales.

Less than 2% of the contiguous United States fell at the intersection of all four connectivity mapping approaches. The western regions tended to have more overlap in higher connectivity values, including the Northern Cascades, the Idaho panhandle, the central Rockies, and Colorado plateau regions. However, overlap also occurs in some eastern regions, such as the Ozarks, Appalachia, and up into northern New England (figure 2).

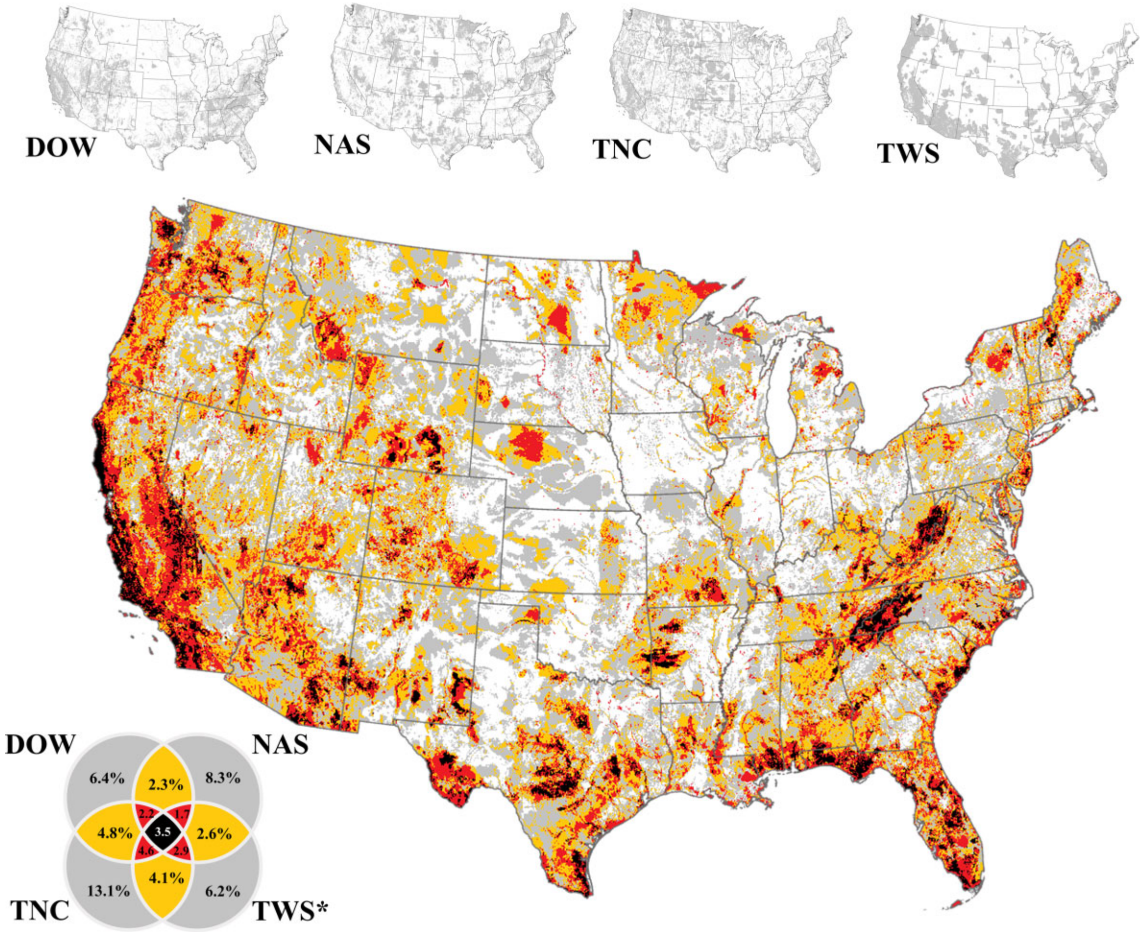

Figure 1. Areas of agreement among biodiversity representation maps. The top-ranked 30% of pixels from four different mapping approaches (Belote et al. 2021, Dreiss et al. 2022, Taylor et al. 2022, Anderson et al. 2023) were overlaid to quantify the extent of overlap between them. We first reclassified the maps to identify the top-ranked 30% of pixels for each. The smaller maps show the top 30% of pixels for each method separately. We then overlaid these maps to show where one, two, three, and all four methods placed a pixel into the top 30% of priorities. The percentage of the contiguous United States covered by each overlay combination is included in the Venn diagram in the legend. The areas in white were not in the top-ranked 30% of pixels for any map. Combinations not shown in the legend are the coincidence between TNC and NAS (6.2%), the coincidence between DOW and TWS (4.2%), and the percentage of the contiguous United States that is not prioritized by any method (26.9%).

Again, near 73% of the contiguous United States fell into the union of all four maps. For key differences in data sets (in gray), connecting climate analogs (DOW) highlighted large areas of the Great Plains that would have otherwise been underrepresented. The relationship of climatic variables to elevation suggested that protecting these areas might imply a conservation focus on different elevational zones and might pick up valley bottoms that might otherwise be missed (Carroll et al. 2018). A focus on bird communities (NAS) brought attention to the Prairie Pothole Region for its importance to the waterbird communities and the northern mid-Atlantic region for breeding eastern forest bird communities. TNC's ecoregional approach to connecting natural land cover tended to concentrate in stream corridors following natural land cover in riparian areas, particularly in the Southeast.

When maps disagree

We demonstrate that confusion on the part of the map user is partially justified: In comparing four data sets related to a common conservation principle (connectivity or representation), we found that they are all in agreement on priority areas for investment at least 3.5% of the time. For any single principle, the combined data sets cover 73% of the contiguous United States (the non-white areas), whereas the proportion of the contiguous United States that falls in areas where all four data sets agree (i.e., full coincidence) is relatively small (1.8%–3.5% of the contiguous United States; figures 1 and 2). Coincidence for biodiversity representation was generally higher, but this difference was minor. However, we also illustrate the importance of using scientific premises as a guide: Although the conservation principles were shared among the maps, different objectives defined the use of particular data sets and analyses, which led to the identification of different priority areas. Perhaps it shouldn't be a surprise that different conservation questions led to different maps. For example, the greatest coincidence in connectivity priorities occurred between the two data sets connecting natural landscapes (TNC and TWS). Others were focused on either connecting climate analogs or areas of high migratory bird conservation value, all three being very different but important components to achieving connectivity for biodiversity conservation overall. Even so, coincidence between TNC and TWS was still low, likely due to another key underlying component: scale. TNC's data were relativized within geophysical settings and ecoregions, rather than scaling data from the national distribution of values. This exemplifies one of the key challenges to spatial conservation planning: incorporating multiple scales of information. Incorporating data from multiple spatial scales and

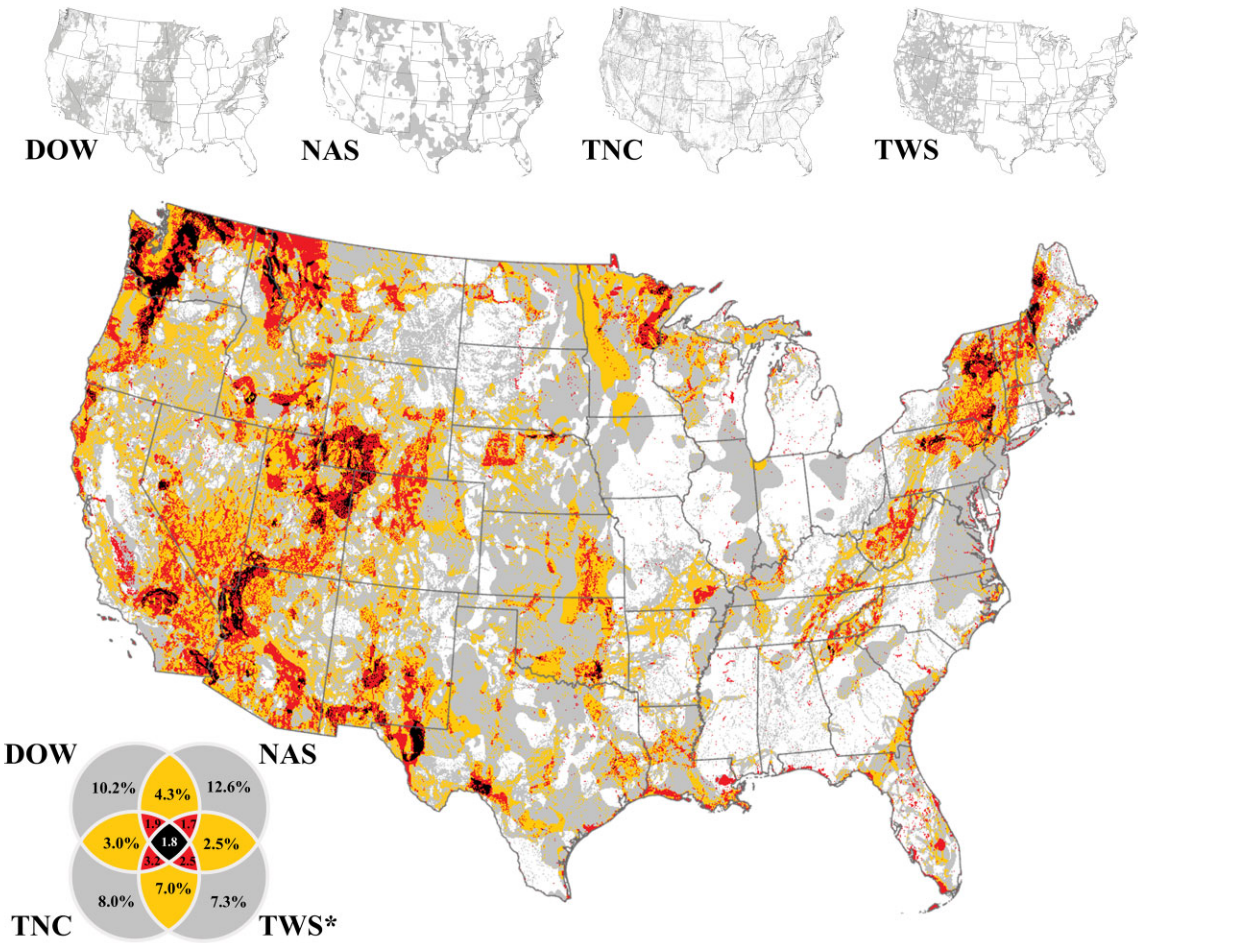

Figure 2. Areas of agreement among landscape connectivity maps. The top-ranked 30% of pixels from four different mapping approaches (Belote et al. 2016, Carroll et al. 2018, Anderson et al. 2023, DeLuca et al. 2023) were overlaid to quantify the extent of overlap between them. We first reclassified the maps to identify the top-ranked 30% pixel for each. Smaller maps show the top 30% of pixels for each method separately. We then overlaid these maps to show where one, two, three, and all four methods placed a pixel into the top 30% of priorities. The percentage of the contiguous United States covered by each overlay combination is included in the Venn diagram in the legend. The areas in white were not in the top-ranked 30% of pixels for any map. Combinations not shown in the legend are the coincidence between TNC and NAS (2.7%), the coincidence between DOW and TWS (4.0%), and the percentage of the contiguous United States that is not prioritized by any method (27.3%).

resolutions into a single prioritization (Lagabrielle et al. 2018) can be advantageous when practitioners' needs are aligned across scales. However, spatial data layers, practitioner needs, and conservation challenges often differ between scales, requiring a multilevel framework that conducts separate analyses at increasingly finer spatial resolutions (DeLuca et al. 2023).

Emphasis is often placed on where maps coincide. At their foundation, the significance of areas of coincidence may not be more than locations where a set of identified conservation objectives or values are present. However, they rarely preserve the internal consistency of each map and are not a panacea for biodiversity conservation. In exercises like this, there will always be values that are not represented, which has historically led to exclusion and the deprioritization of values that benefit human well-being, such as nature access for communities of color (Landau et al. 2020). And it is clear from these maps that a strong focus on conserving areas with full coincidence would lead to a fragmented network of patches and corridors that may not be sufficient for achieving durable, positive outcomes for biodiversity (figure 3). Looking beyond coincidence, our results exemplify the many opportunities that exist for decision-makers working to conserve biodiversity across the country. Over a third of the contiguous United States is identified as a priority area for biodiversity representation of connectivity by at least three organizations. All areas in color can be part of achieving the shared goal of conserving biodiversity and a focus on complementarity across objectives may serve to enhance the multiple benefits, services, values represented in conservation efforts. As such, national maps like ours can be helpful for taking a broad, regional approach for assessing targets and synergies. By using multiple data sets in an ensemble approach, users can both highlight the complementary information provided by these approaches and simplify varied complex data sets for greater interpretability. A combination of data sets puts less pressure on the user to choose between mechanisms and on the decision-maker to have a deep understanding of the methodology when interpreting maps. These national maps are not prescriptive but can be used to help guide and prioritize locations important for biodiversity locally. However, clarification of specific data sets is still needed to help states or local municipalities working to set priorities for contributing to national conservation efforts based on local environments and community needs.

Recent efforts affirm that area-based conservation will continue to be a mainstay of how we approach protecting our nation's biodiversity and raise considerations for policymaking and

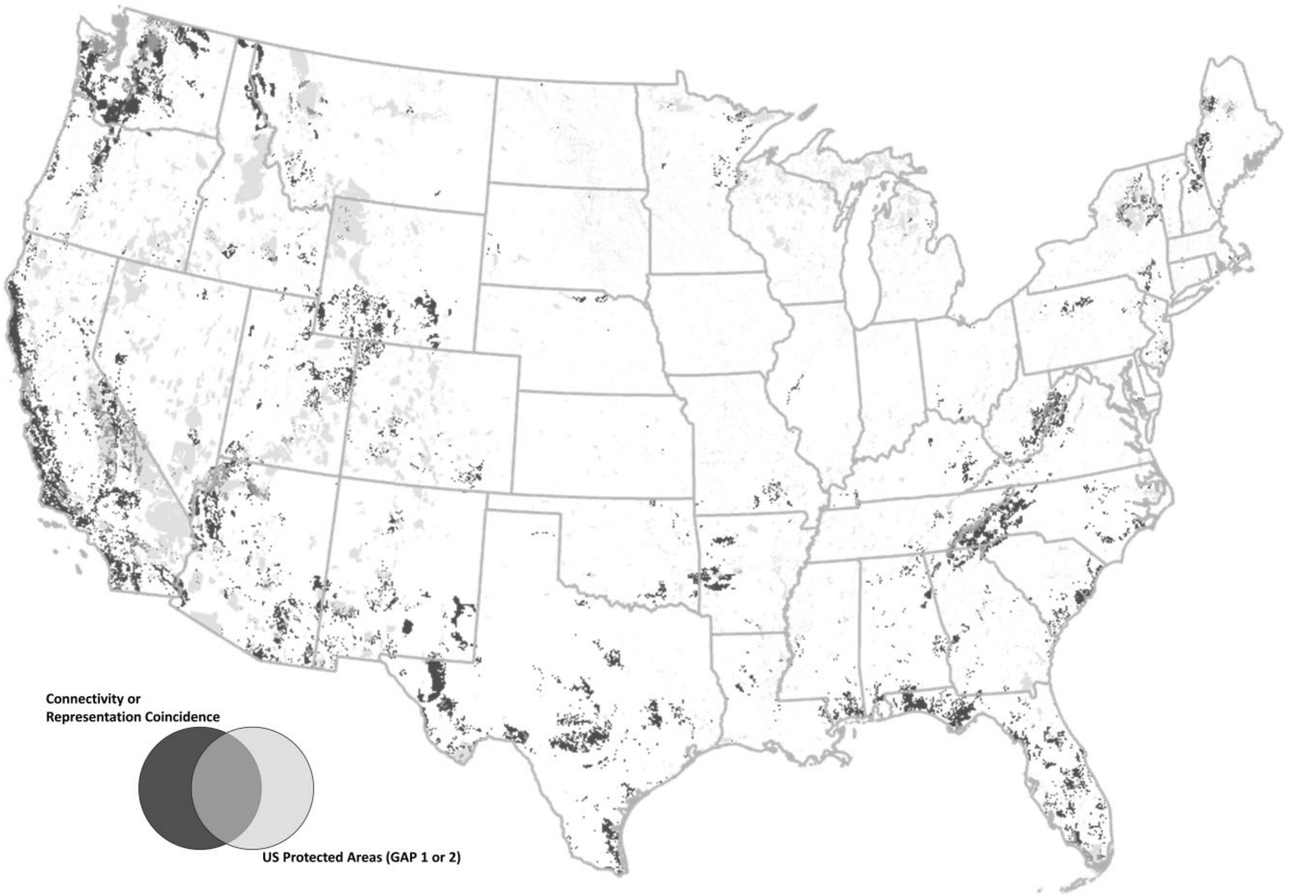

Figure 3. A protected areas network based on priority pixels from two commonly mapped conservation science principles: biodiversity representation and landscape connectivity. Priority areas were identified by overlaying the top-ranked 30% of pixels from four different approaches to mapping biodiversity representation (Belote et al. 2021, Dreiss et al. 2022, Taylor et al. 2022, Anderson et al. 2023) or landscape connectivity (Belote et al. 2016, Carroll et al. 2018, Anderson et al. 2023, DeLuca et al. 2023). We first reclassified each map to identify the top-ranked 30% of pixels. For each principle, we overlaid the maps to show where the priorities coincide. The areas of coincidence were identified as a priority by either all approaches to mapping biodiversity representation or all approaches to mapping landscape connectivity. These areas are overlaid with existing protected areas assigned GAP codes 1 or 2 from the Protected Areas Database of the United States, because these are managed most consistently with biodiversity conservation objectives (USGS 2022).

implementation. In the United States, many laws governing environmental conservation stipulate that the best available science be used as the basis for policy and decision-making. Although all of these maps are tools depicting the best available science, there is not one map to rule them all. To the contrary, new maps will be created to answer new questions that arise. Principles in conservation science can help users avoid the confusion that comes from judging data sets and maps outside of the context of their use and intent. They can also guide scientists, policymakers, and managers in more effectively applying this science. This guidance is becoming ever more important as government agencies are being asked to develop decision support tools to measure and track conservation in the United States (Conservation and Stewardship Atlas, 30×30), identify management direction for National Forest System (USDA USFS, secretarial memo no. 1077-004), allocate funds for National Wildlife Refuge System expansion (USFWS, National Wildlife Refuge Strategic Growth Policy), and more. Whether a map is more correct than another starts with a clear definition of the question or decision being supported, which should serve as a guide to selecting the map most suited to a user's needs. We need internal coherence that is grounded in what these maps all share: key principles for assessing biodiversity conservation. Clarifying the underlying shared principles that reach across jurisdictions and efforts can lay the foundation for map literacy and responsible decision support. We call for a unified guidance to support on-the-ground decisions and guide a more comprehensive understanding of spatial conservation as communities continue to address biodiversity loss, climate change, and nature inequity.

Conclusions

In comparing maps that share conservation principles but differ in their origin, we illustrate the perceived confusion that many map users' experience. Few places on the map were identified as priority areas in all the analyzed data sets. Meaningful explanations for why the maps differ stem from the original purpose and premises of the data. These differences are important to understand for conservationists, policymakers, funders, and others looking to use maps to inform conservation decisions and allocate limited resources to conserving the nation's biodiversity. The perceived confusion is one that persists beyond maps aimed at informing biodiversity conservation. Because the number of maps for decision support will continue to grow, future work should develop clear, science-driven guidance on map selection and use in efforts to address biodiversity loss, climate change, and nature inequity.

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