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Wildlife Connectivity Approaches and Best Practices in U.S. State Wildlife Action Plans

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Abstract: *As habitat loss and fragmentation threaten biodiversity on large geographic scales, creating and maintaining connectivity of wildlife populations is an increasingly common conservation objective. To assess the progress and success of large-scale connectivity planning, conservation researchers need a set of plans that cover large geographic areas and can be analyzed as a single data set. The state wildlife action plans (SWAPs) fulfill these requirements. We examined 50 SWAPs to determine the extent to which wildlife connectivity planning, via linkages, is emphasized nationally. We defined linkage as connective land that enables wildlife movement. For our content analysis, we identified and quantified 6 keywords and 7 content criteria that ranged in specificity and were related to linkages for wide-ranging terrestrial vertebrates and examined relations between content criteria and statewide data on focal wide-ranging species, spending, revenue, and conserved land. Our results reflect nationwide disparities in linkage conservation priorities and highlight the continued need for wildlife linkage planning. Only 30% or less of the 50 SWAPs fulfilled highly specific content criteria (e.g., identifying geographic areas for linkage placement or management). We found positive correlations between our content criteria and statewide data on percent conserved land, total focal species, and spending on parks and recreation. We supplemented our content analysis with interviews with 17 conservation professionals to gain specific information about state-specific context and future directions of linkage conservation. Based on our results, relevant literature, and interview responses, we suggest the following best practices for wildlife linkage conservation plans: collect ecologically meaningful background data; be specific; establish community-wide partnerships; and incorporate sociopolitical and socioeconomic information.*

Keywords: connectivity, conservation planning, corridor, terrestrial vertebrates, wildlife movement

Acercamientos a la Conectividad de Vida Silvestre y las Mejores Prácticas en los Planes de Acción de Vida Silvestre Estatales en los Estados Unidos

Resumen: *Mientras la pérdida de hábitat y la fragmentación amenazan a la biodiversidad en grandes escalas geográficas, crear y mantener la conectividad de poblaciones de vida silvestre es un objetivo común de la conservación. Para estudiar el progreso y el éxito de la planeación de una conectividad a gran escala, los investigadores de la conservación necesitan un conjunto de planes que cubran grandes áreas geográficas y que puedan ser analizadas como un solo conjunto de datos. Los planes de acción de vida silvestre estatales (SWAPs, en inglés) cumplen con estos requisitos. Examinamos 50 SWAPs para determinar la extensión con la cual la planeación de conectividad de vida silvestre, por medio de enlaces, está enfatizada a nivel nacional. Definimos los enlaces como tierra conectiva que permita el movimiento de la vida silvestre. Para nuestro análisis de contenido, identificamos y cuantificamos 6 palabras clave y 7 contenidos de criterio que variaron en especificidad y estuvieron relacionados con los enlaces para vertebrados terrestres de movimientos amplios y examinamos las relaciones entre el criterio de contenido y la información estatal sobre especies focales de movimiento amplio, gastos, ingresos y suelo conservado. Nuestros resultados reflejan disparidades en prioridades de conservación de enlaces y resaltan la necesidad continua de una planeación de enlaces de vida silvestre. Sólo el 30% o menos de 50 de los SWAPs cumplieron criterios de contenido altamente específico (p. ej.: identificar áreas geográficas para ubicación de enlaces o manejo). Encontramos correlaciones positivas entre nuestros criterios de contenido e información estatal sobre el porcentaje de suelo conservado,*

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total de especies focales y gastos en parques y recreación. Complementamos nuestro análisis de contenido con entrevistas a 17 profesionales de la conservación para obtener información específica sobre contextos específicos de estados y direcciones futuras de la conservación de enlaces. Basándonos en nuestros resultados, literatura relevante y las respuestas en las entrevistas, sugerimos las siguientes mejores prácticas para los planes de conservación de conectividad de vida silvestre: colectar información de trasfondo ecológicamente significativa, ser específico, establecer asociaciones a lo largo de las comunidades e incorporar información sociopolítica y socioeconómica.

Palabras Clave: Conectividad, corredor, movimiento de vida silvestre, planeación de la conservación, vertebrados terrestres

Introduction

Habitat loss and fragmentation remain 2 of the leading worldwide threats to biodiversity (Beier & Noss 1998; Hilty et al. 2006; Heller & Zavaleta 2009) and may be further exacerbated by rapid climate change (Mantyka-pringle et al. 2012). Many conservation professionals propose combating anthropogenically driven habitat fragmentation by increasing protected habitat area, improving habitat quality, and preserving connectivity of wildlife populations (e.g., Heller & Zavaleta 2009; Doerr et al. 2011). Planning and designing linkages remains a popular approach for increasing connectivity (Rosenberg et al. 1997; Hilty et al. 2006; Beier et al. 2008), and many studies confirm that linkages increase movement rates of larger terrestrial animals in fragmented landscapes (Gilbert-Norton et al. 2010).

Due to the perceived importance of linkages for wildlife, evaluation of how and if they are incorporated into conservation plans is an important step in assessing their role in improving connectivity. Bottrill et al. (2011) highlight the benefit of multiplan or project evaluation in identifying "persistent and influential" factors for conservation. However, planning for wildlife connectivity can involve consideration of wide expanses of geographic space that cross political jurisdictions, resulting in varying overarching goals, policies, strategies, and timelines that are difficult to compare. Thus, a set of conservation plans with a unified framework is a critical resource in assessment of connectivity strategies across large scales.

State wildlife action plans (SWAPs) represent the first opportunity to assess conservation needs and priorities for the entire United States (Fontaine 2011). Developed in 2005 by individual U.S. states and territories, SWAPs were a federal requirement to receive state wildlife grants (AFWA 2007). Each state had the mandate of addressing 8 essential elements that included the following: distribution of habitats and species, priority research efforts, monitoring plans, multilevel government collaboration, and broad public participation. Although SWAPs were developed on a state-by-state basis, the unified framework of the plans allows them to function together as a single, national data set for evaluating and comparing conservation planning efforts (e.g., Lerner et al. 2006; Lauber et al. 2011). Use of the SWAPs in this way is especially important in evaluating wildlife connectivity and linkage conservation because these conservation actions necessitate consideration of large geographic scales that cross state lines.

Our evaluation of language and content in SWAPs uncovered the depth to which wildlife connectivity, an important focus in peer-reviewed conservation literature, is incorporated into large-scale conservation plans. Due to the diversity of ecosystems, organizations, and policies inherent in the examined state-specific planning efforts, our subsequent broad recommendations, in the form of best practices, can easily be transferred to other conservation plans. Coordinated, strategic conservation planning is needed everywhere (Margules & Pressey 2000; Halpern et al. 2006; Lerner et al. 2006), as is assessment of those plans (Bottrill et al. 2011). Results from our study can be used to improve the rigor and subsequent implementation of conservation plans that address wildlife connectivity at any scale.

We conducted a content analysis on 50 SWAPs in the continental United States in consideration of the following questions: To what degree do SWAPs in the U.S. address wildlife linkages intended for larger terrestrial wildlife and what are some best practices for wildlife linkage planning?

Our analysis of the SWAPs allowed us to identify common linkage-related language to assess to what degree wildlife linkage planning was emphasized nationally. We compiled a list of best practices and recommendations based on our content analysis and the literature. As a supplement, we also conducted interviews with relevant conservation professionals from a subset of states, whose responses corroborate our recommendations.

Methods

Defining Linkages and Focal Species

We define *linkage* as in Beier et al. (2008): "connective land intended to promote movement of multiple focal species or propagation of ecosystem properties." Our study focuses on wide-ranging terrestrial mammals listed as species of greatest conservation need (SGCN) by the SWAPs (Supporting Information) because these

Table 1. List of keywords and content criteria used in state wildlife action plan content analysis.[a]

Keywords	*Content criteria*
Corridor(s)	1: Linkage mentioned
Linkage(s)	2: Habitats identified
Connectivity	3: Species identified
Habitat connectivity	4: Actions recommended
Wildlife connectivity	5: Geographic areas specified
Movement(s)	6: Maps of linkages included
	7: Linkage case studies mentioned

[a]*Keywords were tabulated by counting each instance. Content criteria were tabulated by counting the presence and absence of each criterion.*

species may require more structurally contiguous areas of conserved land than other less mobile species (Newmark 1987; Minor & Lookingbill 2010) and thus are more likely to promote connectivity management strategies across vast geographic areas. We acknowledge that to achieve holistic connectivity management, conservation plans must also incorporate hydrologic connectivity and consider species other than terrestrial vertebrates, as addressed in many of the SWAPs. However, our focus remained on large, terrestrial mammals for the reasons listed above, which outweighed the acknowledged bias toward those species in connectivity research.

Keyword Searches and Content Criteria

We examined the SWAPs of 49 states and Washington, D.C. We excluded Hawaii and Puerto Rico because of archipelago geography and the absence of wide-ranging native mammals. To elucidate common language and to establish the relative depth of linkage conservation in each SWAP, we tallied the frequency of 6 relevant keywords (Table 1 & Supporting Information). We only included keyword instances when the keyword context was relevant to wide-ranging terrestrial vertebrates (Supporting Information). To further assess the depth of linkage-related content, we developed 7 linkage-related content criteria (Table 1 & Supporting Information). The content criteria increase in specificity from *linkages mentioned* as the most general to *linkage case studies mentioned* as the most specific. Content criteria were chosen based on components of linkage design studies (e.g., Hoctor et al. 2000; Wikramanayake et al. 2004; Beier et al. 2008). Directives and explanations behind keywords and content criteria are provided in Supporting Information.

For each state, we collected statewide data that we hypothesized would be relevant to linkage conservation: (1) number of large, wide-ranging terrestrial species listed as SGCN (NBII 2001); (2) federal revenue for state and local governments (2003–2004) (USCB 2004); (3) spending on parks and recreation by state and local governments (2004) (USCB 2004); (4) total state area (USCB 2004); and (5) total area and percentage of state in GAP status 1 and 2 lands. Land with GAP status 1 and 2 has the highest levels of conservation protection in the Gap Analysis Program where extractive or multiple uses are not permitted (Maxwell et al. 2009). Because SWAPs were published in 2005, we collected state spending and revenue data from 2003 to 2004, the most influential time period for SWAP development.

We analyzed relations between statewide data, total instances of all keywords, fulfillment of individual content criteria, and the highest numbered criterion identified per SWAP. Our analysis goals were to explore trends that might provide insight into why some SWAPs emphasized wildlife linkage conservation and to identify useful variables for more comprehensive future predictive modeling. We used logistic regression (test statistic χ^2 from likelihood ratio test) to evaluate relations between dichotomous or ordinal variables or the nonparametric Spearman rank correlation (test statistic ρ) when evaluating continuous variable pairs. To assure that content data were not a result of the number of pages in each SWAP, we tested for correlations between page number and total keywords or content criteria. Statistical significance was assessed at alpha = 0.05 and analyses were conducted using JMP software (version 9.0.0). Because our analysis was purely exploratory and total number of tests was low, we did not correct for multiple comparisons (Hurlbert & Lombardi 2012). Thus, our quantitative results should be interpreted with these inherent statistical limitations in mind, and p-values should be treated as approximations (Breaugh 2003).

Supplementary Interviews with Conservation Professionals

We conducted interviews to gain specific information on the context and future directions of the SWAPs (Supporting Information). Interview responses were used to corroborate best practices but were not a focus of our analyses of SWAP content. We spoke with 17 higher level conservation professionals in 5 contiguous western states to examine intra- and interstate planning. At the time of interviews, all interviewees worked on linkage- or SWAP-related projects. We grouped interviewee responses by topics pertinent to the planning process, subsequent implementation, collaboration, and opinions on the importance of linkage conservation for wide-ranging terrestrial vertebrates. Further details and summarized results are in Supporting Information.

Results

Total keyword instances varied across SWAPs. New Jersey's SWAP contained over 200 instances, and 3 SWAPs contained zero instances (Supporting Information). The frequency of specific keywords also varied considerably.

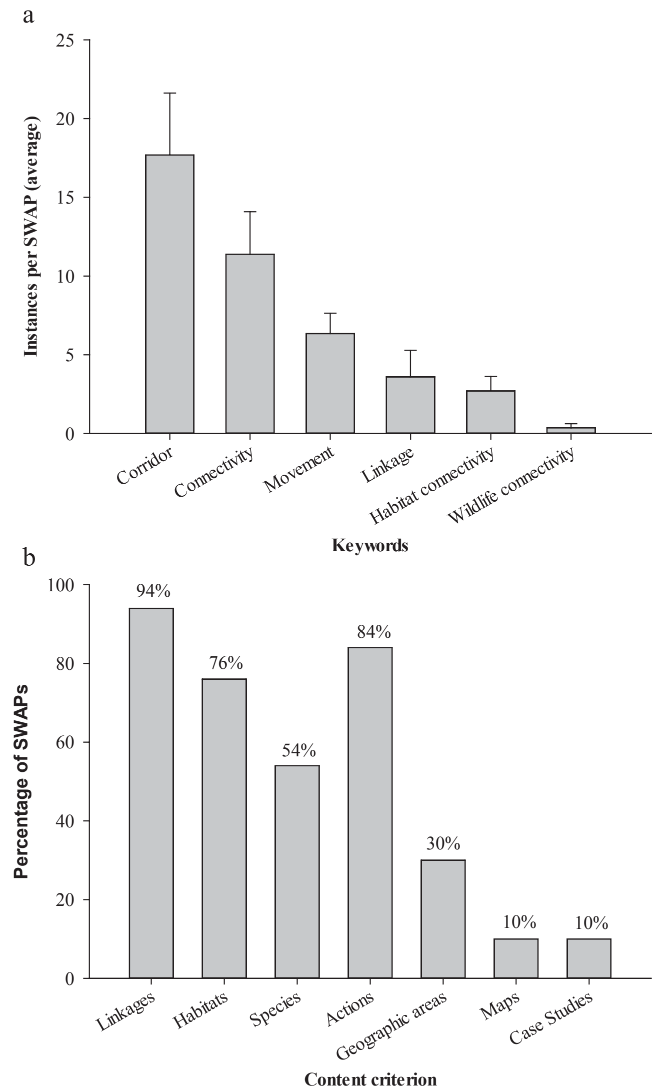

Figure 1. (a) Average (SE) instances of keywords related to wildlife linkages used per state wildlife action plan (SWAP) and (b) absolute percentages of SWAPs that fulfilled each content criteria related to wildlife linkages.

Corridor was the most commonly used keyword with 18 average instances per SWAP, constituting 42% of all instances per plan (Fig. 1). *Connectivity* and *movement* had the second and third highest average instances (11 and 6 instances, respectively). With regards to content criteria, 94% of SWAPs mentioned linkages (criterion 1), whereas only 10% included maps or case studies (criteria 6 and 7) (Fig. 1). Furthermore, although 3 criteria (criteria 1, 2, and 4) were often fulfilled in any given SWAP, the average use of linkage-related keywords was relatively low. The number of pages per SWAP was not significantly correlated with either keyword counts or total number of content criteria (Spearman rank $\rho = 0.18$, $p = 0.22$ and $\rho = 0.13$, and $p = 0.37$, respectively).

Several content criteria were significantly correlated with statewide data concerning species, spending, and percent conserved land (Fig. 2). Because total state area was positively correlated with percentage of land in GAP status 1 and 2 ($\rho = 0.38$, $p = 0.006$), we focused on the more descriptive GAP data in further analysis. Identification of species, criterion 3, positively correlated with the percentage of state lands in GAP status 1 and 2 (i.e., conserved lands) ($\chi^2 = 3.69$, $p = 0.05$) and the number of our focal SGCN ($\chi^2 = 3.93$, $p = 0.05$). Specification of geographic areas, criterion 5, positively correlated with parks and recreational spending in 2004, percentage of conserved lands, and number of focal SGCN ($\chi^2 = 4.47$, $p = 0.03$; $\chi^2 = 9.12$, $p = 0.003$; and $\chi^2 = 4.15$, $p = 0.04$, respectively).

The total number of keywords was significantly and positively correlated with the highest content criterion fulfilled within each SWAP ($\chi^2 = 13.07$, $p = 0.003$). The total number of keywords also was significantly positively correlated with parks and recreational spending ($\rho = 0.33$, $p = 0.02$), number of focal SGCN ($\rho = 0.25$, $p = 0.05$), and percentage of conserved lands ($\rho = 0.41$, $p = 0.003$). In addition, we found a significant positive relation between the highest criterion satisfied per SWAP and percentage of conserved lands ($\chi^2 = 4.99$, $p = 0.03$) (Fig. 3). No other relations were statistically significant.

Discussion

Our results suggested that emphasis on wildlife linkages in SWAPs is often cursory, which contrasts with the fact that 50 SWAPs listed habitat fragmentation as a leading threat (fourth out of 21 ranked threats) (Lerner et al. 2006) and that improving or maintaining connectivity, often via wildlife linkages, is a major objective for wildlife conservation globally (e.g., Bennett 2004; Wikramanayake et al. 2004; Doerr et al. 2011). Furthermore, every SWAP listed at least one large, wide-ranging SGCN. The contradiction between the apparent need for wildlife linkage conservation and our results signifies a notable gap in planning efforts.

There are several possible reasons why wildlife linkage conservation does not feature more prominently in our results. First, linkage conservation was not 1 of the 8 essential elements required in the SWAPs. Second, many interviewees reported linkage conservation plans in their states made prior to SWAP development, potentially lessening the apparent need for linkage discussion within the SWAPs. However, there is minimal reference to other linkage-related plans in the SWAPs (Supporting Information), and this omission could potentially hinder coordinated nationwide planning resulting directly from the SWAP effort. Third, there may be an assumption that large mammals (vs. smaller species) are not as affected by habitat fragmentation because of their ability to

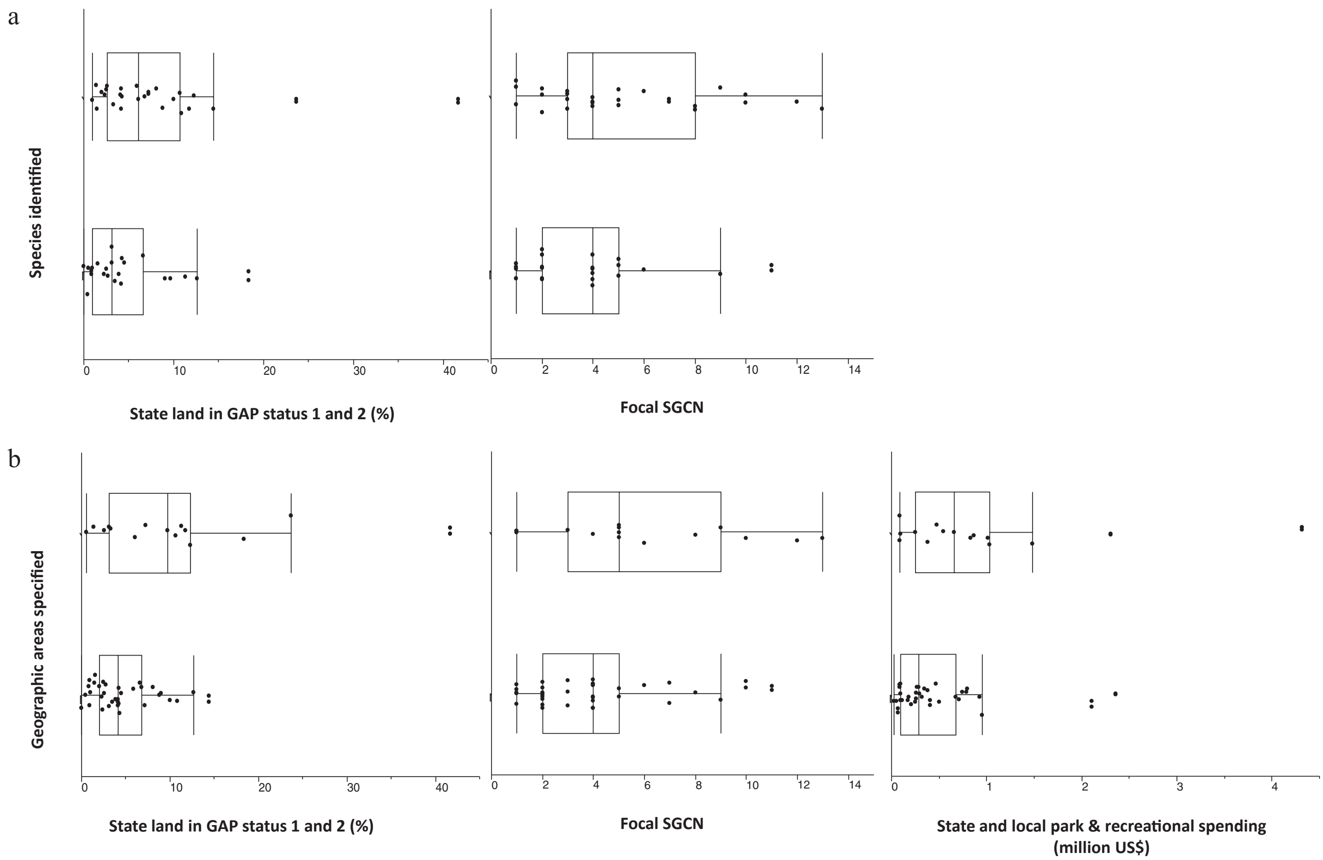

Figure 2. (a) State lands in Gap Analysis Program's (GAP) status 1 and 2 (i.e., protected lands where no extractive or multiple uses are allowed) and the number of focal species of greatest conservation need (SGCN) related to the fulfillment of content criterion 3 (i.e., species identified) ($p = 0.05$ for both). (b) State lands in GAP status 1 and 2 lands, number of focal SGCN, and state and local parks and recreational spending related to the fulfillment of content criterion 5 (specification of geographic areas) ($p = 0.003$, $p = 0.04$, and $p = 0.03$, respectively). The box-and-whisker plots represent quartiles, median, and spread of the data. The y on the y-axis represents fulfillment of the content criteria in a SWAP and N represents nonfulfillment.

disperse long distances. However, the effect of movement disruption from highways, a recurring problem in the United States, likely negates heightened dispersal ability (Minor & Lookingbill 2010). Lastly, other conservation actions such as core-area protection and habitat restoration may be prioritized above linkage conservation depending on state needs. This observation countered our finding that the highest criterion satisfied within a SWAP positively correlated with the percentage of conserved state lands. Thus, it is equally possible that states with more conserved lands have both less need to prioritize land conservation and more options for linkage planning. Nonetheless, we did not find any stated reasoning within the SWAPs themselves for why wildlife linkage planning was sparse. We can only conclude that this aspect of conservation was largely overlooked.

Notwithstanding the often minimal attention to wildlife linkages, we found strong commonalities across SWAPs in terms of language, emphasis, and statewide data. The keyword *corridor* was used more than *linkage* across SWAPs, and *connectivity* was used more than *wildlife connectivity* or *habitat connectivity*. Other analyses on effectiveness of SWAPs emphasized the need for common language (Aldridge et al. 2008), especially with scientific jargon such as "adaptive management" (Fontaine 2011). In the Methods section, we included a definition of our preferred term *linkage* as a way to both justify our use of it and for clarification for readers. We recommend that planners (of SWAPs or other plans) define commonly used jargon (e.g., *connectivity* or *corridor*) because clarifying easily misunderstood terms help in defining goals and actions (Fontaine 2011).

The content criteria reveal the depth of emphasis placed on wildlife linkages in SWAPs. Few plans identified geographic areas of interest or developed rough linkage maps. This is especially worrying as maps are crucial parts of any conservation planning process (Margules & Pressey 2000), especially with wildlife linkages

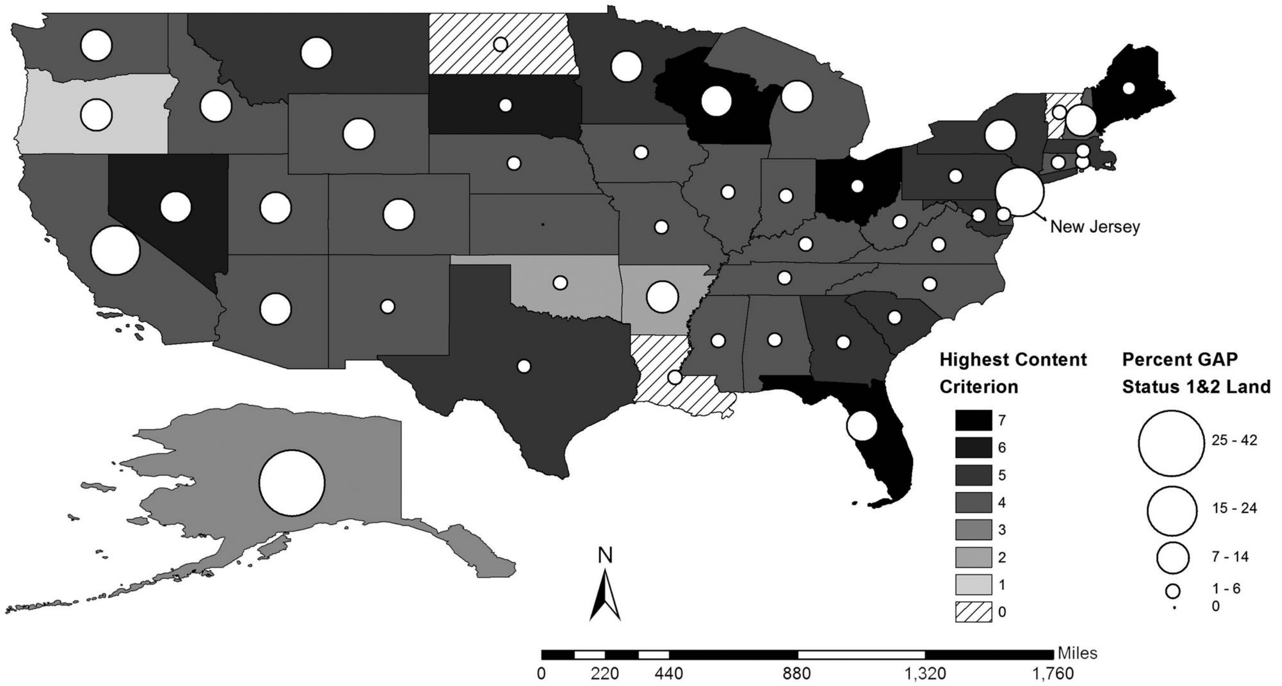

Figure 3. State-by-state percentage of Gap Analysis Program (GAP) status 1and 2 lands (defined in Fig. 2 legend) for each state overlaid onto the highest content criterion satisfied in a SWAP ($p = 0.03$). The more protected land a state has, the higher its top content criterion in its SWAP (i.e., the more specific the planning for wildlife linkages).

(Beier et al. 2008). Lerner et al. (2006) and Aldridge et al. (2008) cited maps as a recurring gap in SWAPs overall. Most plans mentioned linkages in relation to terrestrial habitats and provided some, often general, management actions, whereas only half specified targeted species. We found this latter result surprising considering all states contain at least one focal SGCN. When we examined correlations between statewide data and SWAP content data, we found that generally plans with a higher emphasis on wildlife linkages were from states with higher percentages of GAP status 1 and 2 lands or higher total number of focal SGCN. SWAPs from those types of states were also more likely to have incorporated linkage planning for specific species, habitats, and geographic areas. Though these correlations do not imply causation, they potentially reveal how and why states differ in their approaches to wildlife linkage conservation and priorities for action.

Best Practices for Wildlife Linkage Planning

We examined SWAPs that fulfilled 5 or more of our 7 content criteria and recognized best practices shared among most, if not all, of these 11 plans (Arizona, California, Delaware, Florida, Georgia, Missouri, New Mexico, Oregon, Texas, Washington, and Wisconsin) (hereafter, the most detailed plans). The following best practices are based on these most detailed plans, the published literature, and our supplementary interview responses. Our suggested best practices are largely translatable to aquatic, sessile, or narrow-ranging species. However, the scale of research, management strategy, or degree of collaboration will likely change when applied to different types of species.

Collect Ecologically Meaningful Background Data

The most detailed plans explicitly identify both ecological information and key features of the landscape that could impact wildlife movement through linkages. Information or features include species distributions; wildlife movement barriers; high disturbance areas; migration pathways; habitat types, ecologically sensitive areas; core wildlife areas; and seasonal changes in vegetation composition. We urge the use of common metadata standards in all state plans to aid in communicating data.

When planning for linkage conservation, managers should gather information on species ecology at relevant scales (Bennett 1999) and integrate data for long-term conservation goals such as climate change resiliency (Hudgens & Haddad 2003), suggestions highlighted by our supplementary interviews. Integrating landscape features and wildlife movement data into habitat suitability models can strengthen the efficacy of wildlife linkage projects because species' movement can be linked to landscape features that wildlife use (Bennett 1999; Chetkiewicz et al. 2006). However, background information may result in questioning the efficacy of establishing or maintaining linkages for certain wildlife species (Rosenberg et al. 1997). Common alternatives include stepping stones or assessments of the connectivity gradient across an entire area to avoid restrictions of contiguous linkages (Aune et al. 2011).

Be Specific

The most detailed plans organize information hierarchically based on specific geographic areas, taxonomic groups, or habitat types. This allows for plan implementers to associate goals, actions, etc., to related goals, actions, etc. These plans have specifics regarding spatial analyses; quantitative measurements of species abundance, use, and occupancy of linkages; habitat quality; habitat extent; and maps of proposed or current core wildlife areas.

Many studies, including ones evaluating SWAP gaps (Lerner et al. 2006; Aldridge et al. 2008), strongly advocate stating explicit goals when trying to enhance landscape connectivity for focal species via linkages (Bennett 1999; Hess & Fischer 2001; Hudgens & Haddad 2003). For example, the stated goal *increase connectivity with the use of wildlife linkages* is not as clear as *increase connectivity along riparian corridors using wildlife linkages in the northern Sierra mountain range for* Puma concolor. In addition, language specificity is important as mentioned previously. For example, distinctions should be made between key concepts such as structural versus functional linkages (Bennett 1999; Hess & Fischer 2001; Hodgson et al. 2011) and the scale and scope of conservation goals (e.g., population-scale vs. landscape-scale and habitat connectivity vs. ecological connectivity) (Aune et al. 2011). Furthermore, prioritizing actions, goals, and strategies may enhance the likelihood of plan implementation and continued management actions (Morrison & Boyce 2009).

Establish Community-Wide Partnerships and Foster Collaboration

The most detailed SWAPs outline existing and potential roles of stakeholders in planning and implementation. They also acknowledge the importance of collaboration among agencies, nonprofits, and academics (including across political boundaries). General analyses on SWAPs stress the crucial and highly beneficial impacts of collaboration and the need for further, continued partnerships (Lerner et al. 2006; Aldridge et al. 2008), ideas that our interviewees overwhelmingly supported. Such efforts will greatly aid in actual implementation of planning goals (Aldridge et al. 2008; Lauber et al. 2011). Involvement of the local community through participation and education enables successful plan implementation (Bennett 2004; Aune et al. 2011; Beier et al. 2011). Whether or not a team approach is adopted initially as some recommend (Beier et al. 2006; Hilty et al. 2006; Sanderson et al. 2006; Aldridge et al. 2008), partnerships are critical for implementation, management, and monitoring.

Inclusion of Monitoring and Adaptive Management

As part of the 8 essential elements, monitoring and adaptive management are mentioned frequently throughout the most detailed SWAPs, and some specify monitoring of habitat connectivity as a major goal. Lerner et al. (2006) and Aldridge et al. (2008) highlight the great importance of monitoring within the SWAP framework. Monitoring the efficacy of linkage projects, measuring connectivity, and learning from existing linkage studies are crucial (Beier & Noss 1998; Beier et al. 2006; Bennett et al. 2006). Monitoring and adaptive management of implemented projects help assess whether linkages ensure connectivity (Chetkiewicz et al. 2006).

We also highlight 2 additional best practices identified in the literature but not explicitly discussed in many of our most detailed SWAPs.

Account for Climate Change

In the most detailed SWAPs, only 4 discuss how climate change can exacerbate habitat fragmentation stressors and influence species' distributions. However, several states have since published climate change addendums, encouraged by a recent publication from the Association of Fish & Wildlife Agencies (2007), which lists maintaining and restoring connectivity as an important conservation strategy. All interviewees acknowledged that climate change would be an important component to wildlife linkage planning.

The literature review by Heller and Zavaleta (2009) reveals that improving connectivity is the top recommended conservation action aimed at improving species' adaptation to climate change. Wildlife linkages may be a valuable tool for conserving species capable of dispersing relatively long distances (Vos et al. 2008; Doerr et al. 2011, but for a note of caution on the relative importance of this strategy, see Hodgson et al. 2011). Guidelines for how to plan for and manage climate change appropriate linkages are still developing within the literature (Vos et al. 2008; Beier et al. 2011).

Incorporate Sociopolitical and Socioeconomic Information

Sociopolitical and socioeconomic considerations should also be incorporated into linkage design and acquisition (Bennett 1999; Hilty et al. 2006; Sanderson et al. 2006). Understanding the political and economic environment allows planners to acknowledge and confront the nonphysical obstacles that might impede implementation of linkages. This best practice gets at the idea that the reality of implementation often hinges on nonscientific feasibility issues (Morrison & Boyce 2009).

Many SWAPs acknowledge the importance of wildlife linkage conservation and referenced specific habitats or general actions. However, most SWAPs did little more, with few identifying relevant geographic areas or developing maps. Conversely, interview responses from conservation professionals in the western United States overwhelmingly showed that wildlife linkage conservation is still a top conservation goal. These results reveal a discrepancy between the importance of wildlife linkages and the incorporation of wildlife linkage planning across the United States according to SWAP content. However, our study was not meant simply to describe the state of wildlife linkage conservation but also to provide guidance for future linkage-related conservation plans.

Through our analysis of SWAP content, we identified commonly used language and best practices that may be helpful for conservation planners. Having a common language can be incredibly powerful for continuity and synchronization across organizations and political boundaries (Salafsky et al. 2008). We also recognized the following best practices: collect ecologically meaningful background data, foster broad collaboration, increase specificity of data and goals, include adaptive management, account for climate change, and incorporate socio-related information. Though elements of the best practices appear in other connectivity science syntheses (e.g., Aune et al. 2011; Beier et al. 2011), the ones listed here are uniquely supported by an analysis of existing conservation plans developed in the nonacademic world.

The relevance of our recommendations goes far beyond the scope of the SWAPs. They can be folded into existing and nascent conservation frameworks and are explicitly linked to factors that improve probability and subsequent success of implementation. We acknowledge that integration of recommended best practices will depend on planning organizations' methods of operations and resources. However, increasing the emphasis on wildlife linkages, using common language, and incorporating these best practices can directly improve subsequent iterations of SWAPs and, more broadly, other similar large-scale conservation plans across the globe.

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Supporting Information

Disclaimer: Supplementary materials have been peer-reviewed but not copyedited. Further explanation of focal species selection and directives and an explanation of content (Appendix S1), the interview questionnaire and results (Appendix S2), and state-by-state results for keyword and content criteria (Appendix S3) are available online. The authors are solely responsible for the content of these materials.

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