

Comparative Analysis on the Influence of Land Management on Conservation Methods of Endangered Species Ranges

Honors Thesis

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Abstract

Species ranges play an important role in understanding species ecology for effective conservation management, with the distribution of endangered species ranges across different land management jurisdictions being a key determinant of the conservation strategies and regulatory frameworks that shape species recovery. This study used ArcGIS to perform spatial intersection analyses to quantify the overlap between federally-managed and Indigenous-managed lands, and the extant range of three species of high conservation concern (at least an Endangered listing under the IUCN Red List) in the US: the Black-footed Ferret, the Mojave Desert Tortoise, and the Western Alligator Snapping Turtle. Results found that the Black-footed Ferret and Mojave Desert Tortoise have a significantly larger portion of their total ranges on federally-managed lands, while the Western Alligator Snapping Turtle has a moderately balanced distribution across federal and Indigenous jurisdictions, but exhibits a much smaller amount of overlap with the two land management types across their total range. These patterns indicate that conservation methods for some endangered species depend on the strategies employed under a particular land management type, while others depend on collaborative governance. Overall, this study emphasizes the importance of integrating land governance into species range analyses, and highlights the need for collaborative Indigenous-federal conservation strategies to increase the effectiveness of conservation actions and improve recovery for species of high conservation concern.

Background/Introduction

Species range, defined as the “geographically dynamic boundaries encompassing the set of abiotic and biotic factors within which the presence and survival for a certain species is more likely” (Tomolo and Ward 2018), is an essential component used in ecological studies to specify critical habitat for species. However, the use of species ranges to inform conservation decision-making and determine the listing status of a species under the Endangered Species Act (ESA) is relatively limited and only one of many factors considered when listing a species, despite the essential role that degradation of species ranges play in the decline of biodiversity worldwide (Smith-Hicks and Morrison 2021). Listing a species under the ESA is a long process, often taking many years, and sometimes decades to evaluate the vulnerability of a species and determine if the threats to the species warrant initiating the listing process (Smith-Hicks and Morrison 2021). Following a species’ listing, the extent and condition of their current range can influence the conservation actions that are put into place for the species, with common actions including habitat restoration, monitoring of habitat and species, and instituting legal protections on the critical habitat within the species range. Because the land management type that the species range falls under determines which actions can occur on the habitat, understanding what jurisdictions an endangered species’ habitat is managed by is essential for knowing the conservation options and limitations that can be implemented to protect the species.

Due to the conservation urgency that is associated with species of high concern, this study specifically focuses on species of Endangered and Critically Endangered listings with declining populations since they require increased management intervention to prevent the extinction of the species. By evaluating range overlap of high-concern species on federally-managed versus indigenous-managed lands this study aims to explore how distribution of species range across different land management jurisdictions may affect the conservation effectiveness of these species. The analysis explained within this paper expounds upon previous research done to help provide understanding of how land management types interact with species conservation needs and actions, and emphasizes the importance of collaboration between federal agencies and Indigenous peoples to promote effective conservation of high-concern species.

Literature review

Federal land management inherently includes conservation of endangered species. Federal lands are required to follow laws and policies determined for vulnerable species under the Endangered Species Act (O’Laughlin 2005). Actions under federal land management are prohibited from causing risk or threats to imperiled species or harming habitat for these species (O’Laughlin 2005). Conservation methods employed on federal lands are heavily based in regulations and restrictions on land-use of endangered species habitat for this reason. Conservation practices implemented on Indigenous lands are shaped and restricted by multiple factors, including cultural, legal, and political contexts, with restrictions often being caused by the US federal government (Richmond et al. 2013). US restrictions on, and lack of support regarding, US tribal self-determination (such as the application of federal conservation laws on Indigenous lands without equal tribal authority or input on management plan design or implementation) risks the ability of these Native nations to carry out successful conservation on Native lands (Schmidt and Peterson 2009). An example of such applied federal conservation mandates includes the Endangered Species Act being enforced on Native lands, which limits allowable cultural and economic land use of Native peoples, and restricts conservation actions that employ Traditional Ecological Knowledge (TEK) that forms the basis of much of the conservations practices that Native peoples have historically implemented to promote sustainable populations of species on Native lands (Schmidt and Peterson 2009).

Studies into the influence of land management type on ranges of endangered species and implications for conservation methods are relatively limited. The majority of studies that look into the intersection between endangered species range and conservation practices are focused on the importance of adequately defining species ranges and habitat utilized by endangered species to inform management and conservation decisions to further protect these vulnerable species. However, these studies do not include further discussion into how the land management type that

these species ranges fall on guide conservation actions or implications of traditionally used conservation actions on endangered species management. Taking this information into account, this study aims to further understand how land management type influences conservation practices of species to answer the research question: How does species range overlap on different land management types (federal vs native lands) affect endangered species geographic ranges? Based on the differing regulatory frameworks and mandated conservation under the different land governances, I hypothesized that a greater proportion of endangered species extant ranges will overlap with federally managed lands than with Indigenous-managed lands.

Methods

To answer this question, ArcGIS was used to run analysis on spatial data gathered from three primary sources. Native land layers showing the extent of Indigenous lands in the US were downloaded from the Native Lands Data Portal and the layer showing US Federal Lands was downloaded from ArcGIS Online. The species used in the analysis were selected because they are currently listed as Endangered or Critically Endangered by the IUCN Red List, and met the additional criteria of a current decreasing population trend, and extant range overlap with both federally-managed and Indigenous-managed lands in the US. Following this criteria, I narrowed the analysis down to three species: Black-footed Ferret (endangered listing), Mojave Desert Tortoise (endangered listing) and Western Alligator Snapping Turtle (critically endangered listing). For each of these three species, range data was downloaded from the IUCN Red List. Once all of the collected layers were put into ArcGIS, the extant ranges of each species was separated from the ranges where the species went extinct to focus the analysis on current ranges for the species of interest. Using the extant ranges of each species and the federal and native land layers, pairwise intersections were run in ArcGIS to isolate the areas where each species' current range overlaps with federal and native lands in the US. Maps were then rendered using these intersection layers, as well as the full habitat ranges of each species and the land management type layers to provide a visualization of this data (*Figure 1, Figure 2, Figure 3, Figure 4*).

To determine the areas of each of the layers needed for comparative analysis, the coordinate systems of each layer and basemaps had to be homogenized. The coordinate system of every layer and the map itself was projected into USA Contiguous Albers Equal Area Conic, a projection optimized for the US that ensures preservation of true area and no area distortion of layers. The areas for each layer and intersect were then calculated in ArcGIS and converted into km². The total area of US Federal and Native lands and habitat range of each species (reported in *Table 1*) were used in conjunction with the federal and Native intersects found for each species to find the proportion of Native and federal land each species are currently using and the proportion of total species habitat is managed under federal and Native land management strategies (*Table 2*).

Results

Across the three species used in this analysis, the patterns of species range overlap on federal-managed and Indigenous-managed lands largely varied, with each species having different degrees of dependence on a given land management type. When looking at the percentage of species range that is protected under federal or native land jurisdictions (percentage of intersect overlap on total area of a given land management type), all species showed very limited usage of total federal and native land area. When exploring land management overlap on each species' total habitat range however, the Mojave Desert Tortoise and the Black-footed Ferret ranges have notably larger amounts of their total range under federal-land management than Indigenous management while the Western Alligator Snapping Turtle had a relatively equivalent percentage of its range on each of the two land management types (*Table 3*). These findings suggest that for these species, federal land management plays a larger role in the conservation actions of the Mojave Desert Tortoise and the Black-footed Ferret, while Indigenous and federal land management have a more equal influence in the conservation of the Western Alligator Snapping Turtle.

Endangered Species Ranges and Overlap on Native Versus Federal Lands in the US

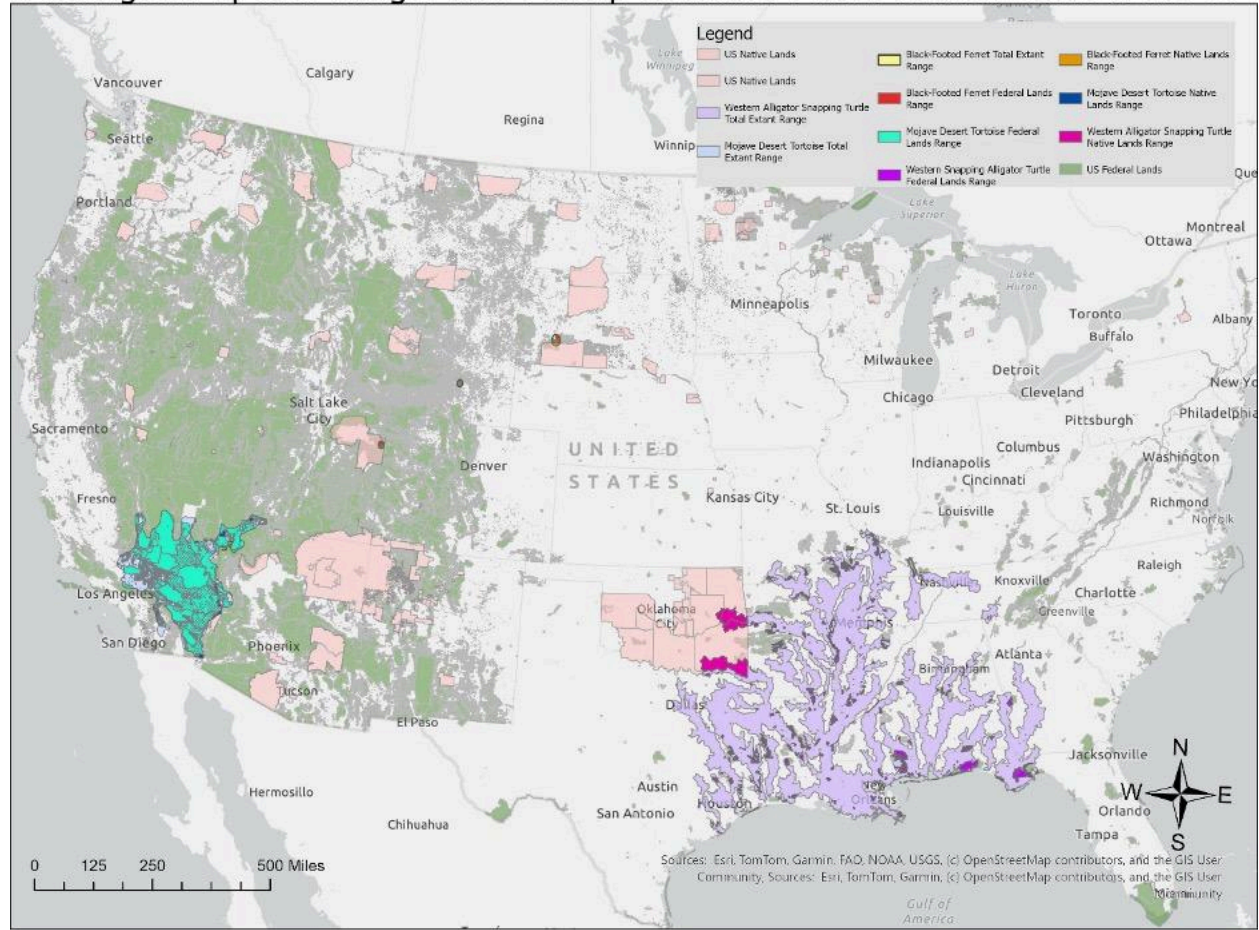


Figure 1: Map of Full Ranges of Black-footed Ferret, Mojave Desert Tortoise, and Western Alligator Snapping Turtle and their Overlap on Federal and Native Lands in the US

Black-Footed Ferret Range and Overlap on Native Versus Federal Lands in the US

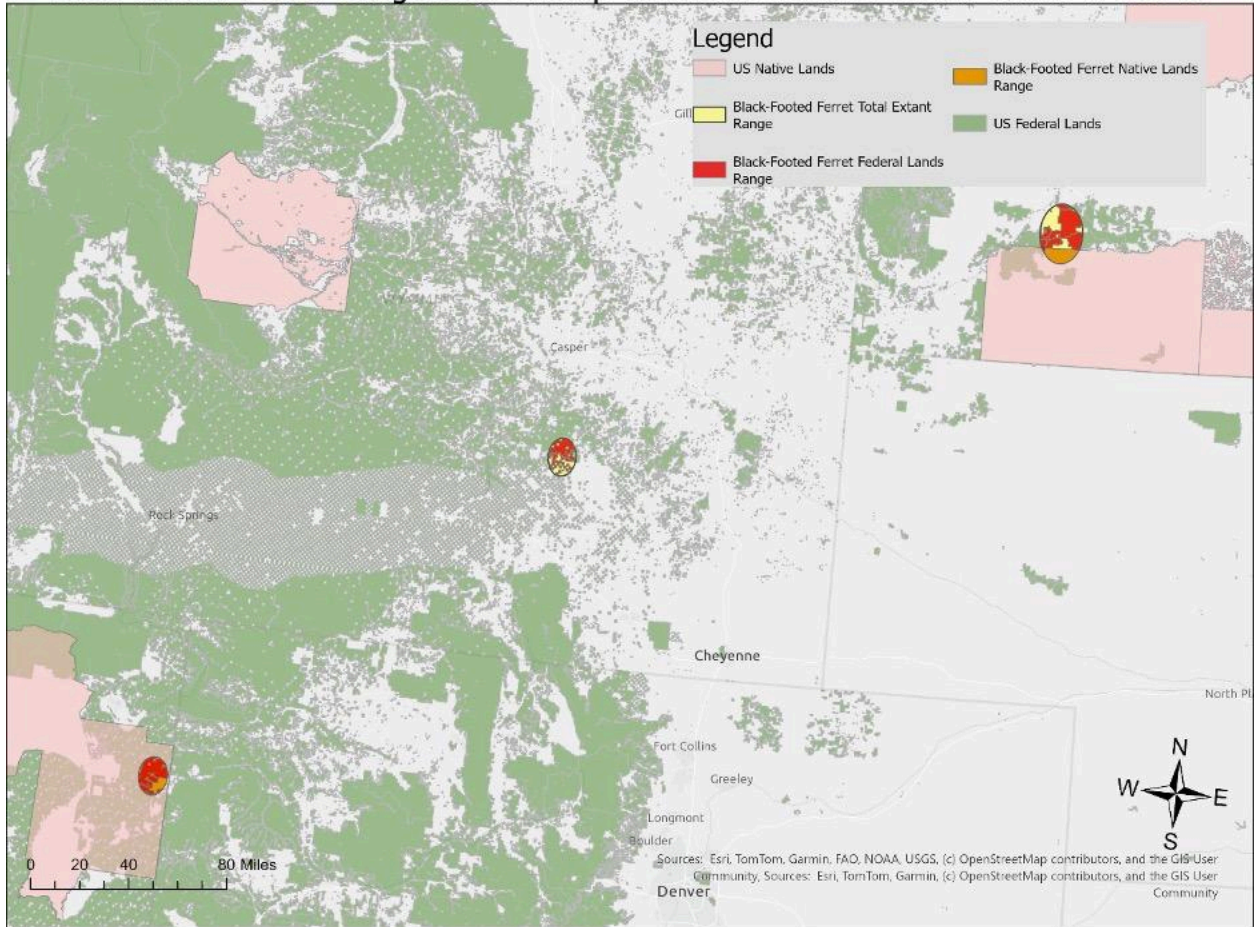


Figure 2: Map of Black-footed Ferret Range (Endangered Listing) Overlap on Federal and Native Lands in the US

Mojave Desert Tortoise Range and Overlap on Native Versus Federal Lands in the US

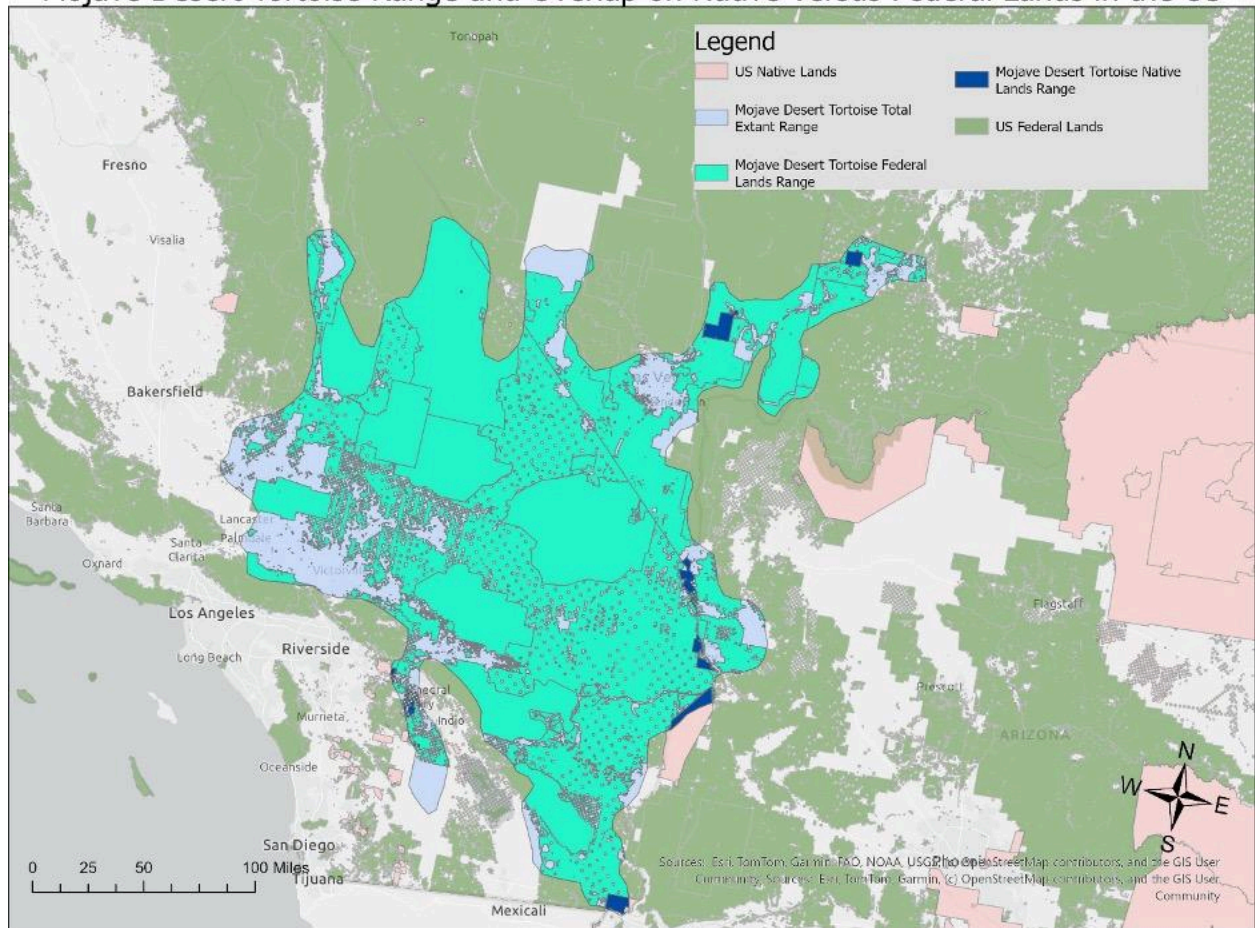


Figure 3: Map of Mojave Desert Tortoise (Critically Endangered Listing) Range Overlap on Federal and Native Lands in the US

Western Alligator Snapping Turtle Range and Overlap on Native Versus Federal Lands in the US

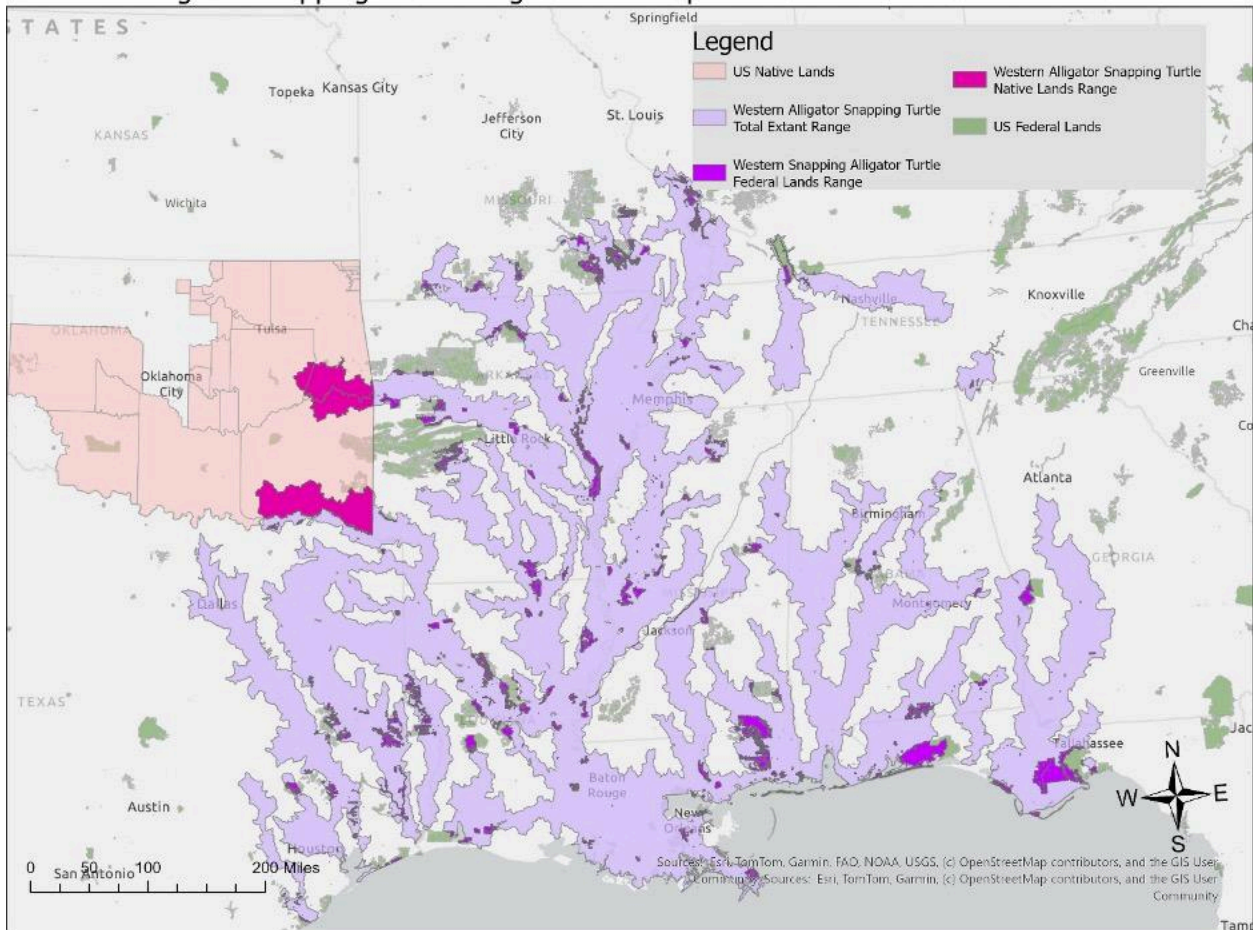


Figure 4: Map of Western Alligator Snapping Turtle (Endangered Listing) Range Overlap on Federal and Native Lands in the US

<u>Land Type</u>	<u>Total Area (km²)</u>
US Federal Lands	5,663,703,935,810
US Native Lands	415,644,620,695
Black-footed Ferret Range	1,595,017,254
Mojave Desert Tortoise Range	106,723,953,609
Western Alligator Snapping Turtle Range	423,171,800,715

Table 1: Total Area/Ranges of Species and Land Management Types (Federal and Native Lands) in km².

<u>Species</u>	<u>Amount of Total Range on Federal Lands (km²)</u>	<u>Percentage of Total Species Range on Federal Land</u>	<u>Amount of Total Range on Native Lands (km²)</u>	<u>Percentage of Total Species Range on Native Land</u>
Black-footed Ferret	966,236,766	62.459%	541,613,998	33.957%
Mojave Desert Tortoise	83,664,543,342	78.393%	1,236,411,005	1.159%
Western Alligator Snapping Turtle	20,110,436,778	4.752%	11,578,465,497	2.736%

Table 2: Land Management Intersect Ranges on Total Species Habitat (Percent Overlap on Total Species Range). This table reports the intersect area of total species range on federal and native lands respectively for each species in km² and the percentage of this intersect area on the total habitat area of each species.

Discussion

This study hypothesized that a greater proportion of endangered species extant ranges will overlap with federally managed lands than with Indigenous-managed lands, due to the differing regulatory frameworks and mandated conservation under the different land governances. The results of the spatial analysis supports this hypothesis, as the Black-footed Ferret and Mojave Desert Tortoise both showed extensive overlap with federally-managed lands compared to Indigenous-managed lands, and the Western Snapping Turtle showed limited overlap with either of the two land management types.

This study emphasizes the importance of inclusion of species range and land management analysis to guide conservation decisions for endangered species, and accentuates the need for collaboration of management strategies to protect species that rely on habitat that falls on different land management types. Understanding the extent of species' range that falls within the jurisdiction of federal or Native land management helps to determine which land governance is more liable for maintaining and improving species viability, particularly for declining populations and species of high conservation concern. For species like the Black-footed Ferret and Mojave Desert Tortoise that have extensive overlap with federal lands across the total range of their habitats, policies and conservation actions managed by federal agencies have a disproportionately high influence on population status and species viability. In species like the Western Alligator Snapping Turtle, which had very small proportions of its range overlapping with both Native and federal lands, collaborative strategies and information sharing between land management governance is essential to monitor the recovery of the species and provide management plans that can bolster populations in areas that are managed/protected under federal or Native land management.

The Western Alligator Turtle having limited range overlap with both federally-managed and Indigenous-managed lands emphasizes the importance of alternative conservation strategies for species of conservation concern whose ranges are largely located on private land. For these species, traditional governance-based practices and protections are insufficient to conduct adequate data collection on population recovery through monitoring. Community-based conservation approaches, such as establishing partnerships with private land owners or creating citizen-science programs for monitoring and data collection, could be valuable ways of collecting information to fill in data gaps regarding species's life history, and increase the engagement of the community in conservation efforts and activities. Conservation initiatives that include citizen science may prove to be effective in conducting crucial data collection on species that have limited occurrence on Indigenous and federal lands since the research or observation of these land governance types is highly restricted by lack of species range overlap on Indigenous or federal land jurisdiction. For species like the Western Alligator Snapping Turtle, community-led monitoring integrated into existing conservation frameworks used on federal and Indigenous lands could improve understanding of population dynamics and inform adaptive conservation management strategies.

The patterns observed in this study, which are consistent with the hypothesized dominance of federally-managed land in endangered species range overlap, can likely be attributed to the differences in total area and distribution of Native and federal lands across the US. Federal lands in the US span a much greater area than Native lands and, therefore, are composed of more varied ecosystems and habitats that increase the chance of endangered species range existence on this land management type. Native and federal lands are also concentrated in the Western states of the US, significantly decreasing the amount of range overlap of endangered species such as the Western Alligator Snapping Turtle on these land management types. Indigenous management of Native lands tend to implement conservation practices that employ traditional ecological knowledge (TEK) that is based in long-term coexistence with species, often focusing conservation efforts more heavily towards species that the Native people utilize for cultural practices. Since the species involved in this study were chosen based on geographic range overlap with different land management types, cultural significance was not taken into account. This decision may affect some of the results found from the study since Native lands are often better equipped for more specialized species conservation when compared to federal lands that often incur revenue to be used for conservation actions, and have strict legal protections that largely uphold habitat quality, therefore protecting more than just targeted species.

The observed patterns found from this study's analysis could substantially shift if an expanded analysis including species not currently classified as Endangered or Critically Endangered, or species with cultural significance to Indigenous tribes were to be incorporated in the study. Range overlap of species with stable or increasing population trends might be less strongly associated with federally-managed lands, as these species may not require, or benefit from, the

level of regulatory protections and habitat change restrictions employed under this land governance. Species that are culturally significant to Indigenous tribes often occur more frequently on or near Indigenous-managed lands since Indigenous people tend to have long-term coexistence with these species that influenced traditional and cultural practices and use of the species. In scenarios such as these, conservation outcomes may be more heavily influenced by community-led management strategies than mandated regulation approaches. Including species of cultural significance to Indigenous tribes in future analyses, therefore, might show greater proportional overlap with Indigenous-managed lands, highlighting the importance of conservation practices that are led by Traditional Ecological Knowledge and support tribal sovereignty in the conservation of species.

While the observed patterns are consistent with the stated hypothesis, they do not imply that federally-managed land employ more effective conservation practices or have better conservation outcomes than Indigenous-managed lands. Indigenous stewardship and conservation practices have been shown in multiple instances to support conservation of specialized species through methods informed by long-term ecological knowledge garnered from coexistence with the species, and targeting culturally important management priorities. Examples such as Indigenous-led bison restoration initiatives suggest that outcomes of conservation actions may be heavily influenced by species-specific management approaches rather than the overlap extent between land management and species range alone. This emphasizes the potential for conservation approaches implemented on Indigenous-managed lands to have a critical impact on species with specialized ecological needs or cultural implications.

Despite the insights that can be understood from the result, this study includes several limitations. Most impactfully, species habitat or home range represents the potential total geographic distribution of a species, but is not a direct measure of the abundance, occupancy, or survival probability of individuals. The intersection analysis in this study indicates the habitat that has the conditions to support the endangered species of interest, but does not address the quality of the habitat within this range or the population distribution found in these areas. Future research should include abundance and occupancy data for species of interest to determine if parts of the range serve as critical habitat for species populations and require more urgent protections and conservation actions to be implemented. Additionally, determining what land management type the critical range/habitat of these species falls under may provide essential insights into which management strategies differentially influence species population persistence and viability over time. Integrating data on legal protections, conservation actions, and land-use implemented within the home ranges of species of interest could help to form a more refined evaluation of the way that land management jurisdiction and practices affect the conservation of high-concern species and could inform more focused and collaborative management plans for endangered species conservation.

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