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Article

Quantifying the National Significance of Local Areas for Regional Conservation Planning: North Carolina's Mountain Treasures

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Abstract: Conservation scientists recognize that additional protected areas are needed to maintain biological diversity and ecological processes. As regional conservation planners embark on recommending additional areas for protection in formal conservation reserves, it is important to evaluate candidate lands for their role in building a resilient protected areas system of the future. Here, we evaluate North Carolina's Mountain Treasures with respect to their (i) ecological integrity, (ii) role in connecting existing core protected areas, (iii) potential to diversify the ecosystem representation of reserves, and (iv) role in maintaining hotspots of biologically-rich areas not well protected. Mountain Treasures represent a citizen inventory of roadless areas and serve as candidates for elevated levels of conservation protection on U.S. federal lands. We compared Mountain Treasures to other candidate lands throughout the country to evaluate their potential national significance. While the Mountain Treasures tended to be more impacted by human modifications than other roadless areas, they are as important as other roadless areas with respect to their role in connecting existing protected areas and diversifying representation of ecosystems in conservation reserves. However, Mountain Treasures tended to have a much higher biodiversity priority index than other roadless areas leading to an overall higher composite score compared to other roadless areas. Our analysis serves as an example of how using broad-scale datasets can help conservation planners assess the national significance of local areas.

Keywords: biodiversity; connectivity; ecological integrity; Mountain Treasures; protected areas; Southern Appalachian Mountains

1. Introduction

For over a century, conservation efforts have led to the establishment of hundreds of protected areas covering millions of hectares in the United States. These protected areas form the foundation for strategies to protect biological diversity and ecological processes upon which people and other species depend. Nevertheless, there is growing recognition that existing protected areas may be insufficient to sustain biodiversity as climate change and land development continue to impact natural ecosystems [1]. In fact, Aycrigg et al. (2016) [2] recognized that "as significant as conservation areas are… they fall short of meeting recommended policy goals of each nation having established by 2020 an ecologically representative and well-connected system of protected areas."

Recent calls have been made to add to the system of protected areas by establishing an ecologically connected network that is more inclusive of ecosystems and species currently under-represented in protected areas [2,3]. In response to these calls, Belote et al. (2017) [4] recently conducted a national assessment of wildland values and priorities for expanding the U.S. protected area system to include the most ecologically intact and wildest lands [5], establish a national connected network [6], and better represent ecosystem diversity [7] and hotspots of range-limited species [8]. Establishing a system of conservation reserves that is more resilient to climate change

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may require adding intact lands that connect existing protected areas and add ecosystem and species representation to the existing system [9–11].

At the same time, Watson et al. (2016) [12] and Martin et al. (2016) [13] recently recognized the importance of protecting what is left of the remaining wildlands, areas where human land use does not dominate ecological systems. Watson et al. (2016) suggest that "protecting the world's last wilderness areas is … our best prospect for ensuring that intact ecosystems and … evolutionary processes persist for the benefit of future generations." Similarly, Ibisch et al. (2016) [14] recently evaluated the global importance of roadless areas for conservation.

Marshall and Dobbins (1936) [15] made similar calls for the protection of large tracts of wildlands after evaluating roadless areas over 80 years ago using paper maps to identify national conservation priorities. Today, national and global high resolution data on human impacts allow conservation scientists to better evaluate human land use changes [16,17], identify roadless and wildland areas [12,14], and map biodiversity [8,18]. These datasets provide important opportunities for assessing the global or national importance of regions or local areas in conservation planning [1]. Without such evaluations, local assessments and management recommendations may fail to consider the full conservation value of lands [1].

In this paper, we use data compiled by Belote et al. (2017) to evaluate the national wildland conservation significance of the "Mountain Treasures" of western North Carolina for their value in completing a regional network of conservation reserves. Ranging in size from 80 to 11,810 hectares, the Mountain Treasures are 53 units of land in the Southern Appalachian Mountains first identified in 1992 by citizens in conjunction with a management plan amendment conducted by the United States Forest Service (Appendix A). This inventory has been updated and refined in anticipation of Forest Plan revision for Nantahala and Pisgah National Forests that began in 2014.

The Nantahala and Pisgah National Forests are managed by the U.S. Forest Service, which administers over 78,000,000 hectares throughout the United States [19]. National Forests are managed under federal direction through the National Forest Management Act, which requires management plans be updated on a regular basis (every 10-15 years). During management plan revisions, the Forest Service evaluates candidates of land units to be recommended to the U.S. Congress for additional conservation protections. Here, we use national data to assess the relative value of the Mountain Treasures, which are candidates for elevated levels of conservation protection, compared to other similar units on all other Forest Service lands.

We evaluated the relative importance of adding the Mountain Treasures to the national system of conservation reserves by assessing their: (1) ecological integrity, (2) importance for connecting existing protected areas, (3) whether the composition of their ecosystems are national priorities for expanding representation, and (4) their importance as habitat for range-restricted and unprotected hotspots of biodiversity. These qualities derive from conservation principles to maintain biological diversity under increasing pressures of climate change and land development. Protecting intact lands (areas of high ecological integrity) that connect protected areas and diversify the ecological representation of conservation reserves are among the highest conservation priorities. Here, we quantified these qualities and compare the Mountain Treasures to other similar candidates for elevated levels of protection occurring on Forest Service lands. In so doing, we demonstrate a relatively straightforward method for evaluating the national significance of local areas during regional land use planning.

2. Materials and Methods

2.1 Study Area Region

The Mountain Treasures of North Carolina are located in the Nantahala and Pisgah National Forests of the Southern Appalachian Mountains. The Southern Appalachians contain one of the most biologically diverse temperate forests in the world [8]. Topography includes both sheltered valleys at relatively low elevations up to the highest mountains of the eastern U.S. This topographic richness provides a very broad range of different habitat niches. In addition, a wide variety of geologic

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substrates also contributes to a wide range of soil types. The geological history is also very ancient, with continuous vegetation likely extending back to the last mass extinction 65 million years ago. The diverse microclimatic conditions, the relatively moderated climate over long periods, and a long geological history without major disturbances, such as direct glaciation or submersion under water, contribute to the high biological diversity of the region. Mountain Treasures range in elevation from 604-1623 meters above sea level with metamorphic and metasedimentary rock characterizing the parent material. Vegetation cover of the Mountain Treasures is diverse, but characterized by species of oak (*Quercus* spp.) and mixed deciduous trees with areas dominated by conifers (*Pinus* spp. and *Tsuga canadensis*), as well as Appalachian mountain balds.

2.2 Quantifying conservation value

To quantify ecological integrity, we used Theobald's map of human modification [20]. This is a composite map developed from spatial data representing land cover, human population density, roads, structures, and other stressors to ecosystems. Lands that maintain a high degree of ecological integrity or low degree of human modification have been referred to as "wildlands" [21], and protecting the remaining wildlands is considered by many among the highest of conservation priorities [12,13,22].

To quantify the value of land units for maintaining or establishing connections between protected areas, we used a mapped connectivity index from Belote et al. [6]. The index was developed to identify the least human-modified corridors between large existing protected areas, which were defined as all wilderness areas regardless of size and all other GAP status 1 and 2 lands ≥ 4046.9 hectares (10,000 acres). GAP 1 and 2 lands are classified as such because laws, policies, or their land management plans mandate that biodiversity be a central conservation goal and that land conversion, commercial development, and resource extraction is prohibited or limited [23]. Lands with a high connectivity index receive a higher wildland conservation value, as they may help to maintain ecological linkages between protected areas [6].

To quantify ecosystems currently under-represented in the existing protected area system, we used an assessment of ecological representation in highly protected lands. Ecosystem representation has recently been calculated using a number of different methods, including based on the proportion of ecosystem area within different GAP status lands [7], wilderness areas [24], and roadless lands [25]. Our assessment of ecological representation is based on the proportion of an ecosystem's total area that occurs in lands identified in the Protected Areas Database (PAD) v 1.4 as GAP status 1 or 2 [23]. We recalculated analyses of Aycrigg et al. (2013) using the latest PAD to map the proportion of total area of each ecosystem occurring in GAP status 1 or 2 areas (Figure 1c). Lands composed of ecosystems that are less well-represented in protected areas are assigned a higher value than lands with ecosystems that are already highly protected.

To quantify the value of land for hosting species currently under-represented in protected areas, we used the conservation priority index of Jenkins et al. (2015) [8] (Figure 1d). This index was developed by overlaying maps of mammal, bird, reptile, amphibian, freshwater fish, and tree species distributions and weighting the rarity of species (calculated based on the size of each species' geographic distribution) and the proportion of its distribution that is protected based on International Union for Conservation of Nature (IUCN) categories I to VI [8]. Lands classified in categories I-VI overlap those considered as GAP 1 and 2 (http://gapanalysis.usgs.gov/blog/iucn-definitions). Areas rich in endemic species with limited geographic distributions that are currently not well-represented in protected areas receive a higher value in our index than areas with few such species.

Finally, we derived an index of composite wildland conservation values, which was produced by summing normalized indices of each quality described above [4]. This index map shows important priorities for adding lands to the national system of conservation reserves. Lands that currently serve as candidates of elevated levels of protection and with higher composite values may be considered high priorities for added conservation protections.

For each quality, we compared the distribution of Mountain Treasures to all other inventoried roadless areas (IRAs) within the entire National Forest System of the contiguous United States. To do

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this, we calculated the mean value of each index for every Mountain Treasure (N = 53) and IRAs (N = 2,408). We plotted the kernel density distributions of each index to compare Mountain Treasures and IRAs. We used this method of plotting over alternatives (e.g., box and whisker, bar graphs) to better evaluate the distribution of data within Mountain Treasures and IRAs. Because our data represent a census of all values within units of interest, we were not interested in conducting inferential statistics to compare distributions. We also rank ordered each Mountain Treasure with respect to the four indices, as well as their final composite wildland conservation value. In addition to comparing values among Mountain Treasures, we also plotted 75th, 90th, 95th, and 99th percentiles of IRAs to quantify the relative importance of individual Mountain Treasures compared to national IRAs.

3. Results

3.1 Ecological integrity and connectivity priority

The mean ecological integrity of the Mountain Treasures was 23% lower than the mean integrity of other US Forest Service IRAs (Table 1; Fig S1; Figure 1A; Figure 2). Despite the lower degree of ecological integrity, Mountain Treasures fall between existing protected areas and maintain an overall connectivity value similar to other IRAs (Figure 1B; Figure 3). The connectivity value of Siler Bald and Bald Mountain is above 90% of all U.S. roadless lands in the lower 48 United States, and sixteen Mountain Treasures possess connectivity value greater than 75% of all designated roadless areas (Fig S2).

Table 1. Summary statistics for each index used to compare North Carolina's Mountain Treasures with other US Forest Service candidates for additional protection. All indices are based on data compiled by Belote et al. (2017) and range from 0 to 1, except for the composite wildland conservation value which had a maximum possible value of 4.

	Mountain Treasures			All other USFS Inventoried Roadless Areas					
Index	**Median**	**Mean**	**SD**	**Median**	**Mean**	**SD**	**75%**	**90%**	**95%**
Ecological integrity	0.67	0.67	0.05	0.84	0.83	0.26	0.90	0.95	0.97
Connectivity priority	0.89	0.88	0.05	0.88	0.86	0.09	0.92	0.95	0.96
Ecosystem representation priority	0.85	0.82	0.08	0.82	0.79	0.12	0.87	0.90	0.92
Biodiversity priority	0.75	0.77	0.09	0.13	0.21	0.20	0.34	0.48	0.61
Wildland conservation value	3.15	3.14	0.13	2.68	2.68	0.26	2.83	2.99	3.11

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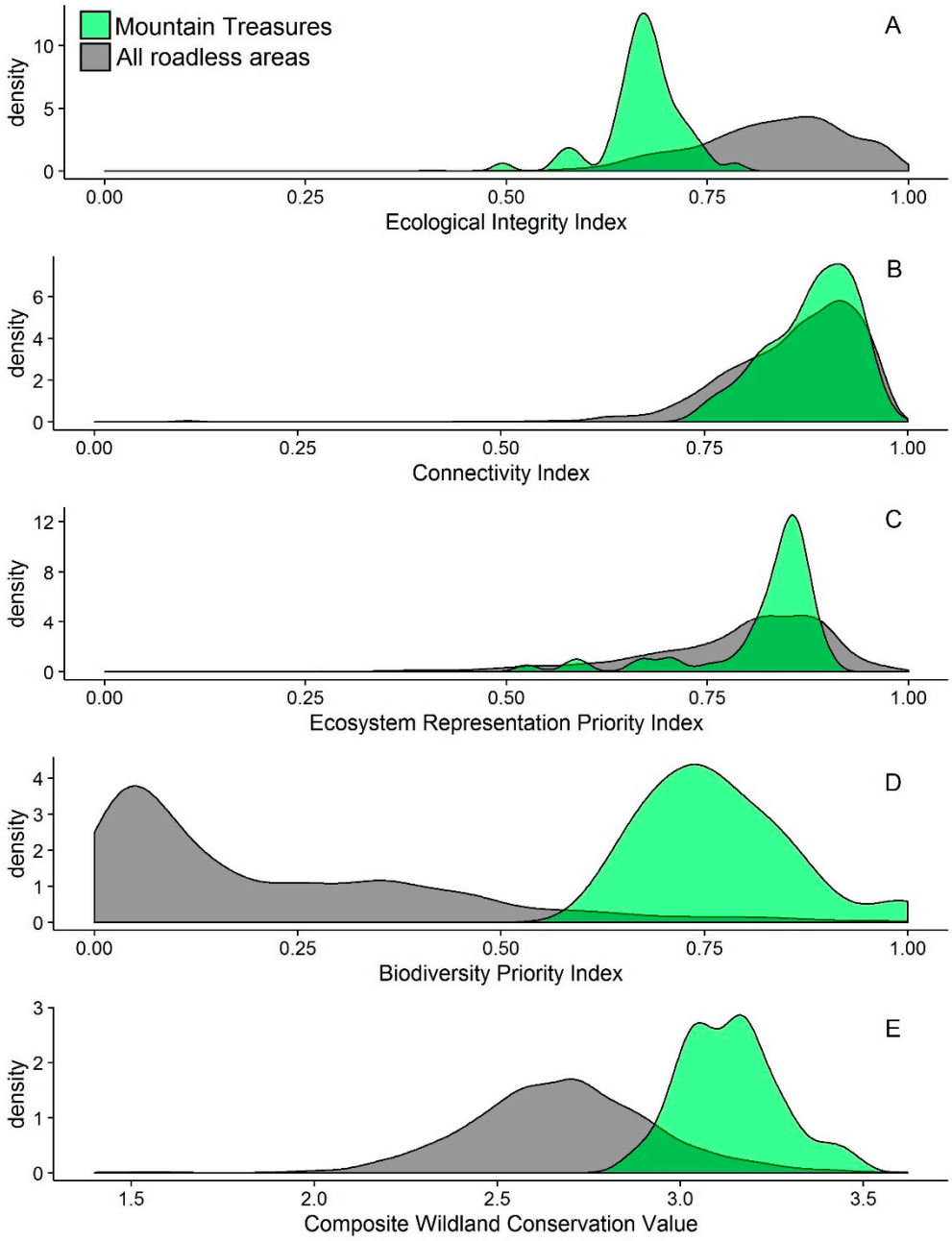

Figure 1. The distribution of conservation priorities for Mountain Treasures (green) and all other roadless areas in the lower 48 United States (grey) based on data from Belote et al. 2017. Values for the top four indices range from 0 (low) to 1(high) nationally. These indices were combined into a composite Wildland Conservation Value index (bottom panel). A = Ecological integrity; B = Connectivity; C = Ecosystem representation priority; D = Biodiversity priority index; E = Composite wildland conservation value.

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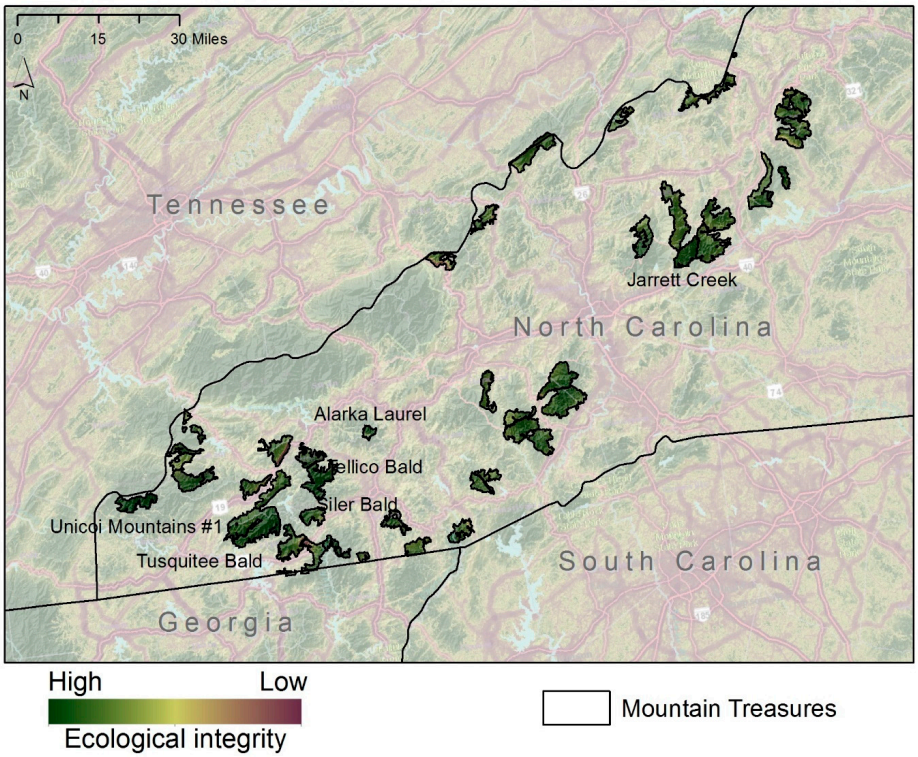

Figure 2. Map of ecological integrity for the Southern Appalachian Mountains highlighting the Mountain Treasures. While the Mountain Treasures have on average lower ecological integrity scores compared to all other roadless areas, it is important to note their regional significance at sustaining relatively intact and wild, some of the wildest places in the Southeastern U.S.

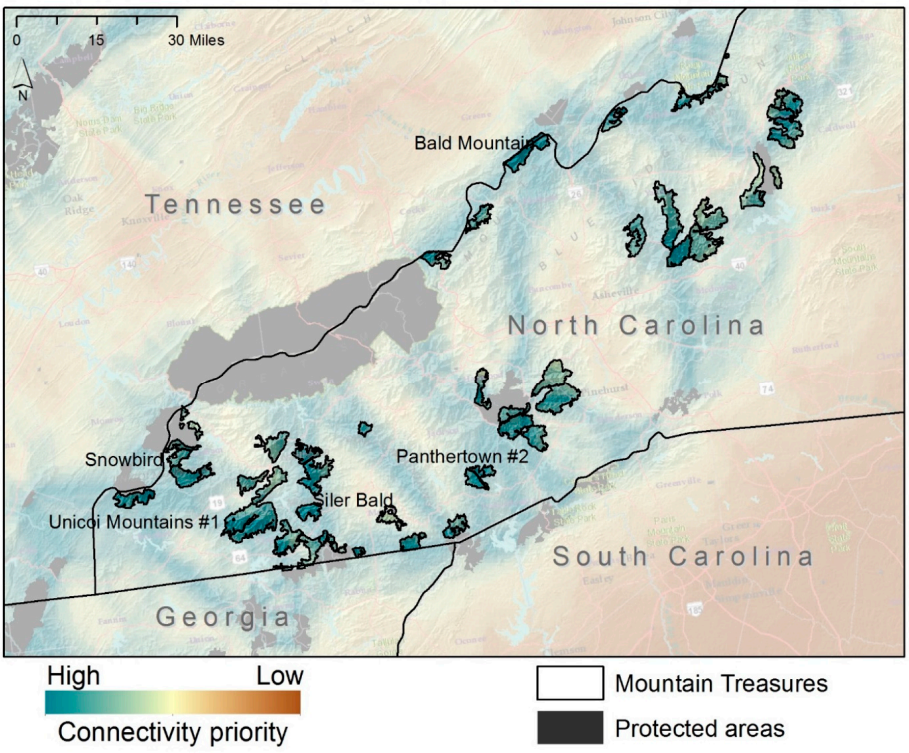

Figure 3. Map of connectivity priority value between protected areas for the Southern Appalachian Mountains highlighting the Mountain Treasures based on data from Belote et al. 2016. Many of the Mountain Treasures lie between existing protected areas and therefore represent important priorities

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for maintaining connections between existing conservation reserves including Great Smoky Mountains National Park and wilderness areas on the Nantahala and Pisgah National Forests.

3.2 Ecosystem representation

Ecosystem representation priority of Mountain Treasures were also comparable to IRAs (Figure 1C). Panther Town #1 and #3, Dobson Knob, Linville Gorge Extension A, Sugar Knob, Nolichucky Gorge, and Southern Nantahala Extension D are composed and dominated by ecosystems poorly represented in protected areas (Figure 4), making these areas a higher priority than 75% of other roadless areas in the U.S. (Fig S3).

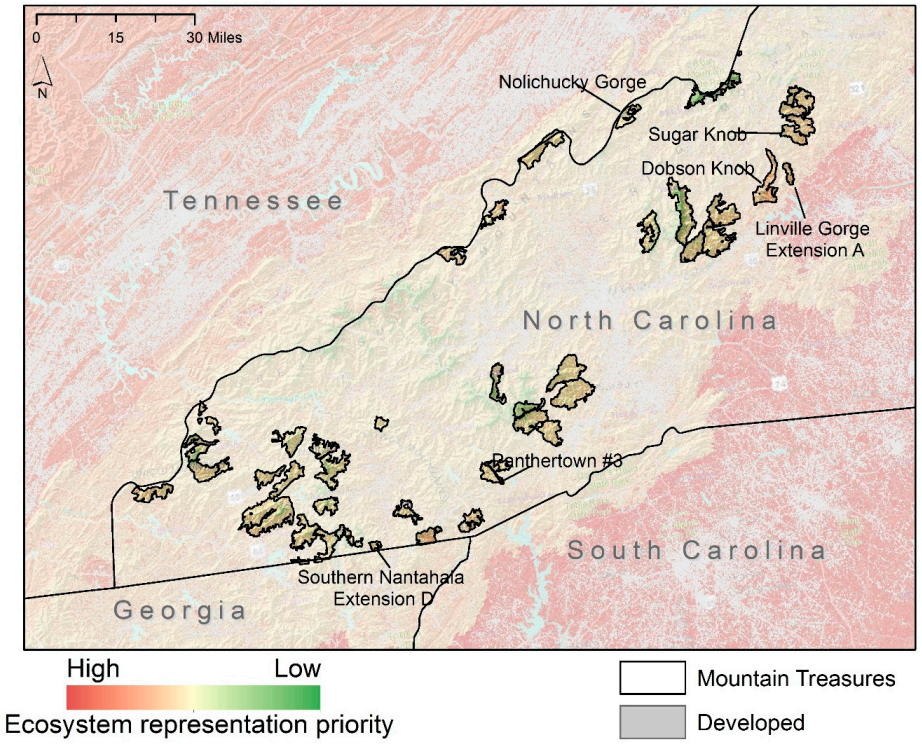

Figure 4. Map of ecosystem representation priorities in the Southern Appalachian Mountains highlighting the Mountain Treasures. Many of the Mountain Treasures are home to ecosystems that are not well-protected based on recent evaluations of how well the existing system of protected areas represents the nation's ecosystem diversity.

3.3 Biodiversity priority index

The biodiversity priority index was on average 73% higher than other IRAs (Table 1; Figure 1D). Santeetlah Bluffs, Snowbird, Joyce Kilmer-Slickrock Extension #1, Lower Snowbird Creek, Southern Nantahala Extensions A1 and A2, Wesser Bald, and Unicoi Mountains #1 have a higher biodiversity priority index than 99% of all other roadless lands in the lower 48 United States (Figure 5). Nearly all Mountain Treasures have a higher biodiversity priority index than 95% of all other roadless areas (Fig S4).

3.4 Composite wildland conservation value

Combined these qualities resulted in a composite wildland conservation priority of Mountain Treasures being on average ~15% higher than IRAs (Table 1; Figure 1E; Figure 6). On average the Mountain Treasures exceed the wildland conservation value of other roadless areas and over half of the Mountain Treasures have a higher value than 95% of all other roadless areas (Figure Fig S5).

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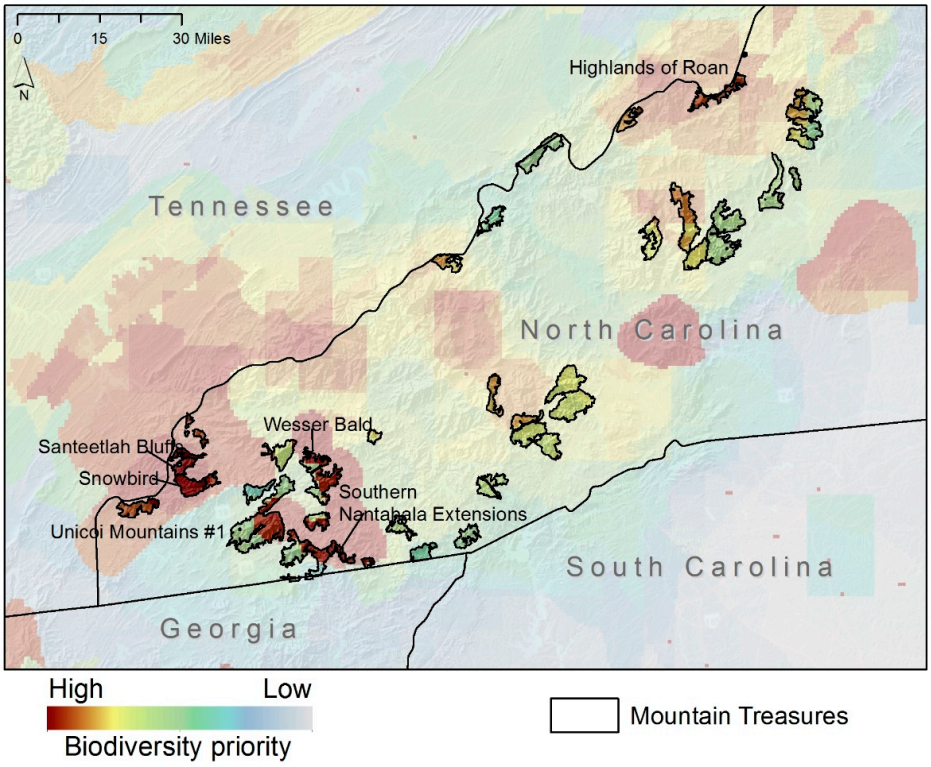

Figure 5. Map of the biodiversity priority index of Jenkins et al. 2015, which identifies key areas containing many range-limited species that are poorly represented in protected areas.

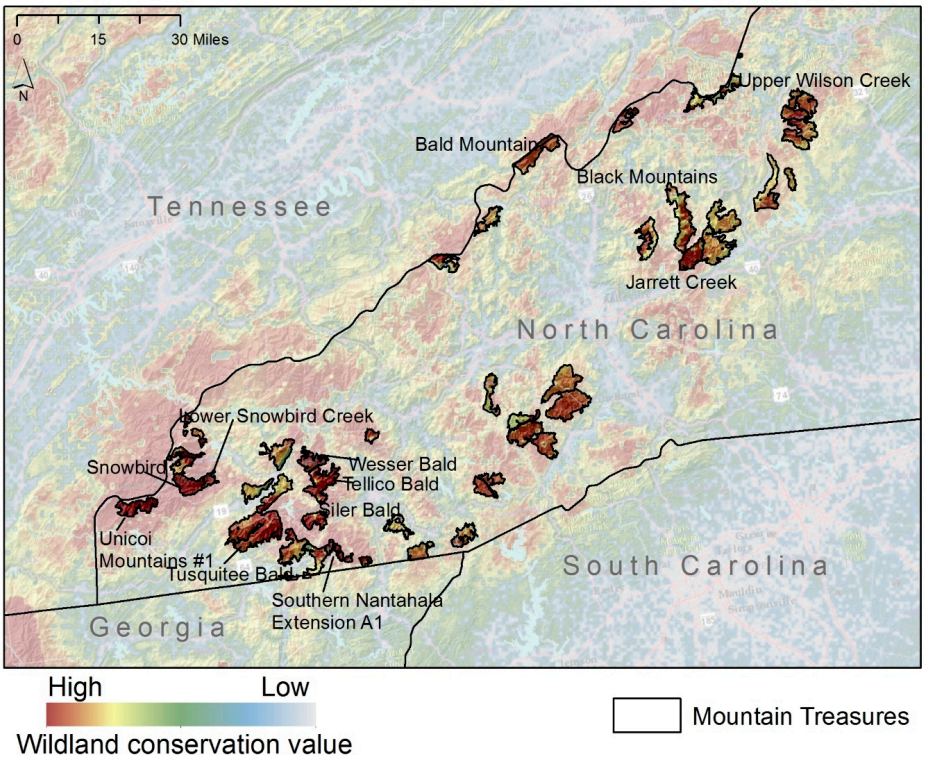

Figure 6. The composite wildland conservation value of Belote et al. 2017 that combined indices of ecological integrity, connectivity, ecosystem representation, and biodiversity priorities into one map.

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4. Discussion

The Mountain Treasures represent some of the most important lands in the U.S. to establish a protected areas system that is intact, connected, representative of ecological diversity and hotspots of range-limited species. Our assessment is based on a number of widely accepted principles from conservation science that provide guidance on how to construct a system of protected areas to maintain biodiversity and ecological processes in the face of habitat fragmentation and climate change [2,3,9,26–28]. A conservation reserve system that is ecologically intact, connected in a network of protected areas, and representative of ecosystem and species diversity may provide the greatest degree of adaptive capacity in the face of a global change [9,29]. Unprotected lands that possess these qualities may be considered high priorities for adding to the existing system of conservation reserves [4]. The Mountain Treasures are not currently designated as highly protected lands.

In their valuable new paper, Aycrigg et al. (2016) state their intent to "start the conversation" about completing a national protected area system that is more representative of ecosystem and species diversity. Our objective here is to use a recent national assessment of wildland conservation values to assess the significance of North Carolina's Mountain Treasures in helping achieve a resilient protected area system of the future. The Mountain Treasures are among the most valuable roadless areas in the country for the qualities they currently maintain. It may be critical to consider their national significance in land management and conservation decisions. Without such broad-scale analyses, local decisions and actions may fail to appreciate important national [4] or global [1] conservation priorities.

The Mountain Treasures are less intact and wild compared to all roadless areas, many of which are in the western U.S. (Figure 1A). This is not surprising given the higher density of human population, roads, and other disturbances experienced by ecosystems of the eastern U.S. Interestingly, at a global scale, biologically-rich areas tend to experience more intensive human modification [17]. Thus, patterns of biodiversity and human modification of the Southern Appalachians represent an example of this global phenomenon [30]. It is worth noting, however, that the Mountain Treasures represents some of the most intact and wildest places in the Southeastern U.S. and the region.

Despite the overall higher degree of human modification and lower degree of ecological integrity of the Mountain Treasures, their importance for establishing and maintaining a nationwide and regional connected network of protected areas is nearly identical to all other roadless areas in the U.S. [6]. Many of the Mountain Treasures lie between existing protected areas and therefore represent important priorities for maintaining connections between existing conservation reserves including Great Smoky Mountains National Park and wilderness areas on the Nantahala and Pisgah National Forests (Figure 3).

The Mountain Treasures are also equally important compared to the other roadless areas with respect to expanding the representation of ecosystem diversity in protected areas (Figure 1C). These roadless areas may be considered as reasonable candidates for future wilderness designation [25], and protecting roadless areas composed of ecosystems poorly represented in wilderness and other highly protected areas should be considered high priorities for additional protections [24]. Designating lands composed of poorly represented ecosystems will ensure that our protected areas system of the future includes all of nature's diversity, and can be used as part of important climate adaptation planning [31].

Compared to other roadless areas – the likely candidates for inclusion in an expanded conservation reserve system – the Mountain Treasures are some of the most biologically rich and represent important conservation priorities [8]. The richness of range-limited and endemic species in the Appalachians compared to other roadless lands is the result of paleo-ecological history, the diverse climatic and edaphic gradients, and seasonal climatic patterns of the region [32]. A number of species occur nowhere else on Earth or are geographically restricted, but remain without formal conservation protection [8]..

When combined, the four indices described above provide important insights into the national conservation significance of the Mountain Treasures. These roadless lands are among the nation's

most important if we are to construct a protected area system of the future that has the best chance of passing our natural heritage on to future generations.

5. Conclusions

Our analysis provides a case study for using national geospatial data that represent individual or combined conservation values to assess the significance of local areas in regional conservation plans. Implementing conservation protections will require work with local communities, federal agencies, and potentially congressional review and legislation. However, we believe it is important to place conservation evaluations into a broader spatial context than is typically considered in decision making (e.g., [33]). Local abundance of values can sometimes conceal the national or global rarity or significance of lands to local conservation planners.

While we believe that local land use decisions should be placed into this global or national context, we also recognize that local evaluations of data on conservation values not reflected in national datasets will remain a critical part of conservation planning. However, a well-known adage of conservation is "think globally, act locally." As global and national data become increasingly available, local conservation planners or land managers can evaluate the broader significance of local areas. These efforts provide important opportunities to not only think globally (or nationally), but also to quantify the global or national significance of lands.

Supplementary Materials: The following are available online at www.mdpi.com/link, Figure S1: Mean value of the ecological integrity index used in Belote et al. 2017 with each Mountain Treasure rank ordered from highest to lowest., Figure S2: Mean value of the corridor index from Belote et al. (2016) and used in Belote et al. 2017 with each Mountain Treasure rank ordered from highest to lowest., Fig S3: Mean value of the ecosystem representation priority index used in Belote et al. 2017 with each Mountain Treasure rank ordered from highest to lowest. Fig S4. Mean value of the biodiversity priority index used in Belote et al. 2017 with each Mountain Treasure rank ordered from highest to lowest., Fig S5: The mean composite Wildland Conservation Value for all Mountain Treasures rank ordered from highest to lowest.

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Author Contributions: R.T.B. and G.H.I conceived and designed the project; R.T.B performed the analysis and analyzed the data; R.T.B. and G.H.I wrote the paper.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. List of North Carolina's Mountain Treasures, their area, mean elevation (meters above sea level), and mean indices (± standard deviation) based on national data of Belote et al. 2017.

Mountain Treasure Name	Hectares	Elevation (m)	Ecological integrity	Biodiversity priority index	Connectivity index	Ecosystem representation index	Composite wildland conservation value
Alarka Laurel	1006	1273	0.73 ± 0.05	0.74 ± 0.03	0.93 ± 0.01	0.83 ± 0.14	3.2 ± 0.14
Ash Cove	2382	940	0.57 ± 0.22	0.62 ± 0.05	0.85 ± 0.04	0.86 ± 0.04	2.88 ± 0.3
Bald Mountain	4696	1010	0.68 ± 0.05	0.66 ± 0.01	0.95 ± 0.02	0.86 ± 0.06	3.16 ± 0.06
Big Ivy #1	4297	1253	0.7 ± 0.05	0.75 ± 0.02	0.87 ± 0.03	0.78 ± 0.16	3.06 ± 0.17
Black Mountains	7248	1386	0.66 ± 0.03	0.79 ± 0.02	0.88 ± 0.04	0.73 ± 0.18	3.06 ± 0.17
Bluff Mountain	2373	837	0.64 ± 0.11	0.64 ± 0.02	0.87 ± 0.05	0.87 ± 0.08	3.02 ± 0.17
Boteler Peak	4320	1023	0.65 ± 0.13	0.72 ± 0.1	0.89 ± 0.06	0.85 ± 0.09	3.11 ± 0.2
Cedar Rock Mountain	3513	934	0.69 ± 0.04	0.73 ± 0.01	0.9 ± 0.04	0.86 ± 0.1	3.14 ± 0.2
Cheoah Bald	3826	1057	0.56 ± 0.23	0.76 ± 0.07	0.83 ± 0.05	0.84 ± 0.11	2.99 ± 0.28
Daniel Ridge	4782	1195	0.68 ± 0.04	0.73 ± 0.01	0.93 ± 0.02	0.81 ± 0.14	3.15 ± 0.18
Dobson Knob	4771	776	0.67 ± 0.06	0.68 ± 0.01	0.81 ± 0.06	0.89 ± 0.08	3.05 ± 0.11
Fishhawk Mountain	2294	1050	0.68 ± 0.03	0.7 ± 0.01	0.76 ± 0.03	0.85 ± 0.1	2.95 ± 0.19
Harper Creek	3008	710	0.68 ± 0.02	0.69 ± 0.06	0.89 ± 0.05	0.87 ± 0.09	3.14 ± 0.13
Highlands of Roan #1	1643	1551	0.67 ± 0.04	0.83 ± 0.01	0.93 ± 0.02	0.6 ± 0.19	3.04 ± 0.2
Highlands of Roan #2	2145	1482	0.65 ± 0.05	0.83 ± 0.02	0.86 ± 0.03	0.62 ± 0.18	2.97 ± 0.18
Jarrett Creek	3633	964	0.72 ± 0.03	0.75 ± 0.02	0.94 ± 0.03	0.85 ± 0.1	3.23 ± 0.17
Joyce Kilmer - Slickrock Extension #1	1444	1223	0.66 ± 0.04	0.98 ± 0.03	0.89 ± 0.04	0.79 ± 0.16	3.24 ± 0.24
Joyce Kilmer - Slickrock Extension #2	936	927	0.69 ± 0.02	0.84 ± 0	0.79 ± 0.03	0.85 ± 0.12	3.17 ± 0.06

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Joyce Kilmer - Slickrock Extension #3	489	604	0.64 ± 0.06	0.84 ± 0	0.83 ± 0.04	0.88 ± 0.05	3.19 ± 0.09
Joyce Kilmer - Slickrock Extension #4	132	997	0.71 ± 0.01	0.84 ± 0	0.8 ± 0	0.86 ± 0.06	3.18 ± 0.02
Laurel Mountain	5411	1053	0.67 ± 0.1	0.74 ± 0.01	0.81 ± 0.04	0.85 ± 0.1	3.06 ± 0.18
Linville Gorge Extension A	1151	653	0.71 ± 0.03	0.68 ± 0	0.76 ± 0.02	0.87 ± 0.11	3.04 ± 0.03
Linville Gorge Extension B	251	654	0.68 ± 0.03	0.68 ± 0	0.89 ± 0	0.87 ± 0.09	3.01 ± 0.28
Lost Cove	2392	824	0.67 ± 0.04	0.76 ± 0.04	0.89 ± 0.05	0.86 ± 0.09	3.16 ± 0.16
Lower Snowbird Creek	1097	868	0.73 ± 0.02	0.9 ± 0.07	0.91 ± 0.02	0.87 ± 0.04	3.41 ± 0.08
Mackey Mountain	6110	790	0.68 ± 0.04	0.69 ± 0.01	0.84 ± 0.04	0.86 ± 0.05	3.04 ± 0.14
Middle Prong Extension	2708	1330	0.67 ± 0.02	0.78 ± 0.01	0.85 ± 0.08	0.75 ± 0.17	2.99 ± 0.13
Nolichucky Gorge	2285	893	0.66 ± 0.03	0.79 ± 0.01	0.92 ± 0.05	0.86 ± 0.11	3.26 ± 0.06
Overflow	2432	950	0.65 ± 0.04	0.62 ± 0	0.92 ± 0.04	0.87 ± 0.11	3.04 ± 0.21
Panthertown #1	1890	1207	0.68 ± 0.05	0.7 ± 0.01	0.93 ± 0.03	0.85 ± 0.14	3.19 ± 0.07
Panthertown #2	1529	1117	0.66 ± 0.02	0.7 ± 0.01	0.94 ± 0.03	0.86 ± 0.07	3.16 ± 0.11
Panthertown #3	127	1268	0.66 ± 0.03	0.67 ± 0.02	0.93 ± 0.04	0.86 ± 0.1	3.17 ± 0.05
Piercy Mountain Range	3686	1046	0.66 ± 0.11	0.73 ± 0.09	0.82 ± 0.04	0.86 ± 0.05	3.07 ± 0.21
Pigeon River Gorge	2473	868	0.5 ± 0.21	0.78 ± 0.01	0.88 ± 0.06	0.85 ± 0.11	2.97 ± 0.4
Santeetlah Bluffs	1800	1327	0.63 ± 0.03	1 ± 0	0.9 ± 0.02	0.73 ± 0.18	3.19 ± 0.19
Shining Rock Extension	1968	1623	0.64 ± 0.05	0.78 ± 0.02	0.89 ± 0.03	0.6 ± 0.19	2.88 ± 0.17
Siler Bald	2542	1231	0.68 ± 0.07	0.83 ± 0.08	0.96 ± 0.01	0.83 ± 0.11	3.28 ± 0.17
Slide Hollow NC	80	933	0.69 ± 0.01	0.8 ± 0.02	0.77 ± 0	0.86 ± 0.11	3.17 ± 0.03
Snowbird	3630	1214	0.7 ± 0.04	1 ± 0.01	0.93 ± 0.02	0.83 ± 0.12	3.47 ± 0.13
South Mills River	6929	937	0.7 ± 0.05	0.74 ± 0.01	0.88 ± 0.04	0.86 ± 0.05	3.18 ± 0.08
Southern Nantahala Extension A1	1014	1187	0.7 ± 0.03	0.88 ± 0.01	0.93 ± 0.05	0.87 ± 0.05	3.38 ± 0.09
Southern Nantahala Extension A2	703	1244	0.74 ± 0.02	0.88 ± 0	0.84 ± 0.04	0.86 ± 0.05	3.29 ± 0.09
Southern Nantahala Extension B	3174	1140	0.58 ± 0.23	0.76 ± 0.15	0.85 ± 0.04	0.83 ± 0.13	3.02 ± 0.25
Southern Nantahala Extension D	634	978	0.63 ± 0.05	0.81 ± 0.1	0.93 ± 0.02	0.86 ± 0.04	3.22 ± 0.16
Southern Nantahala Extension E	468	847	0.69 ± 0.01	0.64 ± 0.01	0.94 ± 0.03	0.87 ± 0.03	3.15 ± 0.04

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Sugar Knob	2501	786	0.59 ± 0.11	0.73 ± 0.04	0.9 ± 0.06	0.87 ± 0.08	3.09 ± 0.14
Tellico Bald	5068	1133	0.75 ± 0.03	0.81 ± 0.09	0.92 ± 0.06	0.83 ± 0.12	3.29 ± 0.15
Terrapin Mountain	2691	957	0.65 ± 0.08	0.66 ± 0.01	0.9 ± 0.05	0.86 ± 0.13	3.05 ± 0.21
Tusquitee Bald	11810	1031	0.73 ± 0.03	0.76 ± 0.1	0.92 ± 0.03	0.84 ± 0.1	3.26 ± 0.13
Unicoi Mountains #1	3615	838	0.78 ± 0.02	0.85 ± 0.06	0.94 ± 0.02	0.87 ± 0.05	3.44 ± 0.1
Upper Wilson Creek	3771	817	0.66 ± 0.09	0.73 ± 0.05	0.89 ± 0.05	0.86 ± 0.1	3.11 ± 0.17
Wesser Bald	2693	982	0.69 ± 0.1	0.87 ± 0.15	0.93 ± 0.03	0.86 ± 0.07	3.32 ± 0.17
Woods Mountain	5131	800	0.67 ± 0.04	0.69 ± 0	0.81 ± 0.04	0.87 ± 0.05	3.03 ± 0.1

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