FINAL REPORT

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For the project entitled:

A landscape-level assessment of conservation features and values in the proposed Owyhee Canyonlands National Conservation Area

Submitted to:

The Pew Charitable Trusts

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INTRODUCTION

Fundamental principles of systematic conservation planning (e.g., Margules and Pressey 2000) suggest that an ecologically functional protected areas network requires a sufficient land base, should protect a variety of habitats, and—perhaps most critically—needs to be interconnected (DeFries et al. 2007, Cumming et al. 2015). Yet, in the United States, as is the case in other places in the world, protected areas have rarely been selected to meet these criteria (Scott et al. 1993, Jenkins et al. 2015). Indeed, existing protected areas in the U.S. are likely insufficient to guard against the long-term loss of species and the habitats they require (Scott et al. 2001). Thus, there is a critical need to expand and better connect the existing protected areas network.

In the western U.S., vast areas of still undeveloped public land have the potential to enhance the ecological effectiveness of the U.S. protected areas network (Rodrigues et al. 2004). This is particularly true if the ecological significance and context of currently unprotected lands are used to determine the location of new areas for future conservation and protection (Dickson et al. 2014). Extensive areas of public land administered by the Bureau of Land Management (BLM), for example, have the potential to maintain and further connect important components of biological diversity and ecological function in the West. Herein, we examine BLM lands because this federal agency administers more land than any other agency in the U.S. and because these lands help form the 'connective tissue' among multiple protected areas and jurisdictions.

In this context, the proposed 2,579,032-acre Owyhee Canyonlands National Conservation Area (OCNCA) in southeastern Oregon presents a significant opportunity to conserve key elements of native biodiversity and ecological function within this region, within the BLM's jurisdiction, and across the western U.S. A recent study by Dickson et al. (2014) was designed to provide a sound scientific basis for future proposals for conservation-based special designations in the western U.S., with an emphasis on BLM lands. Results from this study suggested that areas within and around the OCNCA were among the most important in the West, in terms of their conservation value. Here, we leverage input data and models results produced by this study, as well as other sources of readily available spatial data, to conduct an assessment of conservation features and values across the OCNCA and adjacent lands. We focused our assessment on information that highlighted the ecological importance and representativeness of the OCNCA in both landscape and regional settings.

Assessing the ecological importance of the OCNCA

For our assessment, we first summarized the conservation value of currently unprotected roadless lands within the proposed OCNCA boundary relative to equivalently sized unprotected roadless lands within BLM's jurisdiction, based on the approach and results described in Dickson et al. (2014). In addition, we mapped and summarized nine landscape-level indicators of connectivity and integrity, biodiversity, resilience to climate change, and remoteness (see also Dickson et al. 2014). Specifically, we used readily available spatial data and published methods to model two indicators of potential landscape connectivity and integrity: ecological flow (see below) and proximity to the nearest protected area (USGS 2011a); four indicators of biodiversity: vegetation community diversity (Scott et al. 1993), rarity-weighted species richness (Chaplin et al. 2000; updated in 2008), geological diversity (Garrity and Soller 2009), and surface water availability (USGS 2008); one indicator of resilience to climate change: topographic complexity (Smith et al. 2011); and two indicators of remoteness: night sky darkness (NOAA 2012) and landscape naturalness (the inverse of human modification; Theobald 2013). Data for each indicator was generated using a 65,000-acre scale of analysis and a 270-m pixel resolution (methods detailed in Dickson et al. 2014). Although we focused our assessment on the OCNCA, our indicator maps extended across all 11 western states, permitting comparisons between the OCNCA and equivalently sized areas within two different extents: all BLM lands in the West and all lands (public and private) within the 11 western states. Finally, we summarized two indicators of habitat quality for greater sage-grouse (*Centrocercus urophasianus*) across the extent of the species' current range (Schroeder et al. 2004), including landscape naturalness (Theobald 2013) and percent composition of sagebrush- (*Artemisia* spp.) dominated land cover types (within an 18-km radius; Knick and Connelly 2010) to allow comparisons between the OCNCA and other areas within the current range of the sage-grouse.

We derived a model and map of ecological flow among existing protected areas within the 11 western states in order to quantify the ability of currently unprotected areas to enhance potential connectivity across the existing protected areas network. This connectivity model was designed to inform land use planning and policy efforts concerned with the maintenance of connectivity processes (e.g., migration and dispersal, gene flow) for multiple terrestrial species simultaneously. Specifically, we used a model of human modification (Theobald 2013) to estimate landscape resistance (see Krosby et al. 2015) and concepts from electronic circuit theory (McRae et al. 2008) to estimate the flow (as measured by current density) of ecological processes across the region.

We determined the values of each of the indicators relative to the larger landscape using a simple scoring system based on percentile ranks. Specifically, the mean value of each indicator within the OCNCA was compared to the distribution of means of a large ($n > 100$) random sample of areas across the larger landscape (e.g., all BLM lands, all lands in the 11 western states, or all lands within the current range of the sage-grouse). The size of each of the random samples was equivalent to the size of the proposed OCNCA. Scores ranged from 0 to 100. For example, a score of 98 for a given indicator would indicate that the mean value of that indicator in the OCNCA was greater than or equal to 98% of equivalently sized random samples. Although we considered a given indicator to be relatively important if its score was above 50.0, scores below this value could still reflect substantial ecological importance.

Assessing the ecological representativeness of the OCNCA

The ability of any protected areas network to capture biodiversity and maintain ecological function will depend on the variety of ecosystem components (e.g., vegetation and landform types that contribute to habitat) that are represented within the network (Aycrigg et al. 2013). In the U.S., only 12% of lands have protected status (USGS 2011a), and these lands have typically not been selected on the basis of representation (Pressey 1994). Thus, as a second step, we assessed the degree to which the OCNCA diversifies the existing protected areas network by increasing representation of different ecosystem components. We compiled spatial data on major ecosystem (USGS 2011b) and landform (Theobald et al., in review) types across the western U.S. and within the proposed OCNCA. Next, we calculated the percentages of different ecosystem components in the western U.S. that are represented in the current protected areas network, including lands managed specifically for conservation of species (IUCN 2008) and those within the BLM National Conservation Lands (NCL) system. We also calculated the percentages of ecosystem components that would be represented within the protected areas network following any designation of the proposed OCNCA.

RESULTS AND DISCUSSION

Areas within the OCNCA are among the most valuable, unprotected roadless lands in the western U.S.

The Dickson et al. (2014) assessment of unprotected roadless BLM lands in the western U.S. suggested the OCNCA harbors areas with highly significant conservation value. Based on their results, and compared to a random sample of equivalently sized unprotected roadless BLM lands in the western U.S., the mean conservation value across the entire OCNCA ranks greater than or equal to 85% of equivalently-sized random samples (Map 1). The individual constituents of the Dickson et al. (2014) measure of conservation value are addressed in more detail below. These results suggest that unprotected public lands that are relatively roadless and undeveloped, such as those in and around the proposed OCNCA, may afford the best opportunity to conserve natural elements and ecosystem processes (Davidson et al. 1996, Watts et al. 2007).

The OCNCA has exceptionally high potential to facilitate ecological connectivity

The maintenance of connectivity processes is one of the most important aspects of biodiversity and landscape-level conservation (Taylor et al. 1993, Noon et al. 2009). Considering potential ecological connectivity across all jurisdictions and lands in the West, we observed some of the strongest patterns of current (i.e., ecological) flow within the region of southeastern Oregon that includes the OCNCA (Map 2). Compared to a random sample of lands from both within BLM's jurisdiction and across the West, we observed exceptionally high values for ecological connectivity within the OCNCA (Figs. 1 and 2). Similarly, Theobald et al. (2012) observed a relatively large number of important 'routes' for potential connectivity through this region. The OCNCA is part of an important complex of well-connected habitats for multiple wide-ranging species, including, but not limited to: mule deer (*Odocoileus hemionus*), pronghorn antelope (*Antilocapra americana*), and bighorn sheep (*Ovis canadensis*). Because BLM lands dominate this part of the western U.S., roadless and relatively unmodified landscapes in BLMs domain may be key to the movement of fundamental ecological processes among protected areas and across other jurisdictions. New protections or special designations for lands within this domain could help to build a true network of protected areas that promote the environmental conditions that facilitate the abilities of species and ecosystems to adapt to future climate change (Heller and Zavaleta 2009, Game et al. 2011).

The OCNCA would enhance the ecological effectiveness of the region by connecting existing protected areas

Our assessment of connectivity and proximity to protected areas suggests that the OCNCA and surrounding BLM lands provide important features that can facilitate the movement of multiple organisms within and across jurisdictions, now and under future climate conditions (Stein et al. 2008, Cross et al. 2012), provided that these lands are left unmodified and intact. Considering random samples of lands within BLM's jurisdiction and across the West, we observed very high values for the proximity of the OCNCA to existing protected areas (Figs. 1 and 2, Map 3). Moreover, the OCNCA would serve to permanently conserve and interconnect 22 different Wilderness Study Areas (WSAs; totaling 1,242,849 acres), enhancing the ecological effectiveness and regional importance of these NCL system lands (Darst et al. 2009).

The ecological and geological uniqueness and diversity of the OCNCA contributes to its high value for biodiversity conservation

Our analysis of biodiversity values in the OCNCA, including vegetation community diversity, geological diversity, rarity-weighted species richness, and surface water availability indicated that the OCNCA has high value with respect to these features, especially when compared to BLM lands (Figs. 1 and 2, Maps 4 and 5). The OCNCA ranks in the 87th and 66th percentiles compared to other BLM lands and other western lands, respectively, in terms of its vegetation diversity. This diversity includes a blend of Intermountain Basins, Columbia Plateau, and Rocky Mountain vegetation types, including a mix of six different types of sagebrush steppe and shrublands (USGS 2011b). Sparsely vegetated volcanic badlands, such as the Columbia Plateau Ash and Tuff Badlands, which occur in large tracts in the OCNCA, also are known to harbor numerous endemic plants (BLM 2002).

In addition, the OCNCA has relatively high geological diversity (Figs. 1 and 2, Map 5) and a unique geological history. Lava flows and other remnants of volcanic activity in the area over the past several million years have formed the template upon which dynamic sedimentary and erosional processes have played out, leaving behind colorful swirls of clay and silt, and the recognizable tafoni (or 'honeycomb') features among the welded tuff ash deposits. In addition to its visual appeal and its scientific and historical significance, this geodiversity is an important driver of biodiversity (e.g., Lawler et al. 2015), giving rise to a variety of geomorphic features and a substantial collection of springs (cold and hot), riparian areas, meadows, and other wetland habitats that each support numerous aquatic biota (BLM 2002) (Map 5). Relative to other, typically arid BLM lands, the OCNCA was in the 72nd percentile of surface water availability (Fig. 2).

Species richness is one of the most fundamental and important measures of biodiversity (Magurran 2004). Because rare and endemic species are key elements of total biodiversity in a given area (Myers et al. 2000), we used NatureServe's rarity-weighted richness index ('species richness' for convenience; refreshed 2008) to map and evaluate this component of biodiversity (see Chaplin et al. [2000] for references and modeling methods). The OCNCA exhibits high adjacency and reasonable overlap with areas of relatively high rarity-weighted species richness (Map 4), suggesting the presence of rare and endemic species. Compared to other western lands, the OCNCA was in the 58th percentile of rarity-weighted species richness (Fig. 1). Indeed, ground data suggest the OCNCA is home to over two dozen special status and endemic plant species, including sterile milkvetch (*Astragalus cusickii* var. *sterilis*), Ertter's senecio (*Senecio ertterae*), Packard's blazingstar (*Mentzelia packardiae*), and Owyhee clover (*Trifolium owyheense*) (BLM 2002).

The OCNCA is one of the most remote and most intact landscapes in the western U.S.

Our analysis suggests that the OCNCA is one of the most unmodified large landscapes on BLM lands and within the western U.S. (Figs. 1 and 2, Map 6). Based on the map extent derived by Dickson et al. (2014), the OCNCA contains approximately 1,061,258 acres of roadless lands greater than 5,000 acres in size, in addition to the 1,242,849 acres of provisionally protected roadless lands included in WSAs, totaling 2.30-million acres or 89% of the OCNCA (see Map 1). The OCNCA also has some of the lowest levels of light pollution in the western US, and as a result, one of the darkest night skies of any equivalently-sized areas on BLM lands or in the western U.S. (Figs. 1 and 2). In North America, light emissions have historically increased at an estimated rate of 6% annually, resulting in a rapid increase in light pollution (Cinzano and Elvidge 2003). Considering our results, the OCNCA may afford one of the best opportunities in the U.S. to preserve remote environmental assets of both human and ecological significance (Watts et al. 2007).

The OCNCA contains one of the most intact, contiguous sagebrush habitats within the current range of the sage-grouse

The sagebrush biome is the largest semi-desert ecosystem in the West. Nevertheless, it's also considered one of the most endangered ecosystems in the U.S. (Noss et al. 1995). Increasing land conversion, grazing pressure, non-native invasive plants (e.g., cheatgrass [*Bromus tectorum*]), uncharacteristic wildfire events, and climate change are among the principal causes of sagebrush habitat loss and fragmentation (Miller et al. 2011). Although Oregon has more sagebrush than almost any other state, sage-grouse and their habitats are vulnerable (Miller et al. 2011), and have the potential to become further disconnected without greater land protections (Manier et al. 2013). Our results suggest that the OCNCA encompasses large portions of intact, contiguous sage brush habitat (Fig. 3, Map 7). All of the OCNCA is overlapped by the highest priority habitat identified for sage-grouse, in terms of potential connectivity among populations (Crist et al. 2015). Such highly connected priority areas and habitat linkages will be key to the long-term viability of sage-grouse populations (Crist et al. 2015).

The OCNCA would enhance the diversity of the U.S. protected areas network

Based on our assessment of representation, the proposed OCNCA stands to increase the variety of vegetation and landform types in the U.S. protected area network, a number of which are currently underrepresented. The majority of protected areas in the western U.S. occur within high montane and alpine ecosystems (Fig. 4). This underrepresentation presents a significant bias, since most shrubland- and grassland-dominated ecosystem types are offered little protection. Nevertheless, our assessment indicated that the OCNCA encompasses a relatively large amount of cool semi-desert scrub and grassland, which is currently underrepresented in the existing protected areas network (Fig. 4; Aycrigg et al. 2013). Significant biases also are evident with respect to the protection of major landform types around the West, and cliffs and mountain tops have much more protection than basins, flats and valley bottoms (Fig. 5). However, the OCNCA includes a diversity of landform types (Fig. 5). The diverse topography of the OCNCA would contribute substantially to the portfolio of protected areas lacking these uncommon terrain features.

CONCLUSION

Our assessment of the OCNCA in regional, jurisdictional, and West-wide contexts highlighted the intrinsic value of the area with respect to multiple ecological indicators of conservation value, namely habitat connectivity, proximity to nearest protected areas, night sky darkness, landscape naturalness, and vegetation and geological diversity. Considering also the results of Dickson et al. (2014), protective designation of the proposed OCNCA would substantially grow and enhance the existing network of protected areas in this relatively unfragmented region, while supporting fundamental ecological processes (Davidson et al. 1996, Scott et al. 2001, Darst et al. 2009). The value of this area in sustaining the ecological function and large contiguous landscapes that sustain high levels of connectivity, biodiversity, resilience to climate change, and remoteness—within and across jurisdictions—should not be underestimated.

ACKNOWLEDGMENTS

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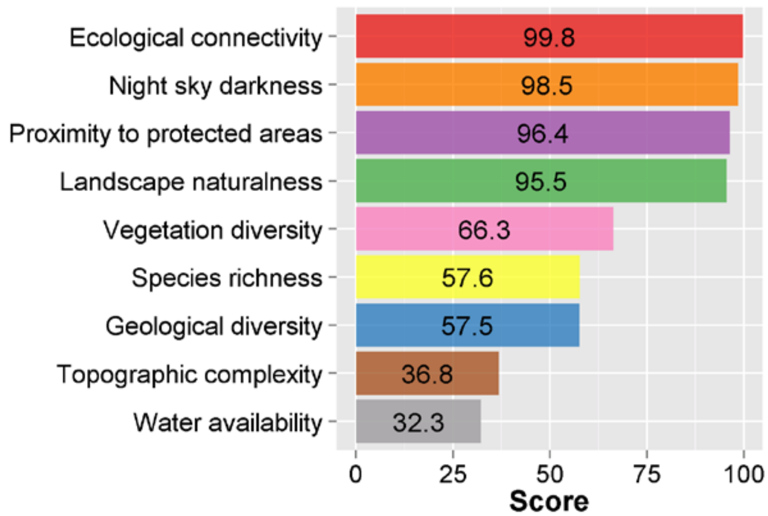


Figure 1. West-wide comparison*: Scores received by the proposed OCNCA for each of nine ecological indicators by comparing them to a random set of equivalently-sized areas located across the entire western U.S. Potential scores range from 0-100 (100 being highest). A score of 98 for a given indicator indicates that the mean value of that indicator in the OCNCA was greater than or equal to the mean value in 98% of equivalently-sized random samples. Scores of 50 or higher suggest a relatively important indicator.*

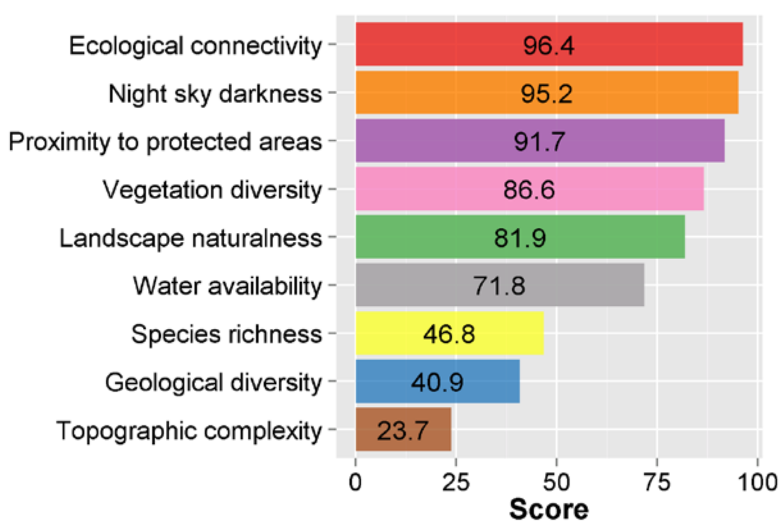


Figure 2. BLM-wide comparison*: Scores received by the proposed OCNCA for each of nine ecological indicators by comparing them to a random set of equivalently-sized areas located across the entire BLM jurisdiction. Potential scores range from 0-100 (100 being highest). A score of 98 for a given indicator indicates that the mean value of that indicator in the OCNCA was greater than or equal to the mean value in 98% of equivalently-sized random samples. Scores of 50 or higher suggest a relatively important indicator.*

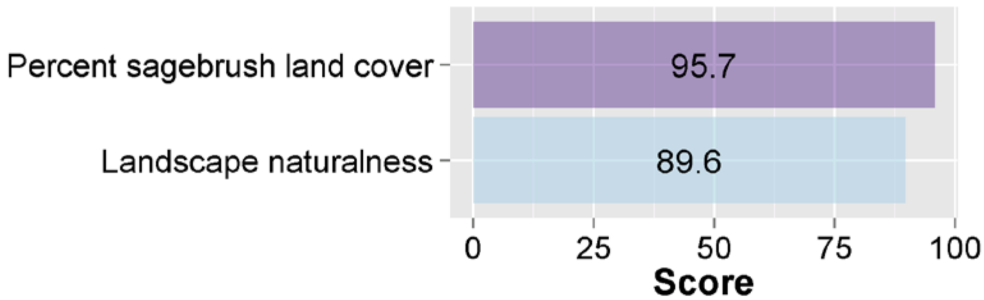


Figure 3*. Sage-grouse range-wide comparison. Scores received by the proposed OCNCA for two ecological indicators of high-quality sage-grouse habitat. The OCNCA were compared to a random set of equivalently-sized areas located across the current distribution of sage-grouse habitat (Schroeder 2004). Potential scores range from 0-100 (100 being highest). A score of 98 for a given indicator indicates that the mean value of that indicator in the OCNCA was greater than or equal to the mean value in 98% of equivalently-sized random samples. Scores of 50 or higher suggest a relatively important indicator.*

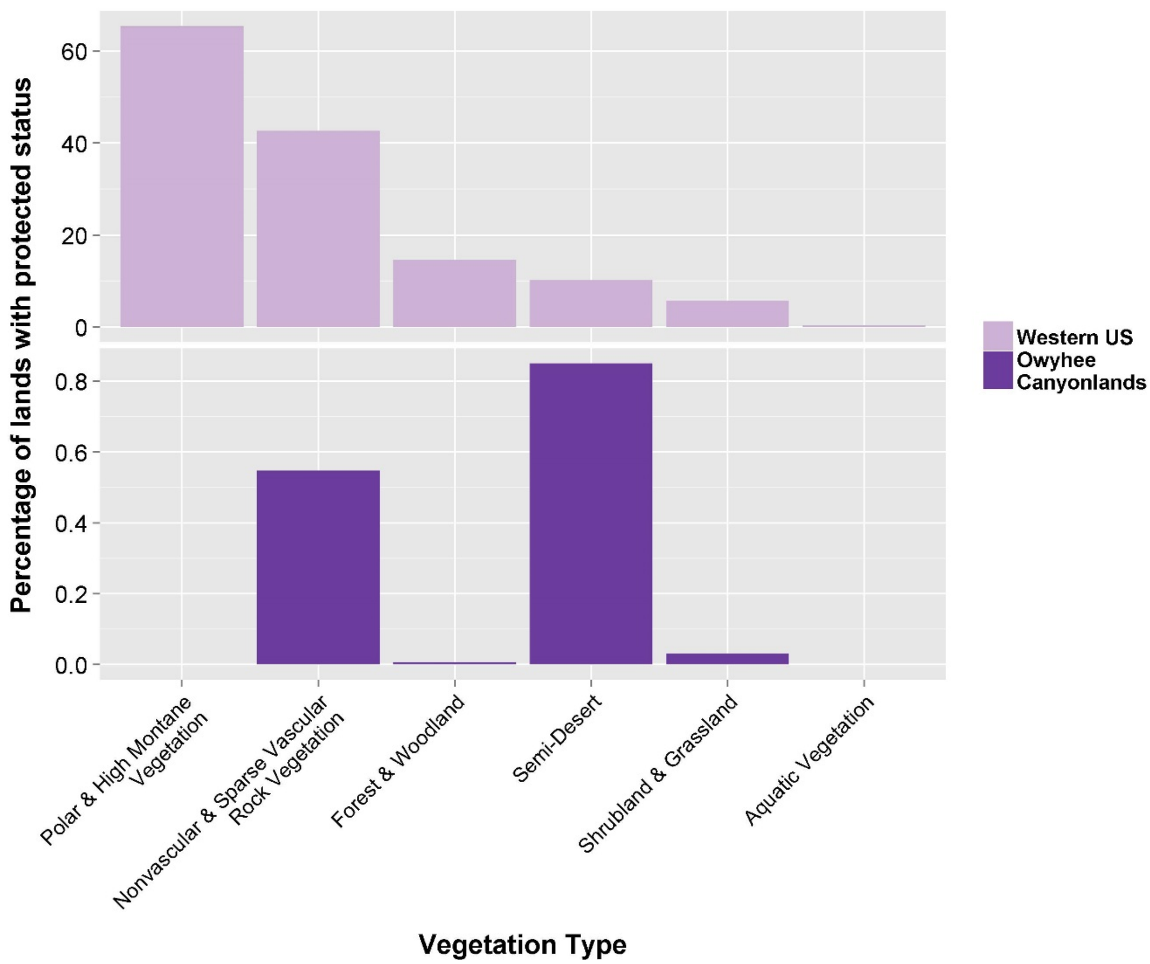


Figure 4. *Percentage of lands within different major vegetation types in the western U.S. that have protected status (upper) and percentage of additional lands that would be protected with designation of the proposed OCNCA (lower). The area would serve to enhance and diversify the existing protected areas network by increasing the representation of key vegetation types, including semi-desert scrub and grassland.*

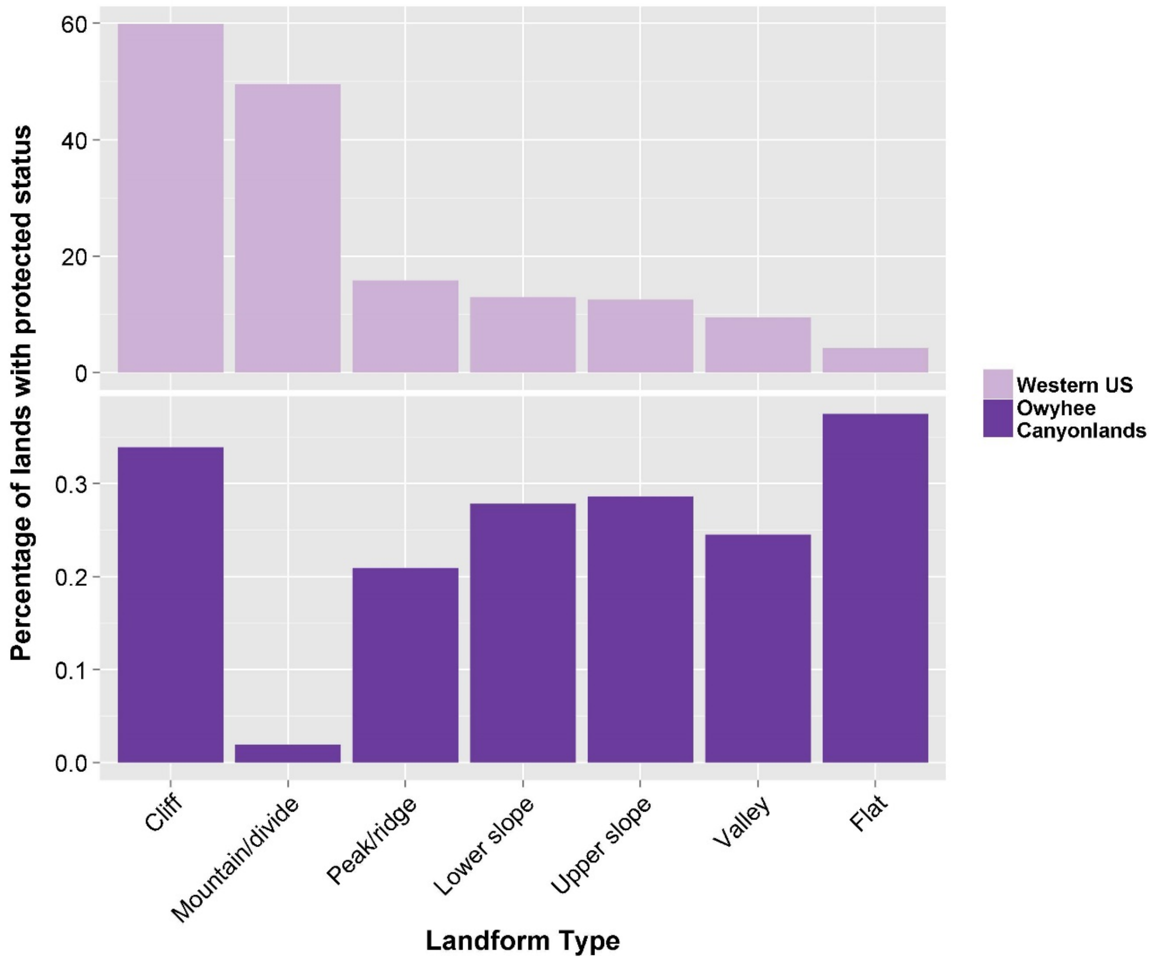
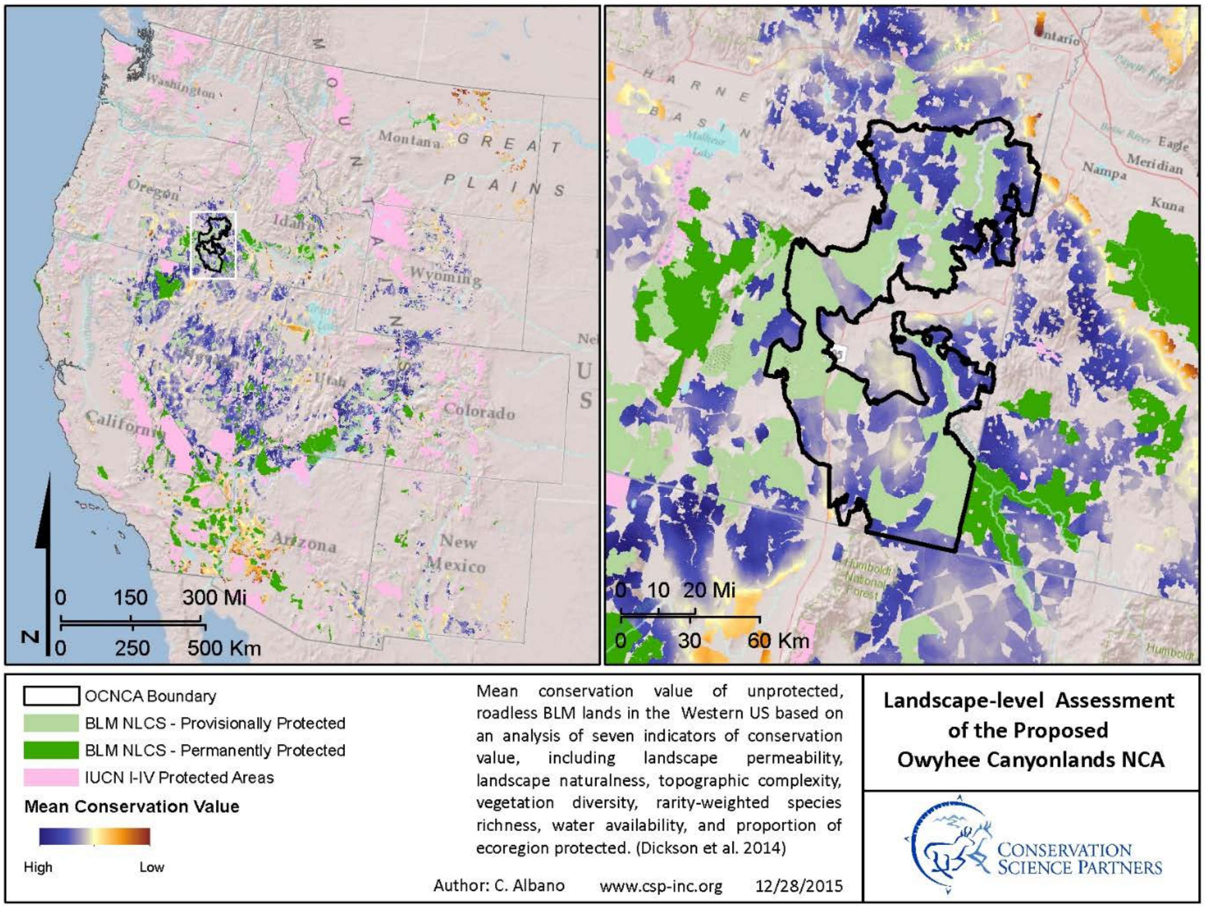
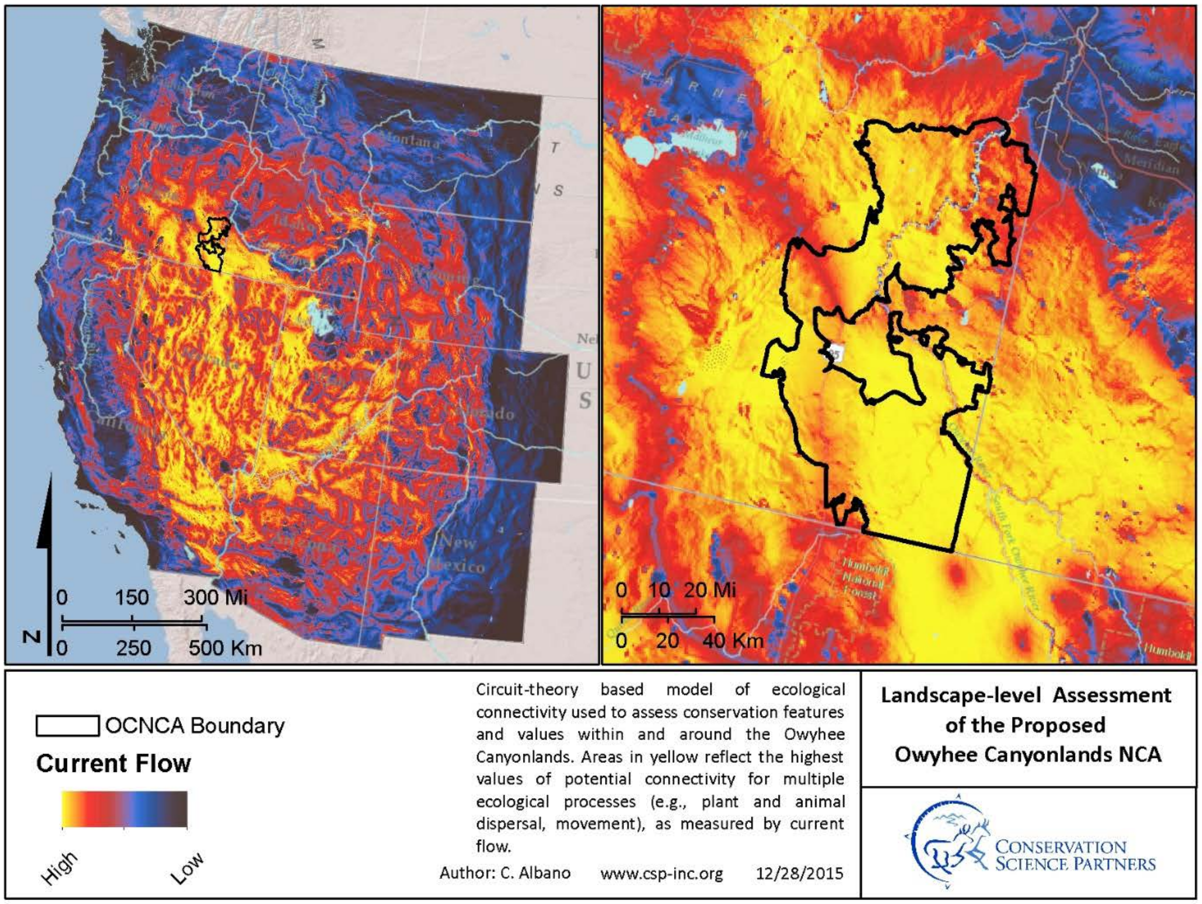


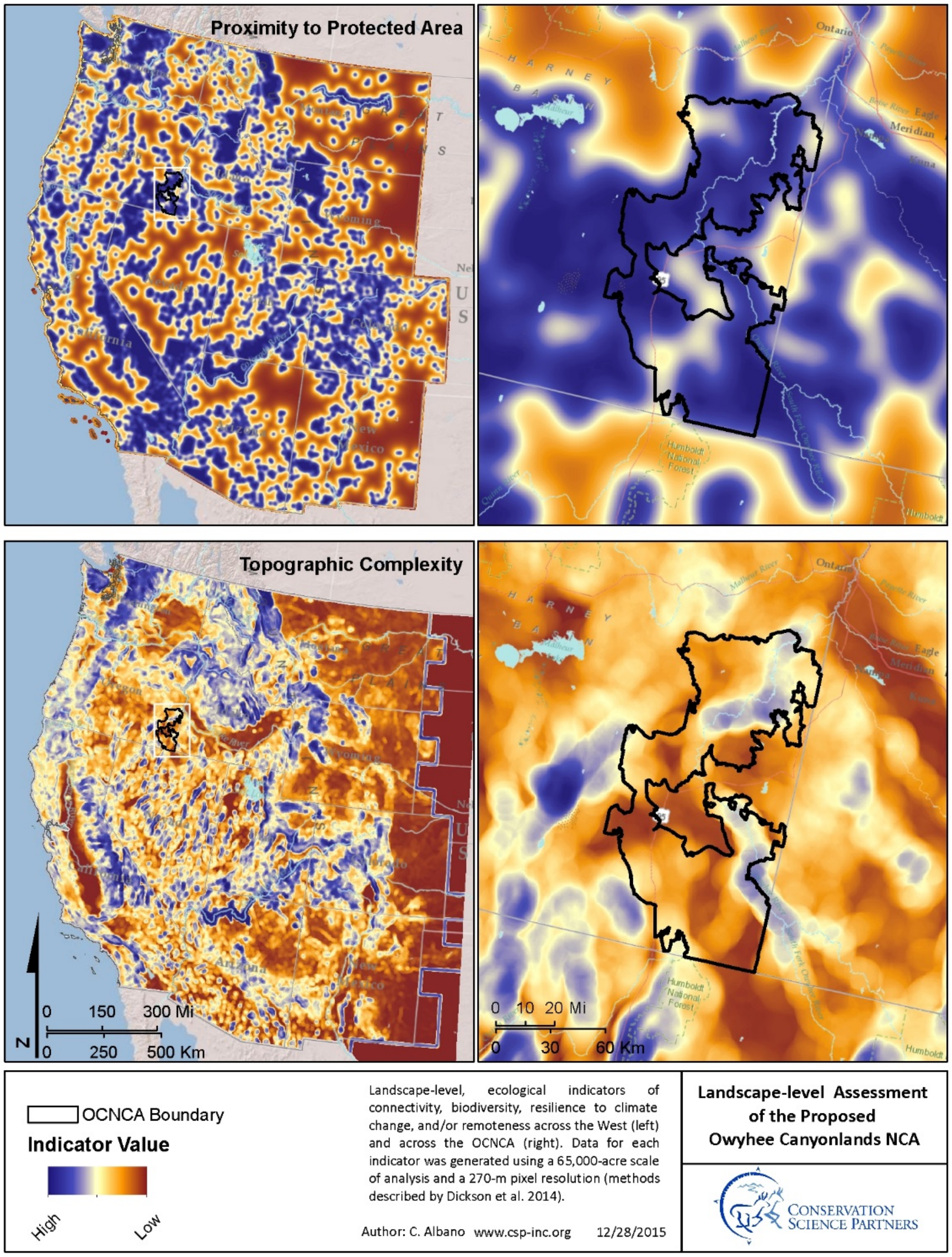
Figure 5. *Percentage of lands within different landform types in the western U.S. that have protected status (upper) and percentage of additional lands that would be protected, with designation of the proposed OCNCA (lower). The OCNCA has a disproportionately higher diversity of landform types than is found across the existing protected areas network. The area would serve to enhance and diversify the existing protected areas network by increasing the representation of most landform types, including valley bottoms and other terrain features that promote biodiversity and connectivity.*



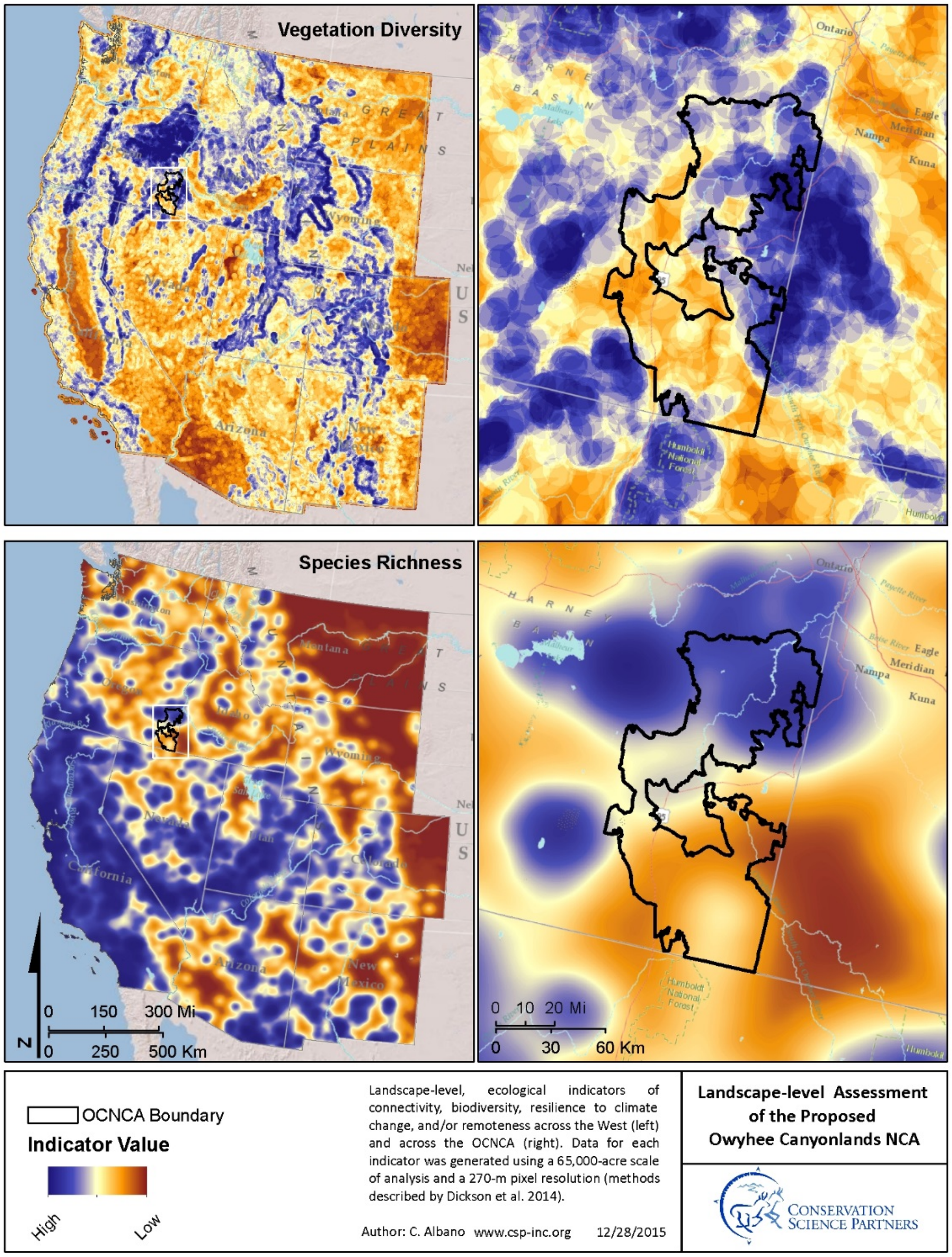
Map 1. *Mean conservation value of unprotected, roadless BLM lands in the western U.S. based on an analysis of seven indicators of conservation value, including landscape permeability, landscape naturalness, topographic complexity, vegetation diversity, rarity-weighted species richness, water availability, and proportion of ecoregion protected (Dickson et al. 2014).*



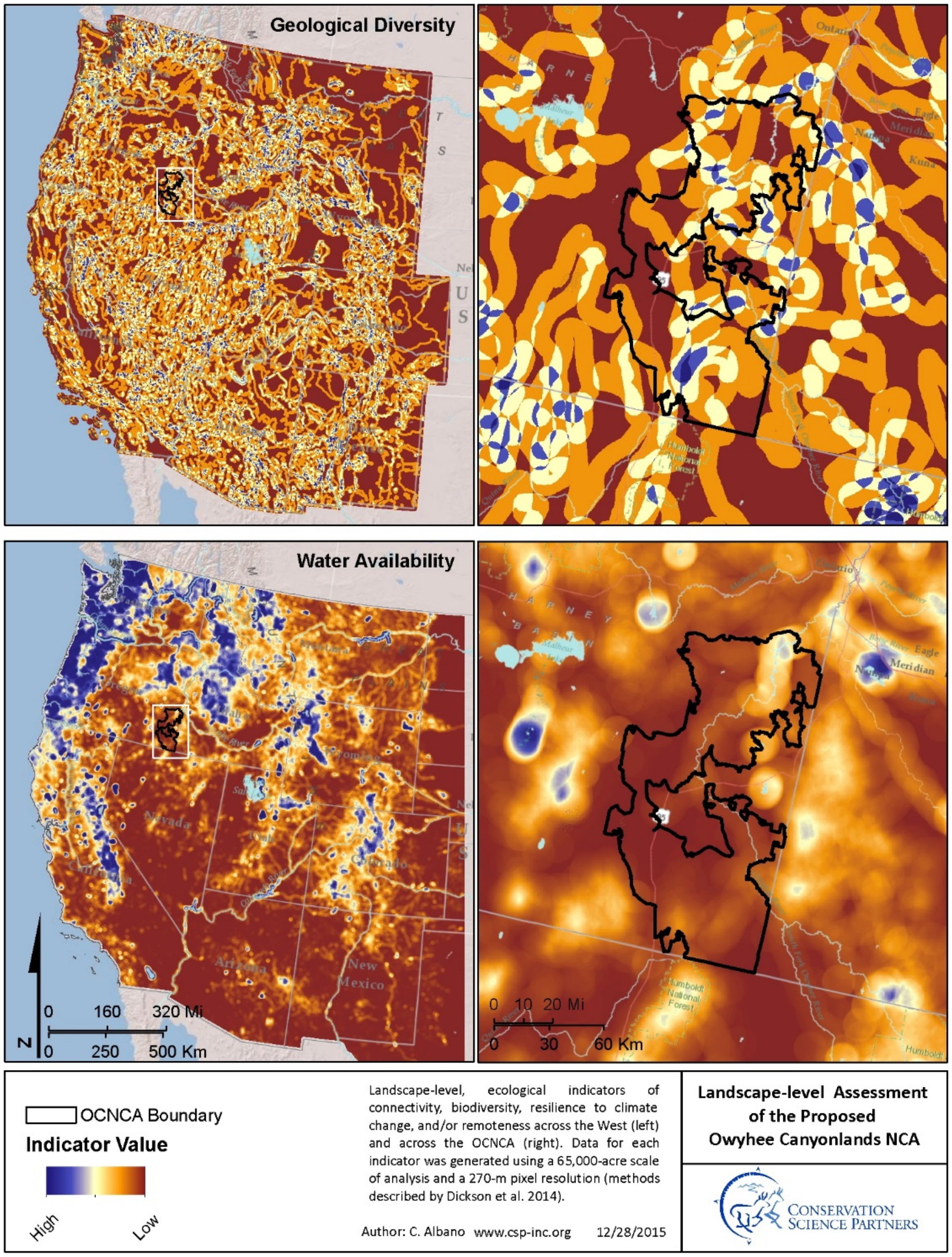
Map 2. *Circuit-theory based model of West-wide ecological connectivity used to assess conservation features and values within and around the Owyhee Canyonlands. Areas in yellow reflect the highest values of potential connectivity for multiple ecological processes (e.g., plant and animal dispersal, movement), as measured by current flow.*



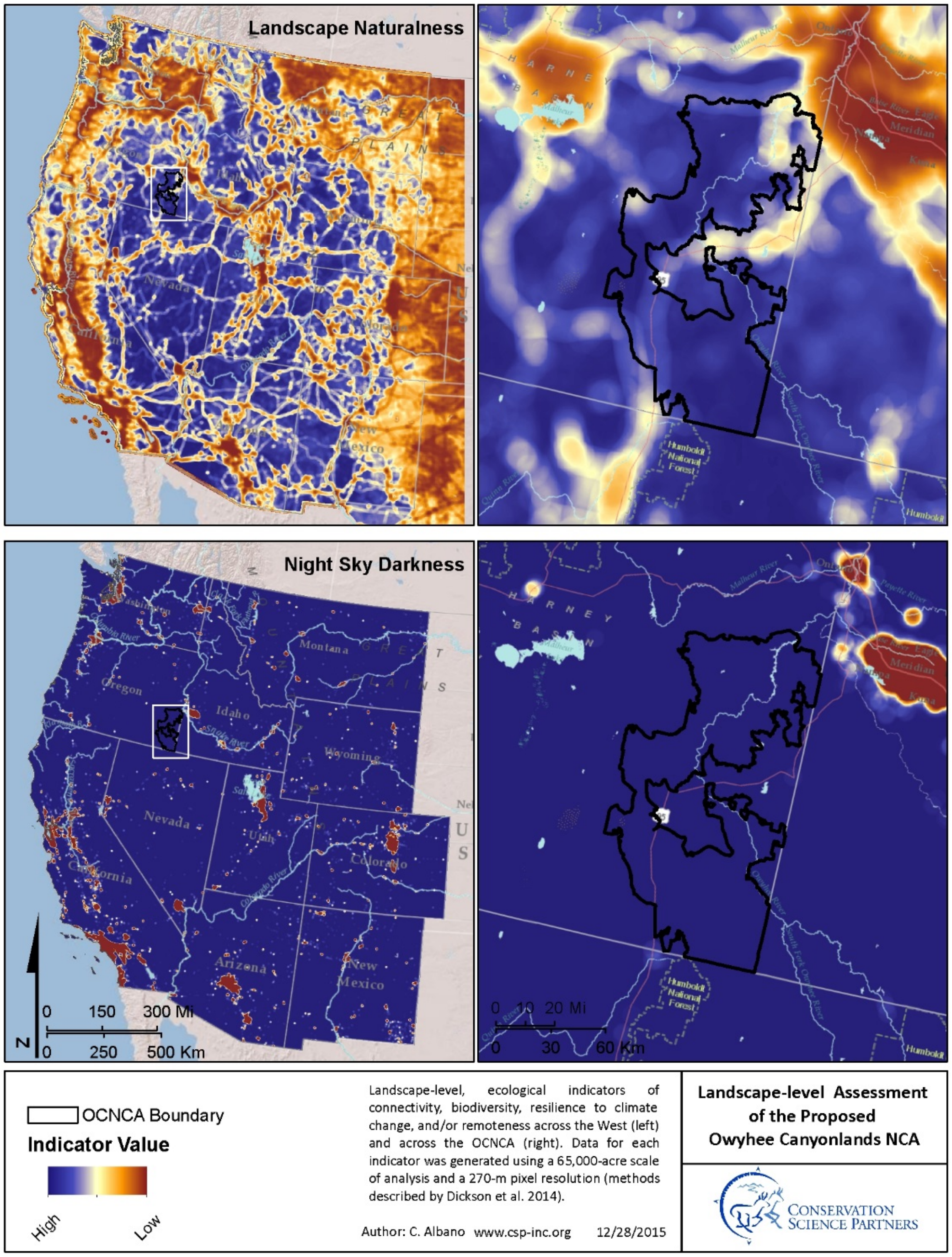
Map 3. *Landscape-level, ecological indicators of* ***proximity to protected area*** *(top) and* ***topographic complexity*** *(bottom) across the West (left) and across the OCNCA (right). Data for each indicator was generated using a 65,000-acre scale of analysis and a 270-m pixel resolution (methods described by Dickson et al. 2014).*



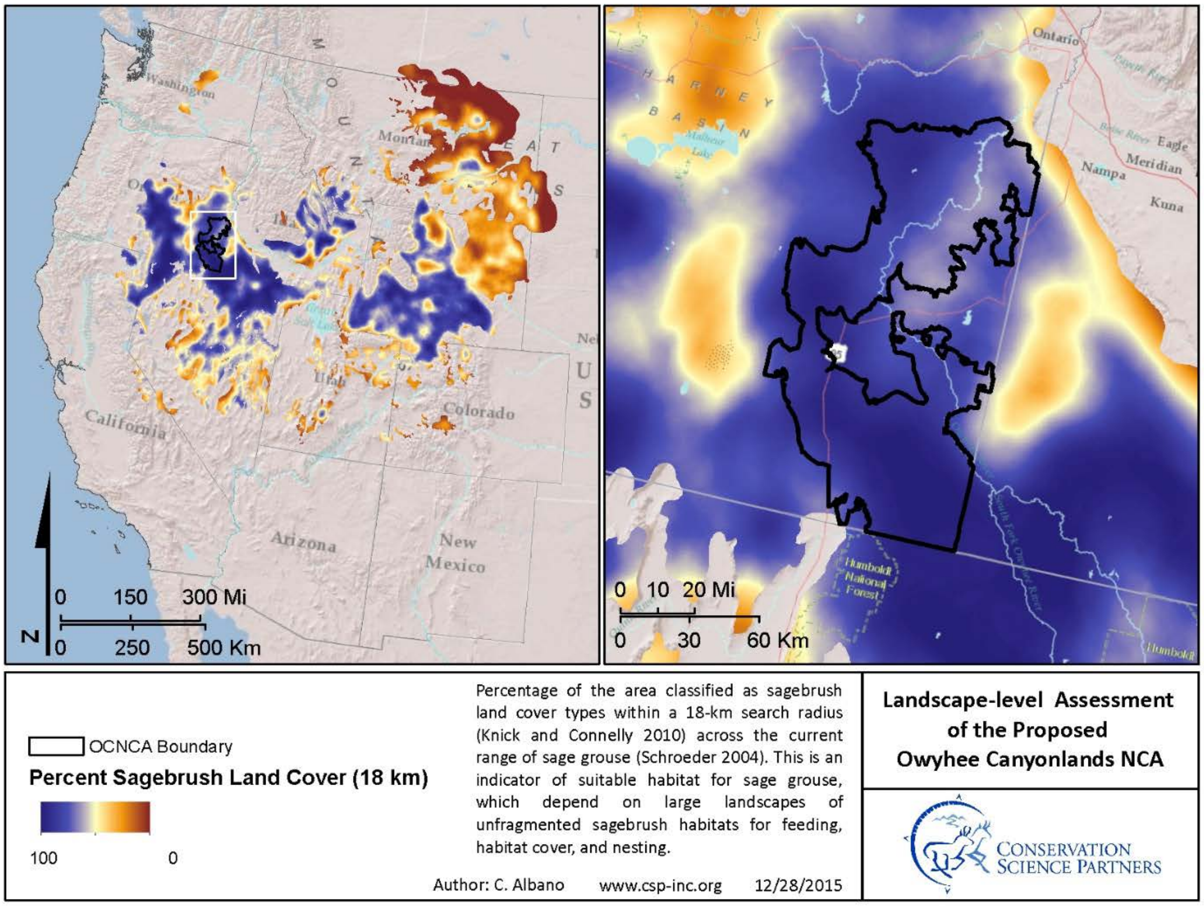
***Map 4.** Landscape-level, ecological indicators of **vegetation community diversity** (top) and **rarity-weighted species richness** (bottom) across the West (left) and across the OCNCA (right). Data for each indicator was generated using a 65,000-acre scale of analysis and a 270-m pixel resolution (methods described by Dickson et al. 2014).*



Map 5. *Landscape-level, ecological indicators of* ***geological diversity*** *(top) and* ***surface water availability*** *(bottom) across the West (left) and across the OCNCA (right). Data for each indicator was generated using a 65,000-acre scale of analysis and a 270-m pixel resolution (methods described by Dickson et al. 2014).*



Map 6. *Landscape-level, ecological indicators of* ***landscape naturalness*** *(top) and* ***night sky darkness*** *(bottom) across the West (left) and across the OCNCA (right). Data for each indicator was generated using a 65,000-acre scale of analysis and a 270-m pixel resolution (methods described by Dickson et al. 2014).*



Map 7. *Percentage of the area classified as sagebrush land cover types within a 18-km search radius (Knick and Connelly 2010) across the current range of sage-grouse (Schroeder 2004). This is an indicator of suitable habitat for greater sage-grouse, which depend on large landscapes of unfragmented sagebrush habitats for feeding, habitat cover, and nesting.*