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Ecological and sociopolitical assessment of congressional and presidential designation of federal protected areas

Tyler G. Creech[1,3] and Matthew A. Williamson[1,2]

[1]*Center for Large Landscape Conservation, Bozeman, Montana 59771 USA*
[2]*Department of Environmental Science and Policy, University of California, Davis, California 95616 USA*

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Abstract. Protected areas are one of the most effective means by which biodiversity is conserved, but are often criticized for either neglecting the importance of local communities or sacrificing conservation objectives for political expedience. In the United States, federal protected areas can be designated via a democratic legislation process or via executive action, which allows for comparison of the ecological and sociopolitical context of these top-down and bottom-up processes. We compared protected areas resulting from congressional designation vs. presidential designation with respect to their ecological context (using measures of biodiversity and climate refugial potential) and sociopolitical context (using measures of local support for conservation and reliance on natural resource-based industries). We found minimal differences between these designation modes for both ecological and sociopolitical variables. These results suggest that presidentially designated protected areas tend to be no more burdensome to local communities and no less valuable for ecological conservation than more widely accepted federal protected areas such as national parks, and they provide new evidence to inform the current debate over national monuments.

Key words: biodiversity; designation process; governance; legislation; national monument; natural resources; protected area; social determinants.

Introduction

Protected areas (PAs) are widely recognized as a primary tool for achieving conservation objectives (Watson et al. 2014), but their establishment often engenders controversy. From a sociopolitical perspective, the PA designation process has been criticized for being top-down and failing to consider the effects of new PAs on local residents (Brechin and West 1990, West et al. 2006). At the same time, the global distribution of PAs has been criticized for over-representing economically marginal lands at the expense of protecting biological diversity, suggesting an over-emphasis on local interests (Joppa and Pfaff 2009, Venter et al. 2017). Developing policy approaches capable of striking an appropriate balance between conservation objectives and the interests of local communities remains a key challenge for conservation planners.

The United States provides an opportunity to evaluate national-level policy approaches for navigating this tension by comparing two forms of PA designation: those originating from presidential proclamation and those originating from congressional legislation. The president's authority to create PAs is limited to proclaiming national monuments under the Antiquities Act of 1906 (54 USC 320301–320303). Congress may also designate national monuments under the Antiquities Act, but has further authority to designate wilderness areas under the Wilderness Act of 1964 (16 USC 1131–1136) and a variety of other federal PAs (e.g., national parks, national preserves, national recreation areas) under the Property Clause of the U.S. Constitution (Article 4, Section 3, Clause 2).

Legislation is often considered the most democratic decision-making process because it requires public officials to vet proposals in public forums and holds them accountable to their constituents for those proposals

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[3] E-mail: tyler@largelandscapes.org

and their positions on them (Zellmer 2004). Legislated PAs tend to occur where the majority of voters want new PAs and/or local economic and development concerns have been addressed (Zellmer 2004). Examinations of congressional designations of wilderness areas, however, suggest that local interest groups and state-level economic concerns may often override stated conservation objectives (Mohai 1987, Booth 1991, Crone and Tschirhart 1998). This is not surprising given that congressional designation often results in stronger restrictions on subsequent land use, and legislators are accountable to their local constituents who are affected by these restrictions (Zellmer 2004).

In contrast, presidential proclamations of national monuments tend to provide fewer opportunities for public input than the legislative process or the public involvement processes led by federal land management agencies (Zellmer 2004). Although less deliberative, the presidential designation process is defended by supporters as consistent with the original intent of the Antiquities Act: to allow for protection of public resources that may be harmed before Congress can act (Wyatt 2016). Freedom from the legislative process and reduced accountability to voters (particularly for “lame duck” presidents) may allow presidential national monuments to advance conservation objectives further than congressionally designated PAs, but may be less accommodating of local socioeconomic concerns (Sanders 2016).

These characteristics of federal PA designation processes suggest that, relative to locations of congressional designations, presidential designations may occur in locations where (1) voters are less supportive of conservation, (2) local economies are more dependent on natural resource use, and (3) ecological value of lands is higher. We used publicly available, national-level data sets to determine whether these hypotheses have empirical support and to explore differences in the ecological and sociopolitical context of recent congressional vs. presidential PA designations. Our analyses are particularly timely because presidential national monuments have been increasingly criticized as arbitrary “land grabs” that are undemocratic and punitive to natural resource-dependent economies (Lin 2002, Rusnak 2003, Sanders 2016). By using the best available data to examine the context of national monuments and other PA designations, we shed light on the validity of these criticisms.

Methods

Scope of analysis

We compared ecological and sociopolitical characteristics of PAs resulting from two designation modes: (1) presidentially designated PAs (PPAs), which included only national monuments; and (2) congressionally designated PAs (CPAs), which included wilderness areas as well as national parks, preserves, monuments, battlefield parks, historic sites, historic trails, historical parks, memorials, recreation areas, lakeshores, seashores, and conservation areas. Although other federal designation types exist (e.g., research natural areas, wilderness study areas, areas of critical environmental concern), these designation types rely on administrative processes that were beyond the scope of this study.

We limited our analysis to PAs designated between 1996 and the present for two reasons. First, we were interested in ecological context at the time of designation (as opposed to long-term outcomes of designation), and spatial data of appropriate resolution and extent for ecological characteristics of interest were only available for the recent past (i.e., data collected during approximately 2001–2013). Second, presidential use of the Antiquities Act increased sharply beginning in 1996 after an 18-yr period of inactivity, reigniting the debate over national monuments (Appendix S1: Fig. S1). In addition, we restricted our analysis to the contiguous United States (lower 48 states and District of Columbia) because data for many ecological variables were unavailable outside of this area (e.g., for marine and island PAs), and no federal PAs were designated in Alaska between 1996 and the present. Finally, we focused on PAs with the potential for significant ecological conservation value by restricting our analysis to those PAs with impervious surface covering no more than one-third of their total area as estimated from the 2011 National Land Cover Database (USGS 2014); preliminary analyses suggested that this represented a useful break point for distinguishing PAs in largely urban settings (e.g., small historic sites) from those in more natural settings that provide habitat for many species.

Characterizing ecological and sociopolitical context

We explored the context of PAs using ecological and sociopolitical variables for which spatially explicit data were available to allow quantification and comparison among PAs. We briefly describe these variables below, and we provide full descriptions of data sources and data processing methods in Appendix S1.

Biodiversity is a common indicator of ecological condition that often informs systematic conservation planning and can be assessed at levels of organization ranging from genes to ecosystems (Ferrier 2002). We evaluated species-level biodiversity of PAs using data on native species richness for six taxonomic groups (birds, mammals, amphibians, reptiles, fish, and trees; Jenkins et al. 2015) and rarity-weighted richness for critically imperiled and imperiled species (G1 and G2 conservation status; NatureServe 2013). To evaluate community-level biodiversity, we calculated the richness of ecological systems, which are mid- to local-scale ecological units that describe plant community complexes influenced by similar physical environments and ecological processes (Comer et al. 2003), as mapped by the National Gap Analysis Program (USGS-GAP 2016).

In addition to protecting habitat, PAs may support biodiversity by serving as climate refugia: areas where species can persist in the face of shifting environmental conditions (Noss 2001, Taberlet and Cheddadi 2002). This benefit may be self-reinforcing, as biodiversity can stabilize ecosystems and allow them to better adapt to a changing climate (Pires et al. 2018). We evaluated the capacity for PAs to support future biodiversity using an index of climate refugial potential (Carroll et al. 2017) derived from backward climate velocity (BCV), the rate of movement required for an organism adapted to a location's predicted future climate to reach that location. Areas with lower BCV should be more easily colonized by organisms shifting their distribution to remain within suitable climatic conditions and thus should have greater potential to serve as climate refugia (Carroll et al. 2015).

The potential socioeconomic impacts of PAs are often evaluated based on the jobs they may create or eliminate. PAs may shift jobs from natural resource extraction-based professions to those associated with amenity provision (Rasker et al. 2013), posing challenges for local community members. As such, we considered regions with workforces that were more reliant on extraction-based jobs prior to local PA designation as areas where such designations were more likely to be economically disruptive and sociopolitically unpopular. We characterized reliance on natural resource extraction using annual employment data from the U.S. Census Bureau's County Business Patterns to estimate the percentage of the total workforce in a county associated with forestry or with minerals extraction (including oil and gas drilling), as these activities are prohibited within most national monuments. We did not consider other natural resource sectors such as hunting, fishing, and livestock grazing because these activities are allowed within most national monuments.

We estimated the level of local public support for conservation using information on the voting records of federal legislators representing communities surrounding PAs. League of Conservation Voters (LCV) generates an annual score for each member of Congress by calculating the percentage of "pro-environment" votes by that member on legislation that LCV deems environmentally significant. LCV scores have been used as a proxy for constituents' environmental attitudes (Kahn 2002, Wagner 2016) and are positively associated with constituent support for various environmental or conservation measures (Kahn 2007, Anderson 2011, Chupp 2011).

Generating PA-level summary measures

Data for all variables were either available as gridded geospatial layers (for ecological variables) or converted to that format from tabular data (for sociopolitical variables; Appendix S1).

Ecological characteristics of PAs were assessed using data sets that were generated recently (2001–2013, depending on the variable) but were not precisely matched to the designation years for individual PAs (1996–2017); thus, our analysis assumed that these contemporary ecological data were broadly indicative of conditions at the time of PA designation. We calculated the minimum, mean, and maximum grid cell values within each PA's boundaries as PA-level summary measures for each ecological variable (except ecological system richness; Appendix S1).

Data for sociopolitical variables were available on an annual basis, allowing us to restrict our analysis to the eight-year period prior to the designation of each PA, thereby avoiding the possibility of conflating context (i.e., conditions at the time of designation) and outcomes (i.e., conditions resulting from designation). We applied a series of spatial buffers ranging from 10 to 250 km to PA boundaries when evaluating sociopolitical context to reflect the fact that PA designation affects and is affected by surrounding human populations. We calculated the minimum, mean, and maximum value of grid cells within buffered PAs for each buffer distance as PA-level summary measures.

Comparisons among designation modes

We used two methods to compare the distributions of PA-level summary measures (i.e., means, minimums, or maximums of grid cell values within the boundaries of each PA) for PPAs and CPAs with respect to each ecological or sociopolitical variable: (1) density plots, which are histogram variations that use kernel smoothing to visualize values with less noise and allow easier comparison of data distributions for groups containing very different numbers of observations, and (2) side-by-side bar plots of the mean ± SD of values for each group. The former provides a more nuanced view of the differences in distributional shapes for PPAs and CPAs, while the latter provides a more traditional summary of differences between the two groups. We did not perform statistical significance tests for differences among distributions because our analysis included complete sampling of the population of interest (i.e., PAs designated within the contiguous U.S. by the president or Congress since 1996).

We performed all geospatial and statistical analyses in R version 3.4.3 (R Development Core Team 2017). All code is available; see *Data Availability*.

Results

We compared a total of 206 federal PAs within the contiguous United States, after removing PAs with impervious surface covering more than one-third of their total area (n = 12) and PAs that were designated initially by the president but later redesignated by Congress and thus could not be assigned exclusively to either designation mode (n = 7). The remaining PAs included 38 PPAs comprising 47,821 km^2 and 168 CPAs comprising

30,438 km^2. Most of the PAs were wilderness areas (n = 139, total area = 22,438 km^2), followed by national monuments (n = 41, total area = 49,042 km^2), with fewer than 10 PAs of each of the remaining designation types (n = 26, total area = 6,780 km^2). CPAs were smaller on average than PPAs, with mean areas of 181 and 1,258 km^2, respectively. PAs of both designation modes were generally concentrated in the western United States (Fig. 1; Appendix S1: Table S4).

Relationships between PPAs and CPAs were qualitatively similar regardless of which summary metric (mean, minimum, or maximum grid cell value within PA boundaries) was used (Appendix S1: Figs. S3–S6), and we henceforth focus on results for mean values. We found little difference among designation modes for most of the ecological variables we considered (Fig. 2, panels A–I; Appendix S1: Table S4). On average, PPAs and CPAs had nearly the same fish richness, mammal richness, amphibian richness, reptile richness, critically imperiled and imperiled species (G1 and G2) rarity-weighted richness, and climate refugial potential. The largest ecological differences among the designation modes were for bird richness and ecological system richness, and in both cases, PPAs exhibited higher richness on average, although these differences were relatively minor when compared to the amount of variation among PAs within each group. For most ecological variables, distributions were similar in shape and largely overlapping for the two designation modes.

Differences among designation modes for sociopolitical variables were also generally small with largely overlapping distributions (Fig. 2, panels J–L; Appendix S1: Table S4), and were not sensitive to changes in buffer width (Appendix S1: Fig. S2); thus, we henceforth focus on results for the 10-km buffer width, which has proven useful in previous studies of PA context (Sánchez-Azofeifa et al. 2003, Gaveau et al. 2009, Martinuzzi et al. 2015). On average, PPAs and CPAs had nearly identical

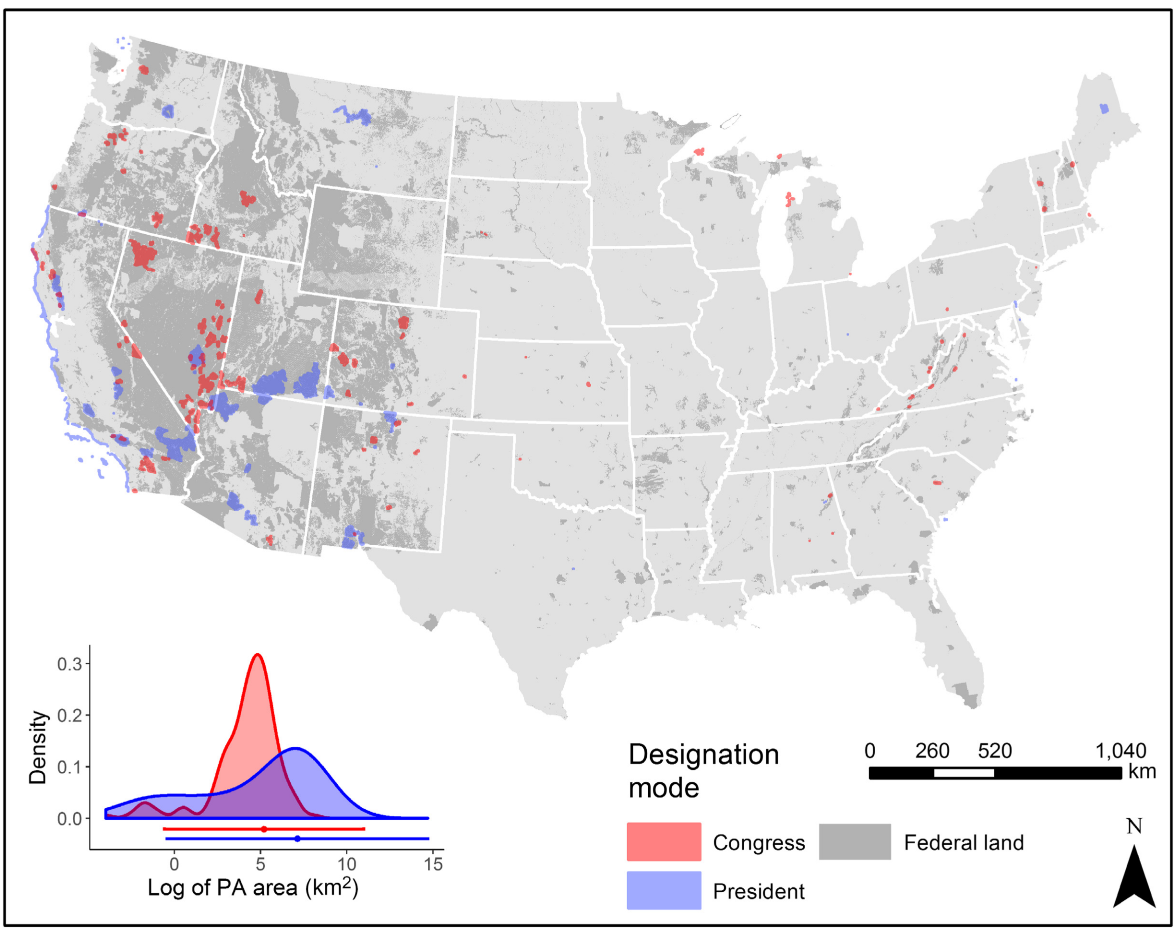

Fig. 1. Geographic and size distributions of contiguous U.S. federal protected areas (PAs) for two designation modes: presidentially protected areas (PPAs) and congressionally protected areas (CPAs). Designations may overlap (e.g., wilderness areas and national conservation areas). Horizontal bars show mean ± SD for each designation mode. Kernel-smoothed distributions of PA sizes are shown on a log scale due to presence of large outliers; mean areas of PPAs and CPAs are 1,258 and 181 km^2, respectively.

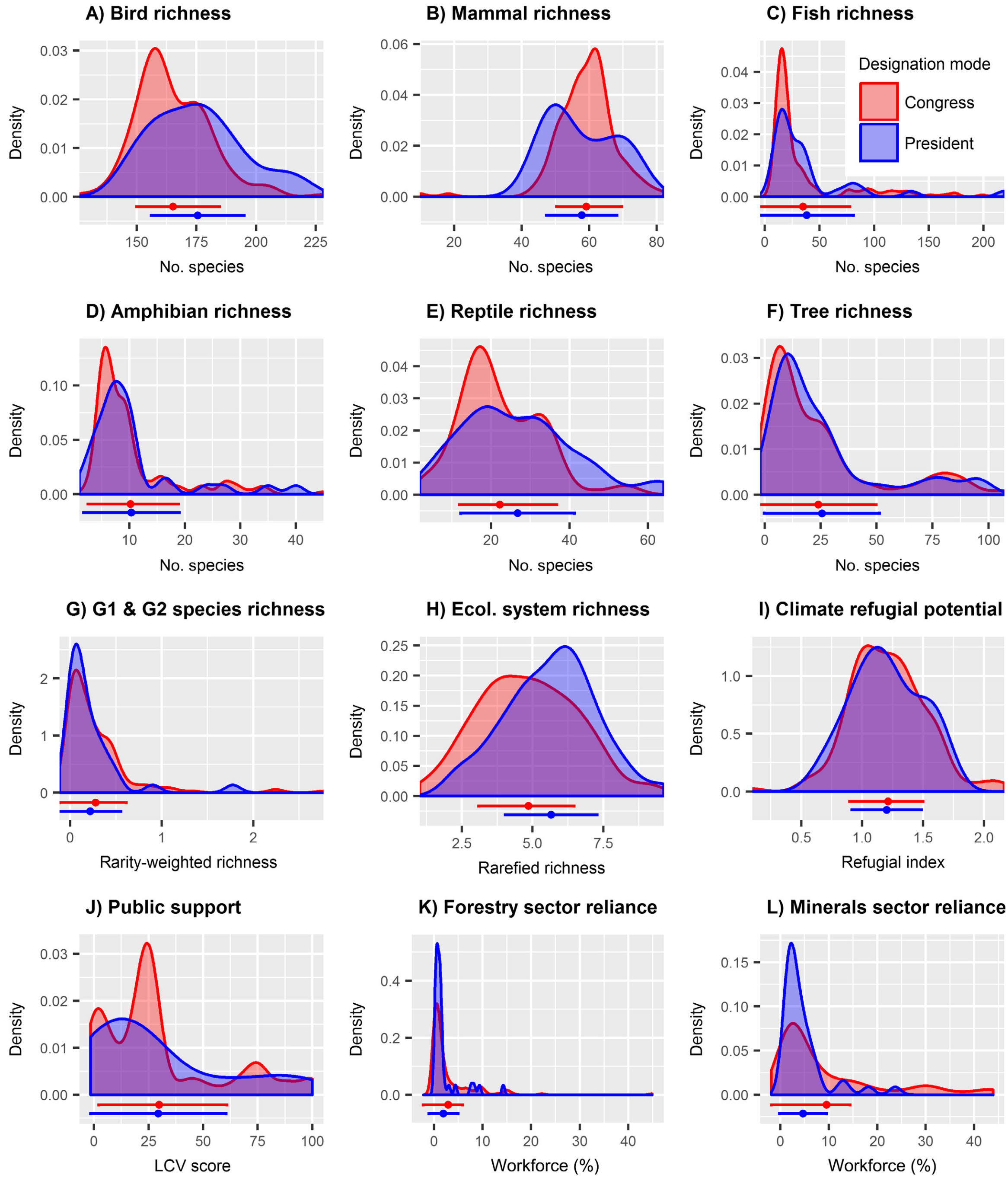

FIG. 2. Distribution of mean ecological (panels A–I) and sociopolitical (panels J–L) values for two designation modes: presidentially protected areas (PPAs) and congressionally protected areas (CPAs). For each designation mode, kernel-smoothed distribution of individual PA values (shaded region) is shown along with mean ± SD (horizontal bar). Individual PA values are means of grid cell values within PA borders (buffered by 10 km for sociopolitical variables), except ecological system richness values, which are counts of unique values (i.e., ecological systems) from a random sample of grid cells. (A–F) Mean numbers of bird, mammal, fish, amphibian, reptile, and tree species, respectively (source: Jenkins et al. 2015). (G) Mean number of G1 and G2 (critically imperiled and imperiled) species, weighted by species rarity (source: NatureServe 2013). (H) Number of ecological systems within PA borders, adjusted for PA size using rarefaction (source: USGS-GAP 2016). (I) Mean climate refugial index; ranges from 0 to 3.29 in contiguous United States, larger values indicate greater refugial potential (source: Carroll et al. 2017). (J) Mean LCV score (percentage of pro-environment votes on environmental legislation) for eight years prior to designation (source: League of Conservation Voters, LCV). (K, L) Mean percentages of workforce employed in forestry and minerals extraction sectors, respectively, for eight years prior to designation (source: U.S. Bureau of Economic Analysis).

LCV scores, with a mean score of approximately 30% for both groups, indicating that federal PAs have been designated since 1996 in areas with relatively low support for conservation as indicated by voting patterns of legislators representing these areas. We found greater variation among CPAs than among PPAs with respect to the percentage of the local workforce employed in forestry or minerals extraction. On average, CPAs were designated in areas with a slightly higher percentage of the workforce engaged in forestry, and approximately double the percentage of the workforce engaged in minerals extraction, than were PPAs. For most PAs, these percentages were low (<10%), indicating that local economies affected by PA designation typically were not highly dependent on natural resource extraction at the time of designation. However, the presence of outliers with >40% of the local workforce employed in forestry (Beaver Basin Wilderness in Michigan) or minerals extraction (Black Rock Desert, North Black Rock Range, North Jackson Mountains, Pahute Peak, and South Jackson Mountains wilderness areas in Nevada; and Jim McClure-Jerry Peak and White Clouds wilderness areas in Idaho) suggested that potential for economic disruptions was more severe for a subset of PAs.

Discussion

Protected areas have been criticized for their failure to consider the interests of local residents (Nepal and Weber 1995, Colchester 2004), yet the spatial distribution of PAs suggests that designations are often driven more by local socioeconomic interests than by biological conservation priorities (Baldi et al. 2017, Kusumoto et al. 2017). In the United States, this tension is exemplified by the controversy surrounding presidential use of the Antiquities Act, with PPAs often labeled by opponents as “undemocratic,” “arbitrary,” or “land grabs” (Lin 2002, Sanders 2016). Our analysis suggests that despite dramatically different designation processes, the ecological and sociopolitical context of CPAs and PPAs are broadly similar. On average, the communities affected by CPAs and PPAs had workforces that were similarly dependent on natural resource use and were represented by legislators with similar conservation voting records leading up to PA designation. CPAs and PPAs also tended to be designated in areas with similar levels of biodiversity and climate refugial potential.

We can think of two plausible reasons why the differences between designation modes that we predicted were not observed. First, we assumed that congressionally designated PAs require a more open, democratic process than those designated by the president, but analyses of both congressional action in general and wilderness designation in particular suggest that interest groups play significant roles in legislative decision-making (Mohai 1987, Crone and Tschirhart 1998, Gilens and Page 2014). Thus, it is possible that the alignment of CPAs and PPAs could be the result of conservation interest groups, economic elites, or pro-business interest groups having a greater effect on policy outcomes than mass-based (i.e., grassroots or membership-based) interest groups (Gilens and Page 2014). Second, similarity among CPAs and PPAs could be because PAs are heavily skewed to the western United States, where the vast majority of federal lands occur (Fig. 1). Variability was smaller within the West than nationwide for most of the ecological variables we considered (Appendix S1: Fig. S9), although not for the sociopolitical variables (Appendix S1: Fig. S10). Repeating our analyses for only those PAs in the eastern United States revealed more notable differences among designation modes for some ecological and sociopolitical variables (Appendix S1: Figs. S7, S8). However, we were interested in comparing PAs as they exist, not in evaluating whether they occurred in optimal locations. As such, the western bias in PA locations reflects a constraint (the existence of federal lands) that affects designation regardless of the process.

Our results have important implications for the recent debate surrounding national monuments. In April 2017, the presidential administration ordered a review of national monuments >405 km^2 (100,000 acres) established since 1996 (Executive Order 13792, 82 FR 20429), all of which were presidentially designated. A report on the findings of the review by the Interior Secretary recommended reducing the size of four monuments, establishing three new monuments, and changing management plans for 10 monuments to prioritize public access, infrastructure, traditional use, and fishing and hunting rights (Zinke 2017). The most notable outcome of the review thus far has been the downsizing of Bears Ears and Grand-Staircase Escalante national monuments to 15% and 54% of their original areas, respectively, via presidential proclamation in December 2017 (Proclamation 9681, 82 FR 58081; Proclamation 9682, 82 FR 58089).

The justifications provided for the administrative review included lack of public outreach in monument designation and potential for monuments to curtail economic growth. Our analysis indicates that Bears Ears and Grand Staircase-Escalante are indeed located in areas with lower-than-average public support for conservation and especially high reliance on forestry or minerals extraction in comparison to federal PAs as a whole (Appendix S1: Table S4). However, our results also show that presidential national monuments are no more likely, on average, than other federal PAs to be designated in areas with low support for conservation or heavy reliance on natural resource-based industries; this is true whether one considers all PPAs in our study (Fig. 2J–L) or only the subset of monuments included in the administrative review (Appendix S1: Table S4). Other than its larger size, the potential economic burden of the typical presidential monument on local communities appears to be similar to that of other PAs. Whether monuments constitute a burden at all is debatable; previous research has shown that U.S. counties with greater area of federal protected lands have higher and faster-growing per-capita incomes (Rasker et al. 2013) and that local economies have expanded following designation of recent national monuments (Headwaters Economics 2017).

Given that PPAs are designated in areas with similar biodiversity value to CPAs but often generate much more criticism, is presidential Antiquities Act authority still necessary for creating a robust national PA network? We argue that such authority remains critical for biological conservation. Approximately 13% of the U.S. terrestrial area is currently protected (UNEP-WCMC 2018), but many in the scientific community have argued that a much larger proportion, perhaps closer to one-half, must be protected to preserve biodiversity and ecosystem function (Noss and Cooperrider 1994, Pressey et al. 2003, Wilson 2016, Dinerstein et al. 2017). Recent history suggests that presidential designation may be the most efficient means of expanding the PA network: since 1996, approximately 40% more federal land in the contiguous United States has been protected by presidential action than by congressional action. Further expansion could help to address the under-representation of species and ecological systems in the existing PA network of the United States (Aycrigg et al. 2013, Dietz et al. 2015, Jenkins et al. 2015), although the highest priorities are largely in the eastern United States where relatively little federal land is available for protection. The ability to designate PAs rapidly and unilaterally makes presidential Antiquities Act authority particularly valuable for responding to sudden threats to ecologically valuable areas that may be degraded before enough support for protection has been amassed to allow congressional designation (Squillace 2002). Presidential designations may also provide a mechanism for protecting whole landscapes that are too extensive to garner congressional support for designation, although the Antiquities Act requires monuments to be “confined to the smallest area compatible with proper care and management of the objects to be protected,” which has led critics to challenge the validity of some of the largest monuments (Vincent 2016).

Our analysis focused on ecological components of conservation value for PAs, but other important conservation values exist, such as recreational potential, cultural significance, and historical preservation. Many, if not most, PAs are designated because they possess multiple conservation values, and even those PAs formally designated for their non-ecological values (e.g., Bears Ears National Monument, designated in part to preserve its cultural, prehistoric, and historic legacy) often yield benefits for ecological conservation and contribute to the biodiversity and climate resilience of the federal PA network. We also focused exclusively on differences between PPAs and CPAs in terms of designation context, that is, the ecological characteristics of PAs and sociopolitical characteristics of nearby communities at the time of (or leading up to) designation. An equally interesting question, but one not addressed here, is whether PPA and CPA designations result in different ecological and sociopolitical outcomes over time. We might expect different outcomes because management of national monuments is often less restrictive than that of most CPAs (e.g., allowing for grazing and hunting to continue after designation), possibly reducing monuments’ burden on local socioeconomic interests while reducing their effectiveness for biodiversity conservation. However, while there is a rich global literature on socioeconomic (Adams et al. 2004, West et al. 2006, Wilkie et al. 2006) and ecological (Bruner et al. 2001, Coetzee et al. 2014, Dudley et al. 2016) consequences of PA designation, this topic has not been explored in the context of U.S. federal designations. Such information could further inform the debate over the role of national monuments in American conservation.

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Supporting Information

Additional supporting information may be found online at: http://onlinelibrary.wiley.com/doi/10.1002/eap.1888/full

Data Availability

Code is provided on GitHub: https://doi.org/10.5281/zenodo.2592710