Golden Kroner, R. E., R. Krithivasan, and M. B. Mascia. 2016. Effects of protected area downsizing on habitat fragmentation in Yosemite National Park (USA), 1864 – 2014. *Ecology and Society* 21(3).

Appendix 1: Supplemental Methods, Supplemental Tables A1.1 to A1.16, and Supplemental Literature Cited

SUPPLEMENTAL METHODS

Study site

All IUCN categories are represented in the Ecoregion except National Monuments (IUCN III) and National Wildlife Refuges (VI). Protected Landscapes (IUCN V) are the most common (45% of protected areas in the Ecoregion), followed by Wilderness Areas, IUCN Ib (26%) and Strict Wilderness Areas, IUCN Ia (14%), Habitat and Species Management Areas IV (11%), and National Parks (2%).

Data collection and formatting

For each PADDD event, we collected information for 22 different descriptive fields: Continent, Country, ISO Country Code, WDPA ID, WDPA Name, Primary Name, All Names, Event Type (downgrade, downsize, or degazette), Enacted or Proposed, Year PA Gazetted, Year of PADDD event, Proximate Cause, Area Affected, Size of PA before PADDD (km^2), Size of PA after PADDD (km^2), IUCN category before PADDD, IUCN category after PADDD, Reversal (yes/no), Offset (yes/no), Systemic Change (yes/no), Sources, and Supporting Information. These fields correspond with the existing data structure used in PADDDtracker.org (WWF 2016) and the technical guidance upon which these data are based (Mascia et al. 2012).

For all spatial data, we conducted calculations at the appropriate projection for central California. We used the NAD 1983 State Plane California III FIPS coordinate system within the GCS North American 1983 Geographic Coordinate System and North American 1983 datum. We digitized maps in ArcGIS 10.1 by scanning each paper map (Greene 1987; Huber 1987), rendering it in GIS, aligning it with landscape features including state and other protected area boundaries, topography, and rivers, and tracing the map by hand using the georeferencing tool bar. The maps that we used for analyses were derived from Greene (1987); the source map included a scale bar in graphic scale format. To assess accuracy, we manually measured the scale bar and converted it to ratio scale using the formula (SFEI 2016):

Ratio scale = 1 : X km (represented by scale bar) * 100,000 cm/km ÷ X cm (measured on map)

We determined that the scale of the original map was 1:392,439. Given best-practice guidelines for reporting uncertainty (Wieczorek 2001), the value can be estimated as 1 mm in relation to the scale. Hence, the uncertainty of the measurement was 392.439 km.

In addition, we reviewed the language of supporting documents to verify the analyses to the extent possible. For instance, we validated the digitized polygons by comparing the calculated areas of the downsizings with text from Runte (1990), which stated that one third of the Park area was removed from protection in 1905. Calculations of area based on digitization show that 32.81% of the Park area was removed; in this case, the calculation underestimates the area of the downsize by less than 1%.

To create the protected area layer, we clipped the WDPA 2014 polygon layer using the Sierra Nevada Ecoregion from the Terrestrial Ecoregions of the World dataset (Olson et al. 2001). In the WDPA, Yosemite is included on two rows: as a National Park and a wilderness area. We merged these together to create the Yosemite layer. We included all roads (US Census Bureau 2014) located in each of the 21 counties in California and each of the three counties in Nevada that overlap with the Sierra Nevada region. We merged the 24 road shapefiles together and clipped them using the Sierra Nevada Ecoregion to create the road layer. The US Census Bureau data includes information for different types of roads, including primary, secondary, and tertiary paved roads, as well as unpaved roads, bike paths, and trails. The majority of the roads located in the Ecoregion are paved "local neighborhood roads, rural roads, or city streets" (89.9%), followed by "private roads for service vehicles (logging, oil fields, ranches, etc.)" (6.4%), and "vehicular trails" - unpaved roads which require a four-wheel-drive (2.0%). The remaining road categories each comprise less than 1% of the total road network. Roads which are paved and wide enough to allow for vehicle traffic comprise > 99% of the road network in the Ecoregion. We determined that eliminating roads which are unpaved and are too narrow to allow vehicle traffic (bike paths, hiking trails) was not likely to affect the results. We treated all roads equally in the analysis as it was outside the scope of this study to weight the road classes based on ecological significance or contribution to habitat fragmentation.

We created the fragments by clipping the protected, never-protected, and downsizes polygons into smaller pieces (fragments) using the roads layer. The 1905 downsizes area extended outside of the Sierra Nevada Ecoregion on the western edge, so we clipped it to fit within the Ecoregion. This clipped an area of <1% of the downsize extent and did not affect the results. We created the downsize lands polygons by digitizing paper maps (Greene 1987; Huber 1987) in ArcGIS. We then clipped these layers to the extent of the Sierra Nevada Ecoregion layer and merged them together. This shapefile included two downsizes: one that occurred in 1905 and one that occurred in 1906. We completed calculations for both downsize events together as well as for reversed and enduring downsizes.

To prepare the never-protected areas, we first created a layer for all lands that are currently and were previously protected within the Park. To do this, we combined the current protected area extent of the Park with areas that had been downsized. We then used the lands that are protected now or were protected previously as a reference when creating the never-protected lands. We used three different options for never-protected lands:

1. Never-protected lands option 1: We created a 1 km buffer in ArcGIS around the areas that are currently or were previously protected as part of the Park.
2. Never-protected lands option 2: We created a 5 km buffer in ArcGIS around the areas that are currently or were previously protected as part of the Park.
3. Never-protected lands option 3: We created a never-protected lands layer covering the entire Sierra Nevada region by erasing all protected areas, including the lands previously

and currently protected in Yosemite National Park, from the Sierra Nevada Ecoregion polygon layer.

For all fragment layers, we removed fragments that were smaller than 0.001 km^2 in area to eliminate map drawing errors. We also manually checked each fragment for map errors in GIS. We identified and deleted three additional data points that were an artifact of map drawing errors. This process affected the calculations for fragment area and area-to-perimeter ratio as these calculations are dependent on each other, but did not affect calculations for road density which were calculated independently of fragment layers.

Road metrics calculations details

We created fragments by first converting the polygons for each land governance type to polylines. We then merged these polylines with the road layer clipped to the extent of each land governance type. We then converted the merged shapefile (roads and boundaries together) into polygons to form the fragments layer. The resultant attribute tables for the fragment layers served as the basis for calculations for fragment area-to-perimeter ratio and fragment area.

We calculated road metrics for total area, fragment area, and fragment area-to-perimeter ratio in ArcGIS using the geometry calculator in each attribute table. We also used attribute tables to count the number of fragments. We calculated road density using the Line Density tool in ArcGIS for all roads using an output cell size of 1408.02, a search radius of 11733.50 (default values for the whole Sierra Nevada Ecoregion, the largest extent in the study). We converted the resultant raster to points and then clipped this to the extent of each land governance type. We report means and standard deviations, as well as medians and IQR values, for line density values.

To analyze the data for forested lands only, we used the National Land Cover Database (NLCD; Homer et al. 2015) clipped to the extent of the Sierra Nevada Ecoregion in the same projection as used previously. When re-projecting the raster, we used the nearest neighbor resampling approach with an output cell size of 30. For the analysis, we extracted and included only land cover types that are categorized as forest (e.g. deciduous, evergreen, and mixed) and excluded all other land cover types. Forest land cover types comprise 60.08% of the Ecoregion, which is dominated by evergreen forest (58.56% of the Ecoregion). The next most common land cover type is shrub land (26.88%) followed by barren land (6.04%), grassland (3.20%), and open water (2.09%). The remaining land cover types each comprise less than 1% of the extent of the Ecoregion. To calculate the fragment area and area-to-perimeter ratio values, we used only fragments that contained greater than 30% forested area; this is the conservative threshold to define a forest used by the United Nations Framework for the Convention on Climate Change (Sexton et al. 2016). Although there is a range of thresholds that can be applied to define a forest ranging from 10% to 60% (as noted in Sexton et al. 2016), we chose a value within the middle of the acceptable range which is utilized by an authoritative source. To calculate road density for forested areas, we clipped the road density points to the extent of the forest polygon that was derived from the NLCD. We ran the same statistical tests, including the Fligner-Killeen test for homoscedasticity, the appropriate test based on the Fligner-Kileen result (e.g. either Welch's t-test or Mann Whitney U), and the appropriate post-hoc tests as necessary. Results are consistent with the results calculated across the entire Ecoregion. The values of the metrics are slightly different when using forested lands only, but the significances of all statistical results are identical with two exceptions. The Fligner-Killeen test at the downsize scale is not significant when using all lands (leading us to use the Mann-Whitney U test) and is significant for forest lands (leading us to use the Welch's t-test).In addition, the Fligner-Killeen test at the Park scale using 1 km buffers is not significant when using all lands (leading us to use the Kruskall-Wallis/Mann-Whitney U test) and is significant for forested lands (leading us to use the Welch's ANOVA and t-test.

Although we used several different sized buffers of never-protected areas to which to compare protected and downsized lands, we recognize that lands nearby the park are not necessarily biophysically similar to lands within the Park. For instance, it is possible that the Park boundaries may have been drawn initially to exclude certain lands which are more suitable for development, timber harvesting, or agriculture. Future research is required to determine whether this selection bias affects the results found here. We attempted to minimize errors in these calculations by using consistent projections and calculation methods. Numbers presented here are intended to be an estimate, rather than definitive values, of the parameters in question and serve as points of comparison between each land governance type that we examined.

SUPPLEMENTAL TABLES

Table A1.1: Habitat fragmentation indicators at the Park scale for forested lands – sensitivity test using a 5 km never-protected lands buffer demonstrate the same results as with a 1 km buffer. See Table A1.2 for results of post-hoc tests.

Land governance type	Statistics	Road density (km^{-1})	Fragment[†] area-to-perimeter ratio (dimensionless)	Fragment[†] area (km^2)
Downsizes	mean (SD)	0.86 (0.51)	0.035 (0.015)	6.96 (46.70)
	median (IQR)	0.95 (0.94)	0.034 (0.023)	0.14 (1.33)
	n	*331*[‡]	*167*[§]	*167*[§]
Yosemite National Park	mean (SD)	0.38 (0.235)	0.042 (0.015)	21.37 (168.87)
	median (IQR)	0.25 (0.46)	0.042 (0.020)	0.020 (0.17)
	n	*762*[‡]	*141*[§]	*141*[§]
Never-protected (5 km buffer)	mean (SD)	1.23 (0.45)	0.032 (0.014)	2.50 (6.97)
	median (IQR)	1.32 (0.63)	0.031 (0.018)	0.37 (2.23)
	n	*177*[‡]	*183*[§]	*183*[§]
Results		$p < 0.001$[ǀ] F = 349.13 num df = 2 denom df = 391.70	$p < 0.001$[#] $\chi 2 = 32.80$ df = 2	$p = 0.20$[ǀ] F = 1.61 num df = 2 denom df = 206.50

[†] Fragment: parcel of land surrounded by roads on all sides

[‡] Number of points sampled

[§] Number of fragments

[ǀ] Welch's ANOVA test result. Choice of test based on Fligner-Killeen test for homoscedasticity (see Table A1.3)

[#] Kruskal-Wallis test result. Choice of test based on Fligner-Killeen test for homoscedasticity (see Table A1.3)

Table A1.2: Post-hoc results from Table A1.1. Habitat fragmentation at the Park scale for forested lands using 5 km buffers for never-protected lands. Results are consistent with comparisons using a 1 km buffer.

Comparison	Road density (km^{-1})	Fragment† area-to-perimeter ratio (dimensionless)	Fragment† area (km^2)
Downsized vs. the Park	$p < 0.001$‡	$p < 0.001$§	$p = 0.33$‡
	$t = 15.58$	$W = 14940$	$t = 0.98$
	$df = 472.52$		$df = 158.11$
Downsized vs. Never Protected (5 km buffer)	$p < 0.001$‡	$p = 0.19$§	$p = 0.22$‡
	$t = -8.38$	$W = 14050$	$t = -1.22$
	$df = 399.08$		$df = 172.76$
The Park vs. Never-Protected (5 km buffer)	$p < 0.001$‡	$p < 0.001$§	$p = 0.19$‡
	$t = 29.45$	$W = 17639$	$t = 1.33$
	$df = 761.00$		$df = 140.37$

† Fragment: parcel of land surrounded by roads on all sides
‡ Welch's t-test result. Choice of test based on Fligner-Killeen test for homoscedasticity (see Table A1.3)
§ Mann-Whitney U test result. Choice of test based on Fligner-Killeen test for homoscedasticity (see Table A1.3)

Table A1.3: Results of Fligner-Killeen tests for homoscedasticity for forested lands indicating which statistical test(s) to perform next at all three spatial scales.

Spatial Extent	We compared these land governance types….	using this metric…	..with the Fligner-Killeen Test and found…	...which indicated that the next test/s to perform was/were…
Downsize Event Scale	Reversed Downsize vs. Enduring Downsize	Fragment Area	$p < 0.001$ $\chi^2 = 12.35$ df =1	Welch's t
	Reversed Downsize vs. Enduring Downsize	Area-to-perimeter ratio	$p = 0.29$ $\chi^2 = 1.14$ df = 1	Mann-Whitney U
	Reversed Downsize vs. Enduring Downsize	Road Density	$p < 0.001$ $\chi^2 = 21.06$ df = 1	Welch's t
Yosemite National Park Scale	Downsize vs. the Park vs. never-protected (1 km buffer)[1]	Fragment Area	$p < 0.001$ $\chi^2 = 40.58$ df = 2	Welch's ANOVA and post-hoc Welch's t
	Downsize vs. the Park vs. never-protected (1 km buffer)[2]	Area-to-perimeter ratio	$p = 0.031$ $\chi^2 = 6.93$ df = 2	Welch's ANOVA and post-hoc Welch's t
	Downsize vs. the Park vs. never-protected (1 km buffer)[3]	Road Density	$p < 0.001$ $\chi^2 = 53.62$ df = 2	Welch's ANOVA and post-hoc Welch's t
Sierra Nevada Ecoregion	Downsize vs. protected in the Ecoregion vs. never-protected in the Ecoregion	Fragment Area	$p < 0.001$	Welch's ANOVA and post hoc Welch's t

[1] Robustness check using 5 km buffer also indicated that the Welch's ANOVA and post-hoc Welch's t-test were most appropriate ($p < 0.001$, $\chi^2 = 59.69$, df = 2).
[2] Robustness check using 5 km buffer also indicated that the Kruskal Wallis and post-hoc Mann-Whitney U tests were most appropriate ($p = 0.21$, $\chi^2 = 3.14$, df = 2).
[3] Robustness check using 5 km buffer also indicated that the Welch's ANOVA and post-hoc Welch's t-test were most appropriate ($p < 0.001$, $\chi^2 = 57.54$, df = 2).

Scale				
	Downsize vs. protected in the Ecoregion vs. never-protected in the Ecoregion	Area-to-perimeter ratio	$\chi^2 = 599.96$ df = 2 $p < 0.001$	Welch’s ANOVA and post hoc Welch’s t
	Downsize vs. protected in the Ecoregion vs. never-protected in the Ecoregion	Road Density	$\chi^2 = 404.22$ df = 2 $p < 0.001$	Welch’s ANOVA and post hoc Welch’s t
			$\chi^2 = 781.92$ df = 2	

Table A1.4: Timeline of Yosemite Boundary Adjustments in Yosemite National Park. Area values calculated in ArcGIS 10.1.

Year	Event Name	Net Area Affected (km^2)	Area of the Park After Event (km^2)	Percent change of Park Area after event (%)	Source
1864	Yosemite Grant Established	125.23	125.23	n/a	H.R. 12187 1964
1890	Yosemite National Park Established	3886.10	3886.10	n/a	Runte 1990
1905	Land Exclusion (downsize)	-1275.00	2611.10	-32.81	Runte 1990; H.R. 17345 1905
1905	Land Offset (addition)	343.79	2954.89	13.17	Runte 1990
1906	Land Exclusion (downsize)	-34.30	2920.59	-1.16	Runte 1990; H.J.R. 118 1906
1914	Land and Timber Exchange (addition)	4.52	2925.11	0.15	16 USC § 51
1930	Rockefeller Purchase (addition)	34.34	2959.45	1.17	Lloyd 1930
1932	Wawona Addition (addition)	34.42	2993.87	1.16	Runte 1990
1937	Carl Inn Addition (addition)	unknown	unknown	unknown	n/a

Table A1.5: Fragment density calculations at three spatial scales for forested lands

Land governance type	Total Area (km^2)	Number of fragments†	Fragment† density (km^{-2})
Enduring Downsize	486.6	160	0.33
Reversed Downsize	645.25	73	0.11
All Downsized lands	1162.65	167	0.14
Yosemite National Park	3013.02	141	0.047
Never-protected lands – 1 km buffer	79.24	80	1.01
Never-protected lands– 5 km buffer	457.44	183	0.40
All protected lands in the Ecoregion	11184.07	1750	0.16
All never-protected lands in the Ecoregion	34411.17	11774	0.34

† Fragment: parcel of land surrounded by roads on all sides

Table A1.6: Habitat fragmentation at the Park scale for forested lands – post-hoc Welch's t-tests results from Table 2.

Comparison	Road density (km^{-1})	Fragment† area-to-perimeter ratio (dimensionless)	Fragment† area (km^2)
Downsized vs. the Park	$p < 0.001$ $t = 15.58$ $df = 472.52$	$p < 0.001$ $t = -4.17$ $df = 299.26$	$p = 0.33$ $t = -0.98$ $df = 158.11$
Downsized vs. Never-Protected	$p < 0.001$ $t = -4.55$ $df = 31.97$	$p = 0.24$ $t = 1.18$ $df = 191.59$	$p = 0.10$ $t = 1.65$ $df = 167.19$
The Park vs. Never-Protected	$p < 0.001$ $t = -10.34$ $df = 27.20$	$p < 0.001$ $t = 5.03$ $df = 192.92$	$p = 0.15$ $t = 1.43$ $df = 140.07$

† Fragment: parcel of land surrounded by roads on all sides

Table A1.7: Habitat fragmentation at the Ecoregional scale for forested lands – post-hoc tests results of Welch's t-tests from Table 3.

Comparison	Statistics	Road density (km^{-1})	Fragment† area-to-perimeter ratio (dimensionless)	Fragment† area (km^2)
Downsized vs. Protected Lands	p	< 0.001	< 0.001	0.89
	t	15.99	4.48	0.14
	df	393.33	222.72	269.95
Downsized vs. Never-Protected Lands	p	< 0.001	0.29	0.27
	t	-21.70	-1.05	166.68
	df	360.19	170.63	1.12
Protected vs. Never-Protected Lands	p	< 0.001	< 0.001	0.07
	t	105.09	-14.12	1.81
	df	7198.74	2063.51	1774.55

† Fragment: parcel of land surrounded by roads on all sides

Table A1.8: Results of Fligner-Killeen tests for homoscedasticity for all land cover types indicating which statistical test(s) to perform next at all three spatial scales examined.

Spatial Extent	We compared these land governance types….	using this metric…	..with the Fligner-Killeen Test and found…	...which indicated that the next test/s to perform was/were…
Downsize Event Scale	Reversed Downsize vs. Enduring Downsize	Fragment Area	$p = 0.009$ $\chi^2 = 6.83$ $df = 1$	Welch's t
	Reversed Downsize vs. Enduring Downsize	Area-to-perimeter ratio	$p = 0.26$ $\chi^2 = 1.26$ $df = 1$	Mann-Whitney U
	Reversed Downsize vs. Enduring Downsize	Road Density	$p = 0.31$ $\chi^2 = 1.02$ $df = 1$	Mann-Whitney U
Yosemite National Park Scale	Downsize vs. the Park vs. never-protected (1 km buffer)[4]	Fragment Area	$p < 0.001$ $\chi^2 = 72.01$ $df = 2$	Welch's ANOVA and post-hoc Welch's t
	Downsize vs. the Park vs. never-protected (1 km buffer)[5]	Area-to-perimeter ratio	$p = 0.24$ $\chi^2 = 2.84$ $df = 2$	Kruskal Wallis and post-hoc Mann-Whitney U
	Downsize vs. the Park vs. never-protected (1 km buffer)[6]	Road Density	$p < 0.001$ $\chi^2 = 361.80$ $df = 2$	Welch's ANOVA and post-hoc Welch's t

[4] Robustness check using 5 km buffer also indicated that the Welch's ANOVA and post-hoc Welch's t-test were most appropriate ($p < 0.001$, $\chi^2 = 98.77$, df = 2).
[5] Robustness check using 5 km buffer also indicated that the Kruskal Wallis and post-hoc Mann Whitney U tests were most appropriate ($p = 0.42$, $\chi^2 = 1.74$, df =2)
[6] Robustness check using 5 km buffer also indicated that the Welch's ANOVA and post-hoc Welch's t-test were most appropriate ($p < 0.001$, 371.37, df = 2).

Sierra Nevada Ecoregion Scale	Downsize vs. protected in the Ecoregion vs. never-protected in the Ecoregion	Fragment Area	$p < 0.001$ $\chi^2 = 1075.38$ df = 2	Welch's ANOVA and post hoc Welch's t
	Downsize vs. protected in the Ecoregion vs. never-protected in the Ecoregion	Area-to-perimeter ratio	$p < 0.001$ $\chi^2 = 408.59$ df = 2	Welch's ANOVA and post hoc Welch's t
	Downsize vs. protected in the Ecoregion vs. never-protected in the Ecoregion	Road Density	$p < 0.001$ $\chi^2 = 2986.43$ df = 2	Welch's ANOVA and post hoc Welch's t

Table A1.9: Habitat fragmentation indicators in enduring and reversed downsizes for all land cover types.

Land governance types	Statistics	Road density (km^{-1})	Fragment[†] area-to-perimeter ratio (dimensionless)	Fragment[†] area (km^2)
Enduring downsizes	mean (SD)	1.10 (0.38)	0.028 (0.017)	2.43 (8.78)
	median (IQR)	1.12 (0.43)	0.028 (0.024)	0.067 (1.32)
	n	*265*[‡]	*217*[§]	*217*[§]
Reversed downsizes	mean (SD)	0.37 (0.45)	0.030 (0.018)	7.01 (54.91)
	median (IQR)	0.14 (0.53)	0.030 (0.031)	0.045 (0.43)
	n	*345*[‡]	*96*[§]	*96*[§]
Results		$p < 0.001$[¦] W = 11308	$p = 0.22$[¦] W = 11316	$p = 0.42$[#] df = 97.15 t = 0.81

[†] Fragment: parcel of land surrounded by roads on all sides

[‡] Number of points sampled

[§] Number of fragments

[¦] Mann-Whitney U test result; choice of test based on Fligner-Killeen test for homoscedasticity (see Table A1.8)

[#] Welch’s t-test result; choice of test based on Fligner-Killeen test for homoscedasticity (see Table A1.8)

Table A1.10: Habitat fragmentation indicators for all land cover types at the Park scale. See Table A1.11 for results of post-hoc tests.

Land governance type	Statistics	Road density (km^{-1})	Fragment[†] area-to-perimeter ratio (dimensionless)	Fragment[†] area (km^2)
Downsizes	mean (SD)	0.69 (0.55)	0.034 (0.015)	6.11 (42.67)
	median (IQR)	0.80 (1.03)	0.034 (0.024)	0.11 (1.11)
	n	*625*[‡]	*201*[§]	*201*[§]
Yosemite National Park	mean (SD)	0.27 (0.32)	0.041 (0.015)	15.67 (144.50)
	median (IQR)	0.16 (0.37)	0.042 (0.021)	0.02 (0.12)
	n	*1530*[‡]	*193*[§]	*193*[§]
Never-protected lands (1 km buffer)	mean (SD)	1.20 (0.56)	0.030 (0.013)	0.99 (1.89)
	median (IQR)	1.31 (0.67)	0.029 (0.017)	0.37 (1.16)
	n	*40*[‡]	*99*[§]	*99*[§]
Results		$p < 0.001$[|] $F = 209.91$ num df = 2.00 denom df = 100.63	$p < 0.001$[#] $\chi^2 = 36.52$ df = 2	$p = 0.09$[|] $F = 2.43$ num df = 2.00 denom df = 262.32

[†] Fragment: parcel of land surrounded by roads on all sides
[‡] Number of points sampled
[§] Number of fragments
[|] Welch's ANOVA test result; choice of test based on Fligner-Killeen test for homoscedasticity (see Table A1.8)
[#] Kruskal-Wallis test result; choice of test based on Fligner-Killeen test for homoscedasticity (see Table A1.8)

Table A1.11: Habitat fragmentation at the Park scale for all land cover types. Never-protected lands delineated using a 1 km buffer. Results of post-hoc tests from Table A1.10.

Comparison	Road density (km^{-1})	Fragment[†] area-to-perimeter ratio (dimensionless)	Fragment[†] area (km^2)
Downsized vs. the Park	$p < 0.001$[‡]	$p < 0.001$[§]	$p = 0.38$[‡]
	$t = -17.97$	$W = 24395$	$t = 0.88$
	$df = 804.00$		$df = 224.00$
Downsized vs. Never-Protected	$p < 0.001$[‡]	$p = 0.07$[§]	$p = 0.09$[‡]
	$t = 5.63$	$W = 8680$	$t = -1.70$
	$df = 44.04$		$df = 201.59$
The Park vs. Never-Protected	$p = < 0.001$[‡]	$p < 0.001$[§]	$p = 0.16$[‡]
	$t = -10.56$	$W = 4950$	$t = 1.41$
	$df = 39.69$		$df = 192.19$

[†] Fragment: parcel of land surrounded by roads on all sides

[‡] Welch's t-test result. Choice of test based on Fligner-Killeen test for homoscedasticity (see Table A1.8)

[§] Mann-Whitney U test result. Choice of test based on Fligner-Killeen test for homoscedasticity (see Table A1.8)

Table A1.12: Habitat fragmentation indicators at the Park scale for all land cover types – sensitivity test using a 5 km never-protected lands buffer demonstrate the same results as with a 1 km buffer. See Table A1.13 for results of post-hoc tests.

Land governance type	Statistics	Road density (km^{-1})	Fragment[†] area-to-perimeter ratio (dimensionless)	Fragment[†] area (km^2)
Downsizes	mean (SD)	0.69 (0.55)	0.034 (0.015)	6.12 (42.67)
	median (IQR)	0.80 (1.03)	0.034 (0.024)	0.11 (1.11)
	n	*625*[‡]	*201*[§]	*201*[§]
Yosemite National Park	mean (SD)	0.27 (0.32)	0.041 (0.015)	15.67 (144.50)
	median (IQR)	0.16 (0.37)	0.042 (0.021)	0.02 (0.12)
	n	*1530*[‡]	*193*[§]	*193*[§]
Never-protected (5 km buffer)	mean (SD)	1.18 (0.49)	0.033 (0.014)	2.23 (6.48)
	median (IQR)	1.29 (0.73)	0.032 (0.019)	0.25 (1.69)
	n	*252*[‡]	*217*[§]	*217*[§]
Results		$p < 0.001$[|]	$p < 0.001$[#]	$p = 0.13$[|]
		$F = 555.14$	$\chi2 = 33.15$	$F = 2.04$
		num df = 2.00	df = 2	num df = 2.00
		denom df = 527.84		denom df = 263.84

[†] Fragment: parcel of land surrounded by roads on all sides
[‡] Number of points sampled
[§] Number of fragments
[|] Welch’s ANOVA test result. Choice of test based on Fligner-Killeen test for homoscedasticity (see Table A1.8)
[#] Kruskal-Wallis test result. Choice of test based on Fligner-Killeen test for homoscedasticity (see Table A1.8)

Table A1.13: Post-hoc results from Table A1.12. Habitat fragmentation at the Park scale for all land cover types using 5 km buffers for never-protected lands. Results are consistent with comparisons using a 1 km buffer.

Comparison	Road density (km^{-1})	Fragment† area-to-perimeter ratio (dimensionless)	Fragment† area (km^2)
Downsized vs. the Park	$p < 0.001$‡	$p < 0.001$§	$p = 0.38$‡
	$t = -17.97$	$W = 24395$	$t = 0.88$
	$df = 804.00$		$df = 224.00$
Downsized vs. Never Protected (5 km buffer)	$p < 0.001$‡	$p = 0.46$§	$p = 0.20$‡
	$t = 12.944$	$W = 22172$	$t = 1.27$
	$df = 517.97$		$df = 208.55$
The Park vs. Never-Protected (5 km buffer)	$p < 0.001$‡	$p < 0.001$§	$p = 0.20$‡
	$t = -28.60$	$W = 23653$	$t = 1.29$
	$df = 287.76$		$df = 192.69$

† Fragment: parcel of land surrounded by roads on all sides
‡ Welch's t-test result. Choice of test based on Fligner-Killeen test for homoscedasticity (see Table A1.8)
§ Mann-Whitney U test result. Choice of test based on Fligner-Killeen test for homoscedasticity (see Table A1.8)

Table A1.14: Habitat fragmentation indicators at the Ecoregional scale for all land cover types; results of Welch's ANOVA tests. See Table A1.15 for results of post-hoc tests.

Land governance type	Statistics	Road density (km^{-1})	Fragment[†] area-to-perimeter ratio (dimensionless)	Fragment[†] area (km^2)
Downsizes	mean (SD)	0.69 (0.55)	0.034 (0.015)	6.11 (42.67)
	median (IQR)	0.80 (1.03)	0.034 (0.024)	0.11 (1.11)
	n	*625*[‡]	*201*[§]	*201*[§]
All protected lands in Sierra Nevada Ecoregion	mean (SD)	0.29 (0.43)	0.025 (0.020)	4.90 (78.81)
	median (IQR)	0.11 (0.38)	0.021 (0.034)	0.01 (0.11)
	n	*8073*[‡]	*3274*[§]	*3274*[§]
All never-protected lands in Sierra Nevada Ecoregion	mean (SD)	1.41 (0.69)	0.037 (0.016)	2.04 (14.91)
	median (IQR)	1.35 (0.86)	0.038 (0.016)	0.06 (0.47)
	n	*19,482*[‡]	*18,918*[§]	*18,918*[§]
Results	p	< 0.001	< 0.001	0.050
	F	13373.64	621.31	3.03
	num df	2.00	2.00	2.00
	denom df	1695.19	518.88	504.20

[†] Fragment: parcel of land surrounded by roads on all sides
[‡] Number of points sampled
[§] Number of fragments

Table A1.15: Habitat fragmentation at the Ecoregional scale for all land cover types –results of post-hoc Welch’s t-tests from Table A1.14.

Comparison	Statistics	Road density (km^{-1})	Fragment† area-to-perimeter ratio (dimensionless)	Fragment† area (km^2)
Downsized vs. Protected Lands	p	< 0.001	< 0.001	0.71
	t	-17.83	8.56	-0.37
	df	683.04	243.15	291.74
Downsized vs. Never-Protected Lands	p	< 0.001	0.004	0.18
	t	-31.63	-2.94	1.35
	df	687.48	204.87	200.52
Protected vs. Never-Protected Lands	p	< 0.001	<0.001	0.039
	t	-165.85	-35.23	2.07
	df	22825.15	4078.28	3313.67

† Fragment: parcel of land surrounded by roads on all sides

Table A1.16: Fragment density calculations at three spatial scales for all land cover types

Land governance type	Total Area (km^2)	Number of fragments†	Fragment† density (km^{-2})
Enduring Downsize	527.52	217	0.41
Reversed Downsize	672.56	96	0.14
All Downsized lands	1227.52	201	0.16
Yosemite National Park	3025.11	193	0.06
Never-protected lands – 1 km buffer	98.06	99	1.01
Never-protected lands– 5 km buffer	484.79	217	0.45
All protected lands in the Ecoregion	16026.33	3274	0.20
All never-protected lands in the Ecoregion	38618.52	18918	0.49

† Fragment: parcel of land surrounded by roads on all sides

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