PROTECTED AREAS

# The uncertain future of protected lands and waters

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**Protected areas are intended to safeguard biodiversity in perpetuity, yet evidence suggests that widespread legal changes undermine protected area durability and efficacy. We documented these legal changes—protected area downgrading, downsizing, and degazettement (PADDD) events—in the United States and Amazonian countries and compiled available data globally. Governments of the United States and Amazonian countries enacted 269 and 440 PADDD events, respectively. Between 1892 and 2018, 73 countries enacted 3749 PADDD events, removing 519,857 square kilometers from protection and tempering regulations in an additional 1,659,972 square kilometers; 78% of events were enacted since 2000. Most PADDD events (62%) are associated with industrial-scale resource extraction and development, suggesting that PADDD may compromise biodiversity conservation objectives. Strategic policy responses are needed to address PADDD and sustain effective protected areas.**

Governments have designated nearly 15% of global lands and 7.3% of oceans as protected areas (PAs) (*1*) to "achieve the long-term conservation of nature" (*2*). Amid calls to accelerate PA designation to safeguard biodiversity (*3*), some governments have initiated large-scale rollbacks to legal protections (*4*–*9*). Collectively, legal changes that temper, shrink, or abolish PAs are known as protected area downgrading, downsizing, and degazettement (PADDD) events [(*4*), Fig. 1]. PADDD events can accelerate forest loss, fragmentation, and carbon emissions (*5*, *6*).

Through systematic archival research and expert consultation (see materials and methods), we documented enacted and proposed PADDD events in two regions experiencing rapid environmental policy change: the United States and the nine Amazonian countries. Combined with previously published and unpublished PADDD records from 66 additional countries collected systematically, opportunistically, and through crowdsourcing [(*5*–*9*), table S1], we present the most comprehensive global review to date of the extent, trends, and proximate causes of PADDD.

The United States is home to the first modern PAs—Yellowstone and Yosemite National Parks—and has historically been a global conservation leader. Between 1892 and 2017, however, the U.S. government enacted at least 269 PADDD events in 229 terrestrial federal PAs, removing protections for 15,555 km$^2$ and tempering regulations in an additional 511,307 km$^2$ (Fig. 2). The U.S. government enacted PADDD events in 44 states across all federal land management agencies. The earliest PADDD event was enacted in 1892 in Yosemite National Park, when Congress authorized wagon road and turnpike construction (*6*); in 1905, Congress downsized Yosemite by 30% to enable forestry and mining (*6*). Most U.S. PADDD events ($n$ = 186) resulted from a 2016 National Park Service regulation provisionally allowing Native American tribes to harvest plants for traditional subsistence purposes if the activity will have "no significant ecological impact" (*10*). Conversely, 34 PADDD events were associated with industrial-scale resource extraction and development, including the downsizing of Joshua Tree National Park for mining (1950) and the downgrading of eight national forests to allow ski infrastructure construction (1986).

From 1944 to 2017, the U.S. government proposed at least 737 PADDD events in 426 PAs, which, if enacted, would affect 402,414 km$^2$ of protected lands. The government introduced 90% of U.S. PADDD proposals since 2000, 99% of which were associated with industrial-scale development. For instance, proposals in 2011 and 2015 to authorize infrastructure construction for national security purposes on public lands "within

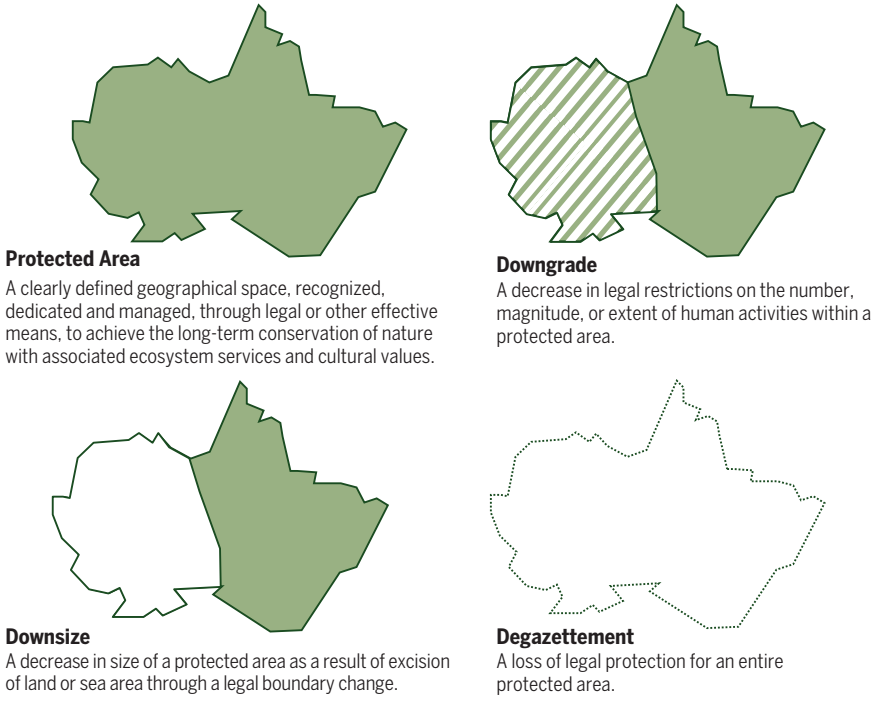


**Fig. 1. Protected area downgrading, downsizing, and degazettement.** PAs are defined in (*2*); downgrading, downsizing, and degazettement are defined in (*4*). PADDD events are legal (de jure) changes, as distinct from (but potentially related to) de facto PA management and performance.

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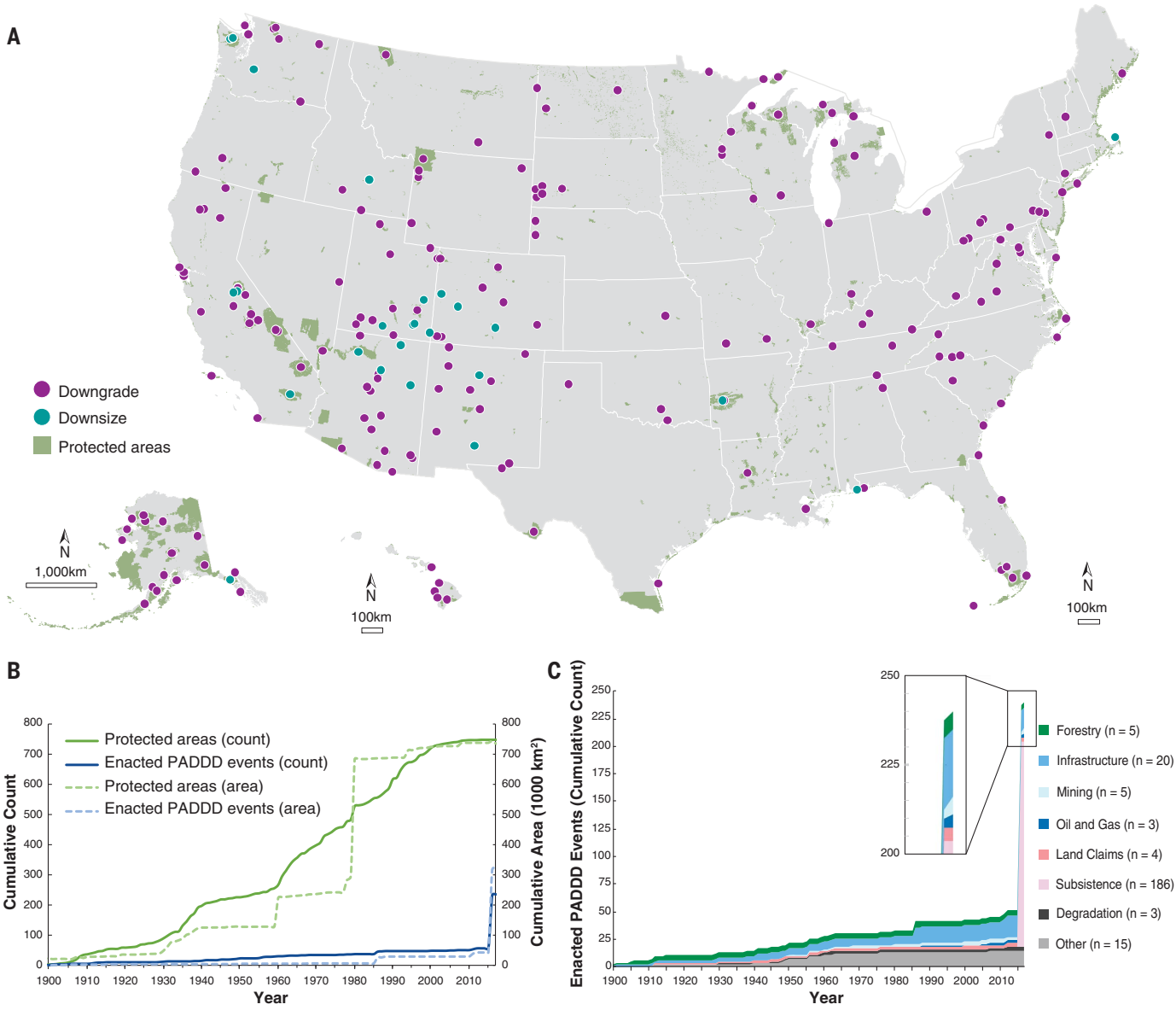


**Fig. 2. Patterns, trends, and causes of PADDD in the United States.** (**A** to **C**) Spatial patterns (A), temporal trends (B), and proximate causes (C) of enacted PADDD events in the United States, from 1892 to 2018 ($n$ = 269). PA layer includes federal terrestrial PAs (source described in the materials and methods).

100 miles" (161 km) of Mexico or Canada would affect 191 PAs (*11*).

Recent PADDD events highlight the increasingly uncertain future of U.S. PAs. In 2017, after 114 unsuccessful proposals over 30 years, the U.S. Congress approved oil and gas development in the Arctic National Wildlife Refuge (*12*). Also in 2017, President Trump enacted the two largest downsizes in U.S. history, reducing Bears Ears and Grand Staircase–Escalante National Monuments by 85% (4657 km$^2$) and 51% (3488 km$^2$), respectively (*13*, *14*); these decisions are currently under litigation. The U.S. government has identified nine additional terrestrial and marine national monuments for downgrading or downsizing (*15*).

To conserve biocultural diversity and ecosystem services, the nine countries of Amazonia established PAs covering nearly 25% of their lands (*1*). Governments in seven Amazonian countries enacted 440 PADDD events (322 downgrades, 86 downsizes, and 32 degazettements) across 245 (12%) state-designated PAs, between 1961 and 2017 (Fig. 3). These PADDD events removed protections for 154,857 km$^2$ and downgraded an additional 209,004 km$^2$. Most (83%) enacted PADDD events were associated with industrial-scale resource extraction and development, followed by local land pressures and claims (9%) (Fig. 4). Of the enacted PADDD events in Amazonia, 5% were simultaneously offset with upgraded or expanded protections (table S23), whereas 67% were later reversed through revocations of downgrades or establishments of new PAs (table S22). PADDD in Amazonia is widespread, with 75% of ecoregions (*16*) and 21% of Key Biodiversity Areas (*17*) currently or potentially affected.

Among Amazonian countries, the prevalence of PADDD varies widely (between 0 and 85% of PAs affected, table S26), at least partly because of different legal frameworks governing PAs. For instance, Bolivia (5% of PAs affected) authorizes extractive activities in certain PAs upon establishment, so the issuance of permits for oil and gas in national parks would not constitute a PADDD event. Higher rates of PADDD in Colombia (85%) and Peru (43%) arose from reforms to national-level laws to authorize mining, agriculture, and

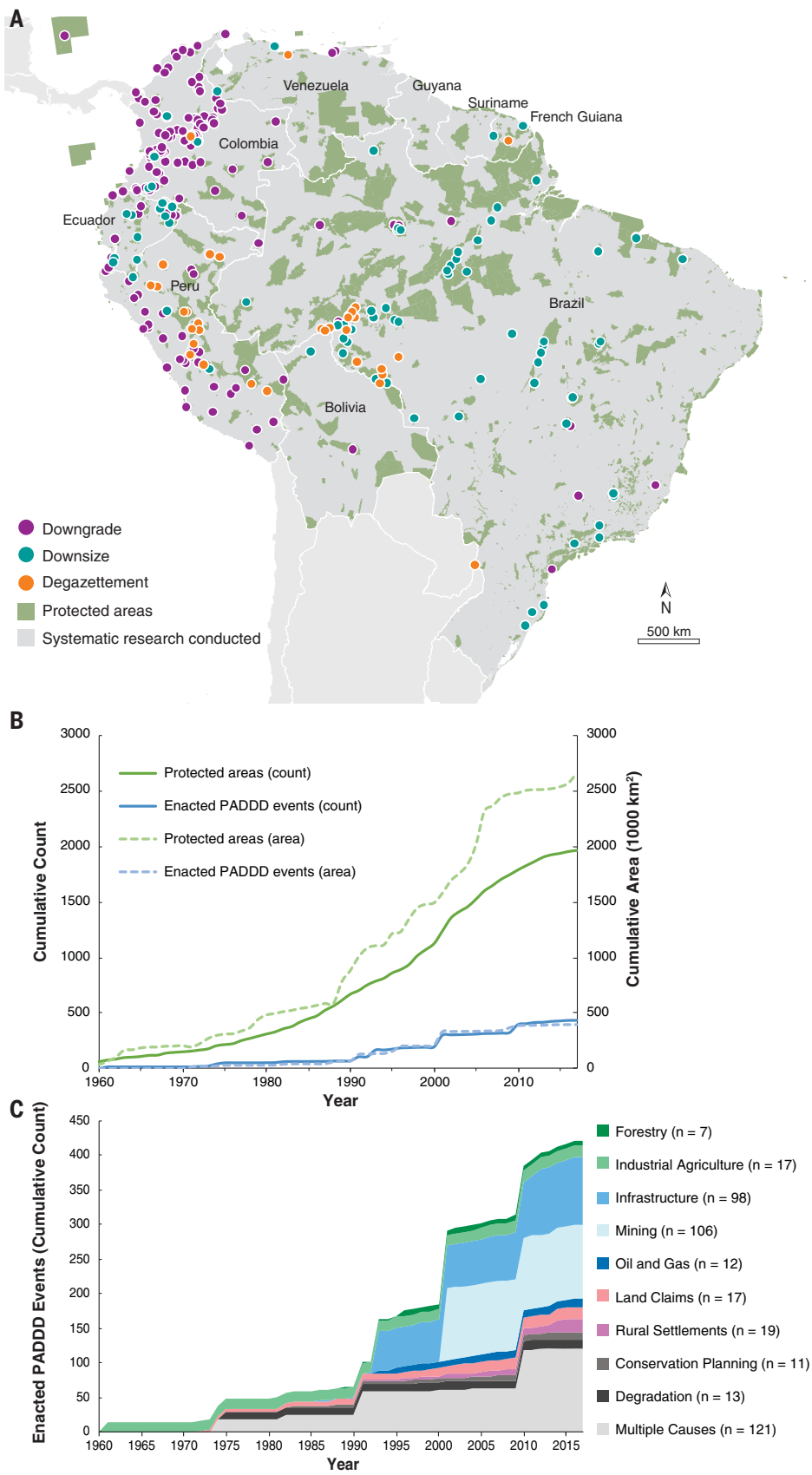


**Fig. 3. Patterns, trends, and causes of PADDD in Amazonia.** (**A** to **C**) Spatial patterns (A), temporal trends (B), and proximate causes (C) of enacted PADDD events in Amazonian countries, from 1961 to 2017 ($n$ = 440). PA layer includes state-designated PAs (sources described in the materials and methods).

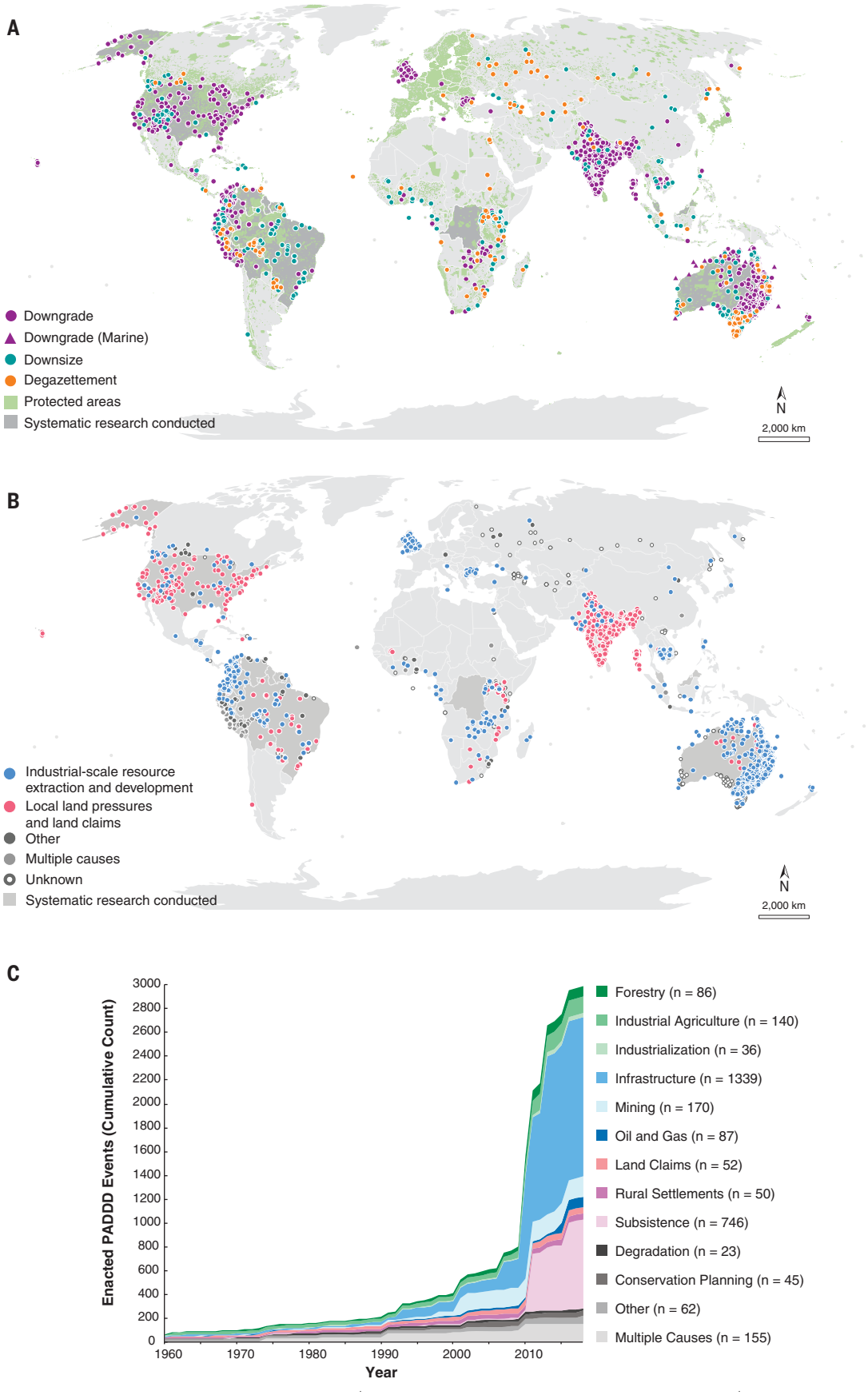


**Fig. 4. Global patterns, trends, and causes of PADDD.** (**A** to **C**) Spatial patterns of PADDD by event type (A) and proximate cause (B) and proximate causes over time of PADDD (C), enacted in 73 countries, from 1892 to 2018 (*n* = 3749). Countries in which we conducted systematic research are shown in dark gray. Spatial data were not available for 354 events, including in the Democratic Republic of the Congo (*n* = 41) and Malaysia (*n* = 123). PAs are from the World Database of Protected Areas, June 2018 (*29*). In (B), "industrial-scale resource extraction and development" includes fisheries, forestry, industrial agriculture, industrialization, infrastructure, mining, and oil and gas. "Local land pressures and land claims" include land claims, rural settlements, and subsistence. "Other" includes degradation (*n* = 24), conservation planning (*n* = 52), refugee accommodations (*n* = 2), shifting sovereignty (*n* = 2), and other proximate causes (*n* = 42). Fisheries (*n* = 16) are included with "other" in (C), because small sample size prevented visualization at this scale. Proximate causes were unknown for 602 events.

infrastructure in multiple PAs simultaneously; many of these changes were later reversed. Brazil is a contemporary hotspot of PADDD; 4% of PAs have been affected by enacted PADDD, with 48% of events enacted or proposed between 2010 and 2017, primarily to authorize hydropower dams. Following regional patterns, PADDD events in Ecuador, French Guiana, and Venezuela authorized infrastructure and extractive activities ($n$ = 20) or ceded lands to local communities ($n$ = 6). No PADDD events were enacted in Suriname or Guyana.

Against a backdrop of PA creation (*1*), rates of enacted and proposed PADDD events in Amazonia have increased since the 1960s (figs. S21 and S22). Governments in four Amazonian countries proposed 22 downgrades, 26 downsizes, and 19 degazettements between 1991 and 2017, affecting 210,763 km$^2$ (table S21). Of these, 15 proposals targeting 6236 km$^2$ are currently under consideration.

Evidence of PADDD demonstrates that PAs are not permanent fixtures on the landscape (*18*). Globally, including in the United States and Amazonian countries, at least 3749 PADDD events (2705 downgrades, 698 downsizes, and 346 degazettements) in 3048 PAs have been enacted in 73 countries since 1892 (Fig. 4), removing 519,857 km$^2$ from protection and tempering regulations in an additional 1,659,972 km$^2$; in total, 1,961,599 km$^2$ has been affected, an area approximately the size of Mexico. Sixty-four percent ($n$ = 2898 of 3710 events with known dates) were enacted between 2008 and 2018, and 78% ($n$ = 2398) between 2000 and 2018. Systematic archival research reveals high rates of PADDD. For instance, PADDD affected 20% of terrestrial PAs in Australia and 43% in the Democratic Republic of the Congo (*5*, *7*). Among enacted PADDD events with known proximate causes ($n$ = 3015), 62% ($n$ = 1884) are associated with industrial-scale resource extraction and development and 28% ($n$ = 852) with local land pressures and claims (*4*, *9*) (Fig. 4). PADDD events can be dynamic: 24% of enacted events were later reversed (table S7), and 5% were offset by means of compensatory protection elsewhere (table S8). Eighty-nine percent of events resulted from systemic changes, whereby one legal action affected multiple PAs (table S9). Furthermore, 24 countries have proposed at least 847 PADDD events; 46 proposals currently under consideration in 14 countries target an additional 32,062 km$^2$ (table S11).

As discussions unfold regarding the future of PAs, it is critical to consider potential risks and consequences of PADDD. In the tropics, PADDD is more likely among larger PAs closer to population centers (*19*). In Brazil, PAs with higher historical deforestation rates were more likely to be downsized or degazetted (*8*, *20*), representing an attempt to align PA status with prior land use, with underperforming PAs preferentially bargained away in negotiations over land governance (*20*). In Peru and peninsular Malaysia, downsizings and degazettements accelerated forest loss and carbon emissions (*5*). Forests downsized from Yosemite National Park are more fragmented today than lands that retained protections or where lost protections were later restored (*6*). Although PADDD may not always negatively affect biodiversity [i.e., by restoring rights to displaced peoples (*10*); optimizing the conservation estate [1.7% of events were related to conservation planning (*21*, *22*)]; or responding to climate change], most enacted PADDD events globally (62%) are associated with industrial-scale resource extraction and development, which is often incompatible with biodiversity outcomes (Fig. 4).

Emerging research illustrates patterns, trends, and causes (*9*); risks (*19*, *20*); and ecological impacts (*5*, *6*, *8*) of PADDD. However, knowledge gaps remain. The global figures presented are conservative estimates of PADDD extent, because legal documents remain inaccessible in many countries. Additional archival research, as presented in (*5*–*8*, *23*) and this study, would generate a more complete understanding of PADDD, especially for marine PAs and for countries where opportunistic data collection suggests widespread PADDD (e.g., India and Cambodia; see supplementary text). Further study of the land-use history, enabling conditions, spread, social and ecological impacts, and relationships between causes and consequences of PADDD will enable risk assessments, whereas consideration of PADDD in PA evaluations will provide more accurate estimates of PA performance (*20*).

Despite knowledge gaps, sufficient research exists to develop evidence-based policies in response to PADDD. First, monitoring and public reporting of enacted and proposed PADDD events are essential. Despite civil society's efforts to monitor PADDD (PADDDtracker.org), standardized tracking of PADDD is not commonplace; the official database of PAs [the World Database of Protected Areas (*1*)] lacks information on legal changes to PAs and proximate causes of PADDD. To systematically track PADDD, national governments should report on PADDD, mirroring mechanisms for reporting on PA establishment.

Public and private sector stakeholders could promote safeguards and processes to incentivize PA permanence. Policies and processes governing PADDD vary widely, suggesting potential reforms for PADDD analogous to those for the establishment of PAs (*24*), such as environmental impact studies, public consultation, and visual representation of legal proposals (*8*). The mitigation hierarchy may help frame deliberations on PADDD proposals: avoid (*25*), then minimize impacts, and, if unavoidable, offset by increasing protections elsewhere (*26*). Reversing PADDD may confer benefits (*6*) but may not restore ecological values, if habitat loss has occurred. Laws could require that decision-makers deliberate PADDD proposals separately from other policies and gain approval from multiple parties (*27*), including from the same, if not higher, level of government as for PA gazettement. Donors and lenders may also consider PADDD and its impacts in their safeguard policies and funding decisions.

As human pressures on the biosphere accelerate, it is critical to strengthen—not roll back—conservation efforts (*25*, *28*). Recent PADDD events in the United States and Brazil are of particular concern; as global leaders in conservation, decisions by the United States and Brazilian governments to erode protections could embolden other countries to do the same. Given the global investment in PAs to conserve nature, it is essential to accelerate research and support evidence-based policy to address PADDD and safeguard PAs.

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## SUPPLEMENTARY MATERIALS

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Materials and Methods
Supplementary Text
Figs. S1 to S34
Tables S1 to S31
References (*30*–*74*)

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**Not all that protected, after all**

The intention of creating protected natural areas is to protect them in the long term from destructive human activities. Governments do not always follow these intentions, however, and often legally remove protections and reduce the extent of protected areas. Golden Kroner *et al.* looked across the United States and Amazonia over the past 200 years and found more than 700 such changes, two-thirds of which have occurred since the year 2000 (see the Perspective by Naughton-Treves and Holland). The majority of these were to permit destructive practices, such as resource extraction. Thus, these changes do not just alter status but lead to irreparable environmental harm.

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