Protected area downgrading, downsizing, and degazettement (PADDD) and its conservation implications

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Abstract

National parks and other protected areas (PAs) are the foundation of global efforts to conserve biological diversity. Conservation policy and practice assume that PAs are permanent fixtures on the landscape, but scattered evidence points to widespread—yet largely overlooked—PA downgrading, downsizing, and degazettement (PADDD). As a preliminary investigation of PADDD and its implications for conservation science and policy, we explore the published literature and contemporary media reports. We identify 89 historic instances of PADDD, in 27 countries, since 1900. Contemporary accounts reveal that PADDD has recently occurred or is currently under consideration in at least 12 countries worldwide. Proximate causes of PADDD vary widely, but center on access to and use of natural resources. Case studies from India and South America highlight the fact that PAs are socially defined and socially constructed governance regimes, responsive to social pressures—including conservation demands—at local to global scales. PADDD challenges longstanding assumptions underlying conservation policy and practice, including efforts to reduce deforestation and forest degradation (REDD), and underscores the need for resilient and robust conservation strategies. Because many fundamental questions regarding PADDD remain unanswered, further research is required to understand this conservation phenomenon and develop tailored policy responses.

Introduction

National parks, nature reserves, and other protected areas (PAs) are the foundation of global efforts to conserve biodiversity. Though the origin of PAs can be traced as far back as ancient Egypt, Yellowstone National Park (USA), established in 1872, is generally recognized as the first PA of the modern era (Lockwood *et al.* 2006, 692–693). Today, more than 122,000 nationally designated PAs cover approximately 12% of the earth's land surface and another 0.65% of its oceans (Wood *et al.* 2008; IUCN and UNEP 2009; United Nations 2009). Myriad provincial and municipal PAs, community conserved areas, private reserves, and other formal and informal PAs complement these nationally designated PAs (Johannes 1978; Langholz & Lassoie 2001; Berkes 2009). Societal expectations for PAs and their roles in biodiversity conservation are codified through the Convention on Biological Diversity, which calls for its 193 member states to establish comprehensive systems of representative and effectively managed PAs by 2010 (terrestrial) or 2012 (marine) (Convention on Biological Diversity 2004).

Conservation policy and practice assume that PAs are permanent fixtures on the landscape, but scattered evidence points to widespread—yet largely overlooked—PA downgrading, downsizing, and degazettement (PADDD). Though the conventional narrative regarding PAs is one of continuous growth in numbers and spatial extent (Figure 1), several countries have scaled back their national PA systems (Figure 2, Zimmerer *et al.* 2004), a contentious practice first observed in the early 1900s (Adams 2004). Nor are the global icons of conservation immune to calls for PADDD (Dowie 2009), as demonstrated by recent government proposals to downgrade Amboseli National Park (Kenya) and the Arctic National Wildlife Refuge (ANWR) (USA) (Corn & Roberts 2008; Veit *et al.*

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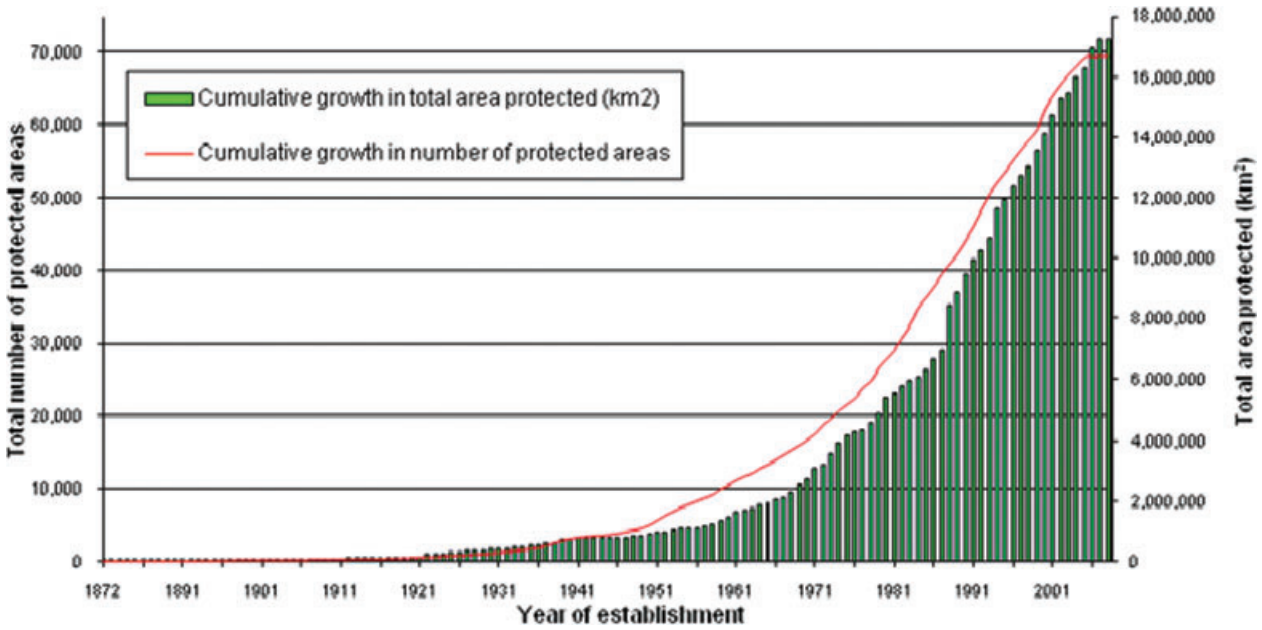


Figure 1 Cumulative growth of nationally designated protected areas (PAs), 1872–2008 (IUCN and UNEP 2009). Note: Graph excludes 52,932 PAs for which date of establishment is not specified within the World Database of Protected Areas.

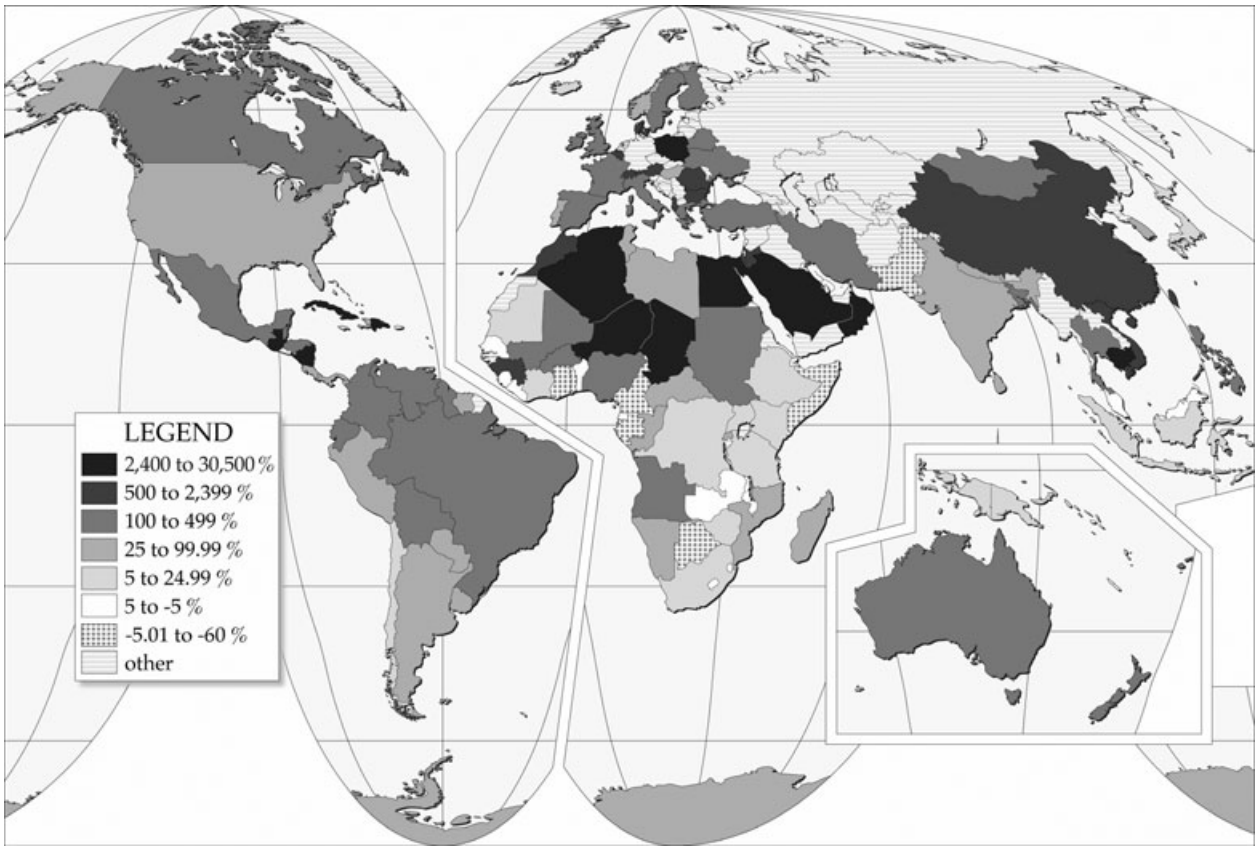


Figure 2 Percentage change in protected area coverage, 1985–1997 (Zimmerer *et al.* 2004). National declines in protected area coverage in Botswana, Cameroon, Gabon, Ghana, Guinea-Bissau, Luxembourg, Pakistan, Somalia, and Togo suggest downsizing and degazettement of protected areas. Figure reprinted with permission of *Ambio* and the Royal Swedish Academy of Sciences.

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2008). Despite the central role of PAs in global conservation efforts, PADDD has never been systematically studied. The extent, patterns, trends, and causes of PADDD remain largely unrecognized and poorly understood—as do the implications for conservation.

As a preliminary investigation of PADDD and its implications for conservation science and policy, we assemble and explore evidence from the published literature and contemporary media reports (for methods and full dataset, see supporting information). We provide an overview of historic and contemporary accounts of PADDD, briefly examine two historic case studies, and then consider the implications of this evidence for conservation policy and practice. We do not consider PA *effectiveness* through an assessment of site administration or *de facto* performance (cf., Bruner *et al.* 2001; Hockings *et al.* 2006). Rather, without making *a priori* assumptions about whether PADDD is "good" or "bad," we investigate fundamental questions about the *de jure existence* and *permanence* of PAs. We define *downgrading* as a decrease in legal restrictions on the number, magnitude, or extent of human activities within a PA (i.e., legal authorization for increased human use); *downsizing* as a decrease in size of a PA as a result of excision of land or sea area through a legal boundary change; and *degazettement* as a loss of legal protection for an entire PA. Notwithstanding various critiques (e.g., West *et al.* 2006; Gaston *et al.* 2008), we assume that PAs will continue to play a leading role in local, national, and international conservation policy and practice. Accordingly, PADDD raises many provocative questions for both scholars and policymakers.

PADDD, 1900–present

PADDD has a long history. In 1903, the British imperial government proposed degazetting the White Nile Reserve in Sudan, with the understanding that another game reserve—more distant from population centers in Khartoum—would be established instead (Prendergast & Adams 2003; Adams 2004). The government proposal sparked concern among a small group of social and political elites in England, who successfully fought the proposed degazettement by arguing that the ~100,000 km^2 White Nile Reserve (Buxton 1902) was necessary to provide wildlife near Khartoum with a sanctuary from otherwise unsustainable hunting (Adams 2004). Inspired by their success, these individuals formed the Society for the Preservation of Wild Fauna of the Empire, the conservation organization known today as Fauna and Flora International. In the years that followed, however, the White Nile Reserve was degazetted, perhaps "replaced" in the 1930s by the Zeraf Game Reserve hundreds of kilometers to the south (Philip Winter, Rift Valley Institute, pers. comm. February 27, 2010; SPWFE 1904).

More than 100 years later, government officials debated legislation to permit oil drilling in the U.S. Arctic National Wildlife Refuge (ANWR), which would downgrade the iconic PA known as "America's Serengeti" (Corn & Roberts 2008). First established in 1960, ANWR doubled in size as a result of national legislation in 1980. Acknowledging the potential oil wealth beneath the ground in ANWR, the U.S. Congress left nearly 6,300 km^2 of the 78,000 km^2 PA open to limited geological and seismic testing, but explicitly prohibited drilling in ANWR without subsequent Congressional authorization. Despite indications of large oil deposits, efforts to pass legislation that would permit drilling for oil in ANWR have repeatedly failed since the late 1970s (Corn & Roberts 2008). As a result, no drilling has occurred. Advocates for oil development have stressed potential economic and national security benefits, while opponents have emphasized risks to vulnerable species and ecosystems and to the cultural heritage of native peoples (Docherty 2001; Corn & Roberts 2008). Legal changes to permit drilling for oil within ANWR may also violate U.S. obligations as a signatory to the Convention on Biological Diversity, setting a precedent for other nations (Docherty 2001).

Though regulations governing ANWR remain unchanged, evidence suggests that PADDD has been widespread in the century since the White Nile Reserve was first targeted for degazettement. Our preliminary examination of the literature reveals at least 89 historic instances of PADDD, in 27 countries, since 1900 (Table 1, S1). The reported causes (where noted) of PADDD range from political bribes to tsetse fly abatement, but center on three main drivers: industrial-scale commodity production and extraction, infrastructure development, and local land claims and human settlement. In some cases, PADDD resulted from an *ex post facto* rationalization of environmental degradation, where authorities reconfigured land or sea governance because the PA had failed to meet its management objectives (Leader-Williams *et al.* 1996; East 1999; Burgess & Clarke 2000). These historic instances of PADDD are consistent with the findings of Zimmerer *et al.* (2004), who report that nine countries (Botswana, Cameroon, Gabon, Ghana, Guinea-Bissau, Luxembourg, Pakistan, Somalia, and Togo) experienced a 5-60% decline in PA coverage between 1985 and 1997.

PADDD is not only a historic phenomenon. Contemporary accounts from recent news headlines show that PADDD is a policy issue in at least 12 countries worldwide, with a few proposals recently agreed upon and numerous others under debate (Table 2). Though most contemporary accounts describe proposals to downgrade, downsize, or degazette a single PA, policy deliberations

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Table 1 Illustrative sample of historic instances of PADDD documented in scientific literature, academic texts, and published reports. See Table S1 in the online Supporting Information for all historic instances of PADDD identified in this study.

Country	Protected area	PADDD event	Year*	Cause (as described in text)	Source
Burma	Pedang Wildlife Reserve	Downgrade	Unspecified	"Army compounds and a small college have been built in the park and a railroad runs right through it."	Dowie (2009, p. 113)
Central African Republic	Dzanga-Sangha National Park	Downgrade	1990	"...two-thirds of Dzanga-Sangha National Park is now classified as a "Special Reserve"..., which enables the Ba'Aka pigmies to remain in the reserve and maintain traditional lifestyles."	Eyong (2007, p. 129)
Ecuador	Cuyabeno Wildlife Reserve	Downsize	1990s	"...discovery of oil, along with the clearing of forest for oil-palm plantations, prompted an official change in the borders of Cuyabeno Wildlife Reserve..."	Terborgh (1999, p. 73)
India	"Several" wildlife reserves	Degazette	1920s	"...opposition to the reserves from rubber planters caused the government to degazette several of them within a few years."	Peluso & Vandergeest (2001, p. 785)
Indonesia	Kutai Conservation Area	Downsize	late 1970s	"In the 1970's, two large industrial complexes were established in the southern section of the area and over 1000 km^2 was degazetted."	Rijksen & Meijaard (1999, p. 227)
Kenya	Mau Forest Reserve	Downsize	2001	"Under the severely corrupt administration of former president Daniel arap Moi (1978–2002), land titles and logging concessions went to Moi families and cronies..."	Dowie (2009, p. 183)
Madagascar	Nature reserve #2	Degazette	1964	"The only Nature Reserve (No 2) on the [Masoala] Peninsula was degazetted in 1964 to permit timbering of the area"	Harcourt & Thornback (1990, p. 165)
Malaysia	Klias National Park	Degazette	1980	"For purposes of a pulp and paper mill and plantation forestry it was degazetted two years later and regazetted as a Forest Reserve in 1981."	Thorsell (1985, p. 47)
Peru	Tambopata Candamo Reserve Zone	Downsize	2000	"...a portion of the transitory Tambopata Candamo Reserve Zone was excised in the year 2000 in response to residents' demands to be 'liberated' from the reserve."	Naughton-Treves *et al.* (2006, p. 36)
Rwanda	Park National de l'Akagera	Downsize	late 1990s	"By mid-1995, the Mutara reserve and the northwestern half of Akagera National park had been occupied by large numbers of people and several hundred thousand cattle and had effectively ceased to be a conservation area. The northern part of the protected area has subsequently been degazetted."	East (1999, p. 73)
South Africa	Mkambati Nature Reserve	Downgrade	2004	"...the Minister of Land Affairs.. formally handed Mkambati Nature Reserve over to Mkambati Land Trust... seven villages became co-owners of the land but agreed to maintain it as a nature reserve..."	Kepe (2008, p. 314)
Swaziland	"Game reserves"	Degazette	unspecified	"The protected areas network began with the establishment of a very few game reserves between 1912–14, but these were subsequently degazetted to make farming land available to World War 1 veterans."	IUCN (1992)
Tanzania	Ruvu Game reserve	Degazette	unspecified	"... Ruvu GR ...was degazetted after heavy encroachment and degradation by agrarian and pastoral societies"	Leader-Williams *et al.* (1996, p. 93)
Uganda	Mgahinga forest reserve	Downsize	1951	"Local demand for farmland was such that the forest reserve had been reduced in size by a third in 1951, and the area was cleared and settled."	Adams (2004, p. 8)
Zambia	Sumbu National Park	Downsize	unspecified	"Using his constitutional powers to alter the boundaries of national parks, Kaunda even degazetted part of Sumbu National Park to facilitate [Zambia Consolidated Copper Mines'] development plans for Kasaba Bay."	Gibson (1999, p. 59)

*Date ranges have been inferred when years are not specified.

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Table 2 Contemporary accounts of PADDD documented in news articles published August 31, 2009–April 30, 2010.

Country	Protected area	PADDD event	year	Cause (as described in text)	Source
Belize	Bladen Nature Reserve	Proposed downgrade	2010	"...environmental groups and the San Pedro Columbia community are mounting opposition to the proposed construction of a dam. The site is the Central River that runs through the Columbia River Forest Reserve and the Bladen Nature Reserve, two core conservation areas."	Great Belize Productions (2010)
Canada	Scaterie Island Wilderness Area	Proposed downgrade	2009	"Humane Society International Canada is speaking out about a move in Nova Scotia to allow a commercial seal hunt off Hay Island, a part of the province's Scaterie Island Wilderness Area."	Canwest News Service (2009)
India	Himachal Pradesh wildlife protected areas	Proposed downsize	2009	"Himachal Pradesh will redraw the boundaries of its wildlife protected areas to allow development activities..."	IANS (2009)
India	Pench National Park	Proposed downgrade	2010	"... the National Highway Authority of India (NHAI) as part of their plan to connect Srinagar and Kanyakumari wants to build a 56 km stretch in Madhya Pradesh which is proposed to cut through Pench National Park..."	Dutt (2010)
India	Karera Sanctuary	Proposed degazette-ment	2010	"The National Board of Wildlife (NBWL) chaired by Environment Minister Jairam Ramesh in a recent meeting approved the state government's proposal to denotify the sanctuary, after its officials said that the bustards were not sighted since 1995 and that most of the land inside the sanctuary sprawling over 202 km^2 was private land and people were facing lot of problems."	Press Trust of India (2010)
Indonesia	"Protected and conservation forest areas"	Proposed downgrade	2010	"President Susilo Bambang Yudhoyono finally signed a regulation legalizing the conversion of protected and conservation forest areas for business purposes."	Simamora (2010a)
New Zealand	Mount Aspiring National Park	Proposed downsize	2009	"A leaked report recommends the Government remove up to 20% of Mount Aspiring National Park from a schedule of protected areas, opening the way for mining and exploration in the designated World Heritage area."	Haggart (2009)
New Zealand	42 protected areas	Proposed downgrade	2009	"The party obtained information showing there were 21 current mineral permits for prospecting and exploration in 42 areas protected from mining by Schedule Four of the Crown Minerals Act".	NZPA (2009b)
New Zealand	"7000 ha of conservation land"	Proposed downgrade	2010	"The Government plans to remove about 7000 hectares of conservation land from schedule 4 of the Crown Minerals Act, which protects it from mining."	Weir (2010)
Philippines	Hundred Islands National Park	Proposed downsize	2009	"The group, which exposed an attempt to "chop-chop" the HINP, expressed alarm that the passage of the proposed measure may be used to develop the island for residential, commercial and industrial purposes."	Benaning (2009)
Philippines	Bulacan Biosphere Reserve	Downgrade	2010	"...road construction, as well as mining exploration and extractive activities on Mt. Bulanjao, have taken place in areas that, according to the ECAN (Ecological Critical Areas Network), fall into the so called 'Core Zones' of maximum protection..."	Lazaro (2010)
Puerto Rico	Northeast Ecological Corridor	Proposed downsize	2009	"Puerto Rico's governor on Friday canceled the designation of part of the island's northeastern coastline as a nature reserve, opening the door to large-scale development along a white-sand beach where proposals for hotel resorts have sparked bitter protests."	Associated Press (2009)
Romania	"Two national parks"	Proposed downgrade	2010	"...criticized the construction of a national road to cross two national parks..."	AFP (2010)
United States	Big Cypress National Preserve	Proposed downgrade	2009	"...a cash-strapped Miami-Dade County has been mulling the possibility of drilling for oil beneath the [Big Cypress National Preserve]... to help pay for the expansion of Miami-Dade International Airport."	Repanshek (2009)

Continued.

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Table 2 continued.

Country	Protected area	PADDD event	year	Cause (as described in text)	Source
United States	Shoshone National Forest	Proposed downgrade	2009	"Casper-based Hudson Group, LLC, is proposing to drill an exploratory [oil] well about 10 miles northwest of Dubois near the forest's southern end."	Gruver (2009)
Venezuela	"Some national parks and reserves"	Proposed downsize	2010	"Some national parks and reserves will be extended and some others will be reduced."	Alvarez (2010)
Zimbabwe	Hwange National Park	Proposed downgrade	2009	"...the country's main power plant says it needs to dig for new coal reserves under a river inside a national park to keep running."	Marawanyika (2009)

may simultaneously affect multiple PAs and even the entirety of a national PA system. In New Zealand, for example, successive governments have granted permits for "prospecting and exploration" in 42 PAs, as prelude to a currently pending proposal to downgrade an unspecified number of PAs—including the Mt. Aspiring National Park, a World Heritage Site—and subsequently permit industrial-scale mineral extraction in these PAs (Haggart 2009; NZPA 2009a, b). Similarly, Indonesia recently instituted legal reforms that would permit conversion of "conservation forests" and 316,000 km^2 of "protection forests" into "production forests," a governmental designation that would allow open-pit mining and conversion to oil palm plantations on these forested lands (Simamora 2010a, b). Industrial-scale petroleum and mineral extraction are the predominant catalysts associated with contemporary PADDD and PADDD proposals, though reports also highlight tourism development and local land claims as causal factors. As is clear from local newspaper headlines, efforts to downgrade, downsize, and degazette PAs are often the subject of political debate and social conflict (Table S2).

Unfortunately, our understanding of historic and contemporary PADDD is limited by a lack of detail in these largely anecdotal reports. Many accounts of PADDD do not include basic information, such as the year in which PADDD occurred or the size of the area(s) affected. Research exploring the context, causes, and consequences of PADDD is even more rare. Fortunately, rigorous studies in India (Agrawal 2005) and South America (Naughton-Treves *et al.* 2006) provide valuable insights into the social, political, and ecological dynamics surrounding PADDD.

PADDD in India, 1850–2000

Agrawal's (2005) study of forest conservation in the Kumaon region of northern India provides compelling insights into PADDD and its conservation implications. In the late 19th century, the economic value of forests and forest products—principally timber, resin, and firewood—increased sharply in Kumaon and elsewhere in the British colony (pp. 65–66). To enhance forest yield and sustainability, as well as government tax revenues, colonial forest department officials responded by establishing forest reserves and instituting other innovative models of scientific forest management (pp. 3–4). The first Kumaoni PAs were established in the late 1860s or early 1870s (pp. 69, 250 note 14), but their spatial extent and restrictions on human activities expanded dramatically following the Forest Act of 1878 (p. 72). In the 1890s, the forest department established forest reserves covering approximately 500 km^2 in Kumaon (p. 83), including some areas that villagers considered as sacred groves (p. 78). Regulations governing forest reserves prohibited use by local villagers, including subsistence activities like grazing cattle and gathering firewood (pp. 72–73). (Though British officials in India did not establish forest reserves to conserve or manage wild animals, governance of valuable wild plants and animals blurred together. Forest reserves often included "shooting blocks" that excluded local residents while giving hunting rights to political elites; many of these forest reserves were eventually converted to national parks (Saberwal & Rangarajan 2003).)

The overwhelming complexity of managing human use of forests *outside* PAs led the forest department to dramatically expand its system of forest reserves early in the 20th century (p. 72). From 1911 to 1916, Kumaoni forest reserves grew from 500 km^2 to more than 7700 km^2 (p. 72)—nearly 80% of forests in the region (p. 3). Though originally divided into three classifications that permitted varying degrees of human activity, regulatory changes during this period effectively excluded local residents from the vast majority of Kumaoni forests (p. 78). "Villagers found that they had limited or no rights left in the reserves. In response, they set fires in the reserved forests in a vivid spectacle of challenge to new forms of government over nature (i.e., reserves). Fires were especially widespread in 1916. Nearly 200,000 acres (approximately 800 km^2) were burned in hundreds

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of separate incidents" (Agrawal 2005, p. 3). These organized and intentional fires (which continued through at least 1921 [p. 80]) were the culmination of other acts of protest against PAs, including attacks on foresters who established reserves in sacred groves (e.g., 1890s); verbal protests at public meetings (e.g., 1907); and nearly ubiquitous noncompliance by local villagers—including coordinated efforts to break the law (especially from 1917 to 1921; pp. 78–81).

The colonial government responded to these local protests with an extensive review and radical transformation of its approach to forest governance (p. 83). By 1927, approximately 5,000 km^2 of forest reserves of limited economic value had been degazetted and transferred to the jurisdiction of the colonial revenue department (p. 83). "Over the next 60 years," many of these forests were eventually designated as "community forests" managed by village-level forest councils (p. 83). The remaining forest reserves, covering nearly 3,400 km^2, were downgraded to permit local residents to collect firewood and fodder (p. 83). Though forestry officials predicted "ultimate destruction" of Kumaoni forests as a result of these policy changes (pp. 83–84), Agrawal argues that delegation and decentralization of authority to local village councils has been essential to conservation of these very forests over the past several decades.

PADDD in South America, 1940–2003

Naughton-Treves *et al.* (2006) examine the history of 15 large (>100 km^2) state-administered forest PAs established in Peru (8 PAs) and Ecuador (7 PAs) between 1940 and 1987. Though the origins of these PAs are unclear, "typically, local communities were not consulted when the PAs were first created" (p. 36). Over the years, as PA regulations were implemented and forest governance shifted, "conflict erupted" with resource-dependent local residents. "Beginning in the 1970s and 1980s, managers at some PAs attempted to prevent resource use by force," in some instances leading to "public outcry and occasional violent protests" (p. 36).

Demand for access to and use of natural resources within these 15 PAs resulted in numerous instances of PADDD. In nine cases, all but one prior to 1993, "rather than attempt to evict local people or impose resource-use restrictions, PA boundaries were legally changed to cede land back to local citizens" (p. 36). On two other occasions, government officials excised portions of a PA to permit drilling for oil and gas. In one of these instances, officials returned the excised area to the PA after exploratory drilling indicated that the available petroleum deposits were not commercially viable; in the other instance, officials added a new piece of land (equivalent in size to the excised area) to the PA. Since 1993, instead of evicting local residents or downsizing PAs to mitigate resource conflict, "conservation agencies are [generally] rezoning land *within* PA boundaries to accommodate human use" (p. 36; emphasis in original). Portions of at least 11 of the 15 PAs were downgraded through the development of "internal zoning plans," which legally authorized an increase in the number, magnitude, or extent of human activities within the PA. "Park managers explained that this approach was the only realistic option given the widespread presence of human settlements and resource use in PAs" (p. 36). By contrast, officials changed PA boundaries on 14 occasions to expand PA coverage (mean expansion 2,900 km^2, range 12.5–8,000 km^2; *SD* 2,700 km^2) and made another nine boundary changes to correct cartographic errors (~10–20 km^2/change). Among these 15 PAs, therefore, PA governance (i.e., rules governing human activities within the PA) changed once every 9 PA years, on average, with PADDD accounting for nearly half of these changes (on average, once every 18.4 PA years).

The impact of these PADDD events on conservation in Peru and Ecuador is unclear. Land returned to local communities totaled more than 2,400 km^2 (269 km^2/downsize; range 0.2–1,330 km^2, std. dev. 415 km^2), representing a 4.1% downsizing of the original combined extent of the 15 PAs (58,158 km^2). Land excised for oil and gas drilling represented another 4,970 km^2 (8.5% downsizing) of the original PA estate, yet areas of comparable size were added to the same PAs from which land was excised, resulting in no net loss of land to oil and gas development. The spatial extent of PA lands downgraded to accommodate human settlement and use is unknown. At the same time that officials were downgrading and downsizing PAs in response to resident and industry demands, however, they were also adding a total of 34,541 km^2 to these 15 PAs, a net 56% (32,120 km^2) increase in their collective total area. Only one of the 15 PAs experienced a net decrease in total area—and that 50 km^2 downsizing represented a modest 1.2% of the total area of the Cayembe Coca Ecological Reserve in Ecuador. The conservation value of the lands excised from or added to the PA estate in these cases is unknown.

Scientific unknowns & policy implications

Collectively, the available evidence suggests that PADDD is a longstanding, widespread, and yet largely overlooked conservation phenomenon (Figure 3). Though additional accounts of PADDD almost certainly lie buried in the published literature, unpublished reports, and in dusty file

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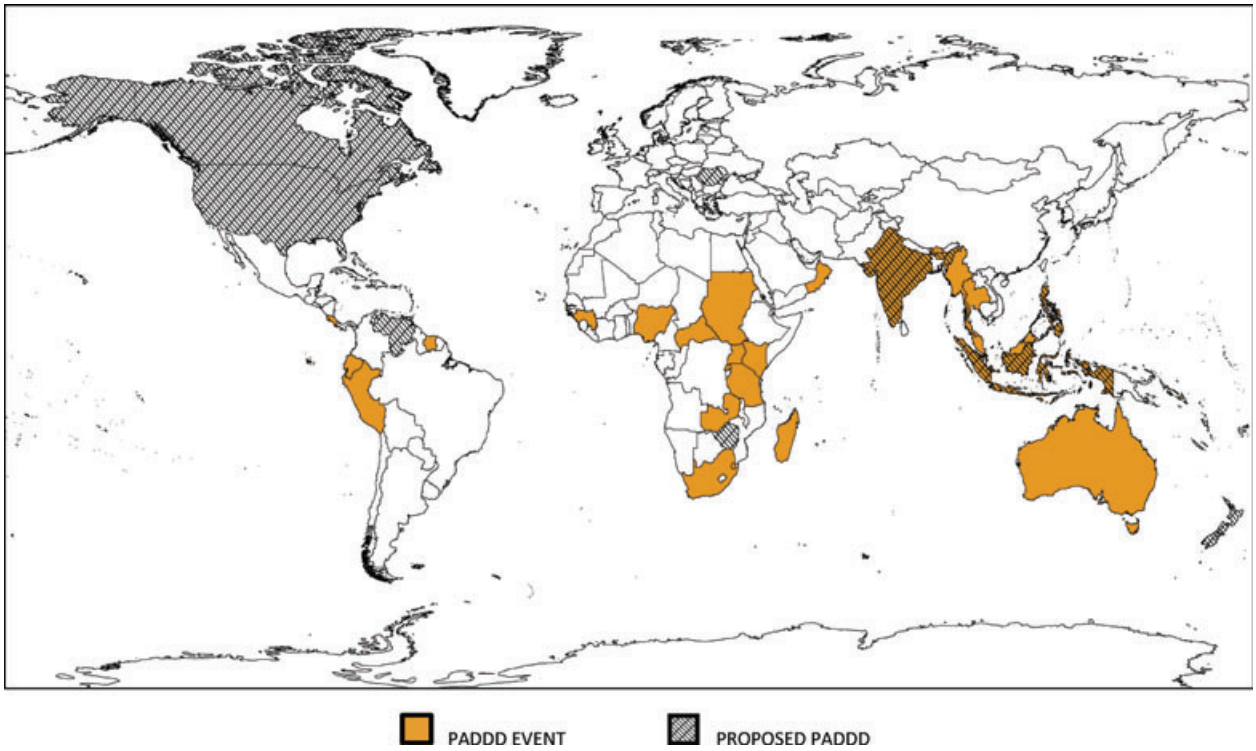


Figure 3 Countries where downgrading, downsizing, or degazettement of protected areas (PADDD) has occurred or has been recently proposed. (Source: Sources cited in Tables 1 and 2, and S1; P. Winter, pers. comm.)

cabinets around the world, our preliminary exploration makes several points clear:

(1) The history of PADDD spans more than a century and has touched at least 36 countries (and likely many more).
(2) PADDD occurs in areas of global importance for biodiversity conservation.
(3) PADDD can substantially reduce the size of the PA estate and expand human activities within PAs, but may occur against a backdrop of increasing PA numbers and spatial extent.
(4) Though some PAs are relatively stable, others have repeatedly seen their boundaries shrink and regulations tempered.
(5) Proximate causes of PADDD vary widely, but often center on access to and use of natural resources.
(6) Perhaps most importantly, PADDD is not just a historic phenomenon, but part of contemporary conservation policy debates around the world.

PADDD highlights the dynamic nature of PAs. As socially defined and socially constructed governance regimes, PAs are responsive to social pressures—including conservation demands—at local to global scales. These social dynamics manifest themselves not only in the creation of new PAs and in the expansion of existing sites, but also in PADDD. Indeed, in some cases, PADDD is linked to the expansion of existing PAs or the establishment of new sites (Fuller *et al.* 2010).

The ecological and social impacts of PADDD remain unclear. Some accounts highlight environmental degradation following PADDD (van Steenis *et al.* 1989; Walpole 2003; Adams 2004). Contrary to conventional wisdom (Terborgh 1999), however, evidence suggests that PADDD may sometimes advance conservation ends (Agrawal 2005). Likewise, contrary to suggestions that PAs inexorably drift (or are actively driven) toward a "fortress" model of conservation that imposes social costs on local people (Brockington & Igoe 2006, p. 443), many instances of PADDD represent efforts to address the concerns and needs of indigenous groups and other local peoples (Agrawal 2005; Naughton-Treves *et al.* 2006).

Many fundamental scientific questions remain regarding PADDD. How common is PADDD? How much of the PA estate has been affected? How much would be affected by current proposals? What are the spatial patterns and temporal trends in PADDD across sociopolitical and biophysical contexts (e.g., countries, ecoregions)? What factors explain these patterns and trends—and through what range of social mechanisms is PADDD occurring?

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Perhaps most importantly, what are the ecological and social consequences of PADDD? We are starting to explore these basic questions and their derivatives, drawing upon diverse methods that range from archival research to remote sensing to citizen science. Through this research, we hope to develop a sophisticated understanding of PADDD that will help decision makers to identify countries and individual PAs most likely to experience PADDD (i.e., predictive analysis); focus conservation investments in key places and on critical issues (i.e., priority-setting); foster transparency, legitimacy, and accountability (i.e., governance reform); and design more resilient and robust conservation strategies (i.e., adaptive management).

PADDD presents a significant challenge to the prevailing conservation paradigm, given that strategies predicated upon permanent and (often) expanding networks of PAs are unlikely to succeed if these very PAs are disappearing from the landscape. Though PADDD may sometimes advance conservation objectives (Agrawal 2005; Fuller *et al.* 2010), in many instances PADDD suggests the need for more resilient and robust conservation strategies. Indeed, conservation strategies must be resilient not only in the face of biophysical perturbations like climate change, but also when confronted by sociopolitical shocks like food shortages, political crises, and spikes in global demand for commodities. Research in natural resource governance (Ostrom 1990) suggests that participatory decision-making arrangements; clear and contextually-congruent resource use rights; active and accountable enforcement regimes that deploy meaningful-yet-graduated sanctions; and accessible conflict resolution mechanisms are likely to foster enduring PAs that provide ecological and social benefits. At the same time, conservation strategies must be robust, so that the potential negative conservation impacts of PADDD are mitigated by a diversity of other conservation behaviors and institutions. The dynamic nature of PAs, however, and the shifting social and ecological context within which they operate, may ultimately require a more dynamic and adaptive approach to conservation from scientists and policymakers.

PADDD also challenges a core assumption of the emerging global framework to reduce greenhouse gas emissions from deforestation and forest degradation (REDD). To date, forests within PAs have been viewed by the global community as a "permanent" storehouse of potential emissions, while forests outside PAs have been seen at risk of deforestation and degradation (Ricketts *et al.* 2010). Accordingly, forests *outside* PAs would qualify for REDD funding based on the economic value of the carbon sequestered within the trees. Forests *inside* PAs, by contrast, would not be eligible for REDD funding because these forests would not provide an "additional" reduction in greenhouse gas emissions above the "business as usual" (BAU) scenario that would unfold in the absence of a climate change treaty. In fact, "BAU" for PAs includes PADDD, a phenomenon that may accelerate in the face of increasing global commodity demands and local land pressures (Figures 4 and 5). This suggests that at least some forested PAs *could* sequester "additional" carbon—and, thus, merit consideration for funding under a REDD regime that accounts for historic rates of PADDD. Developing such baseline rates of PADDD will require much better documentation of the history of PA growth and loss, which is essential to establish the proper incentives for participants in any future REDD regime. Failure to account for PAs and PADDD within a REDD regime could create perverse incentives for PADDD, which countries might carry out to increase the extent of their forests eligible for REDD financing.

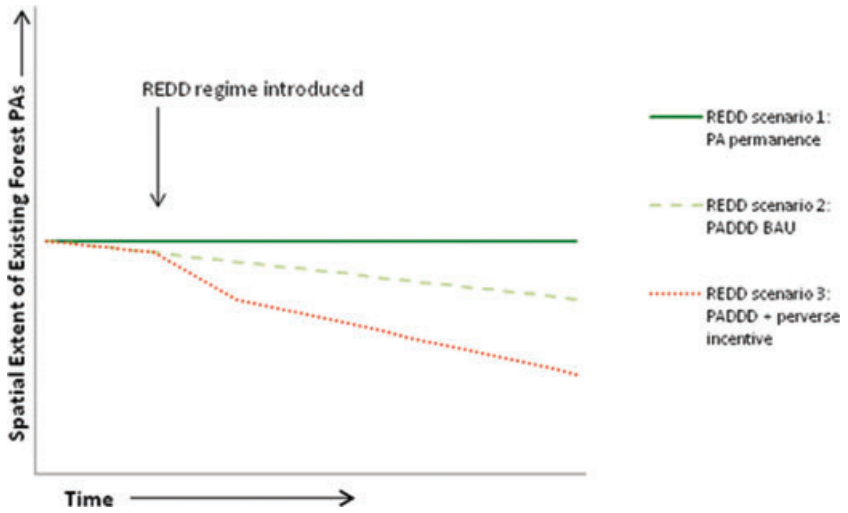


Figure 4 Spatial extent of existing forest protected areas under REDD policies that do not address PADDD. Scenario 1 assumes that protected areas (PAs) are permanent; PA spatial extent remains unchanged. Scenario 2 assumes that PADDD is "BAU" for PAs. Scenario 3 assumes that PADDD is BAU, but that failure to integrate PADDD into REDD policies creates a perverse incentive to accelerate PADDD—especially in the initial years of the new regime governing REDD.

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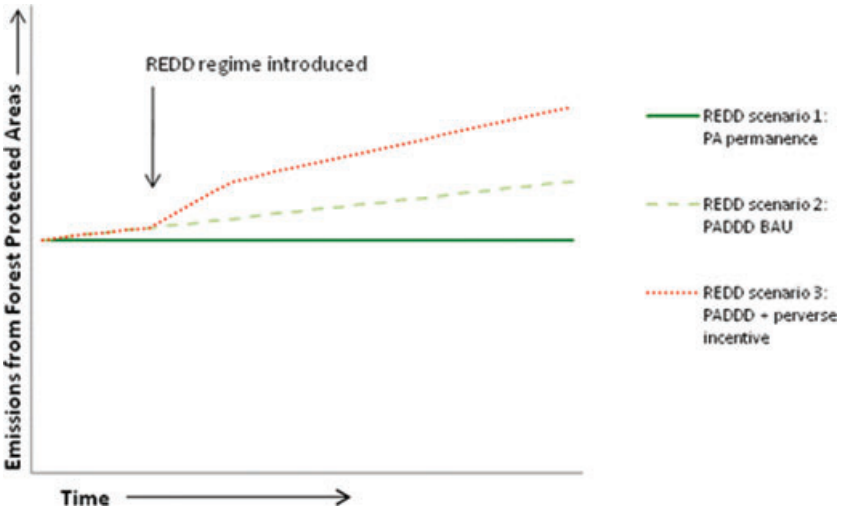


Figure 5 Emissions from existing forest protected areas under REDD policies that do not address PADDD. Scenario 1 assumes that protected areas (PAs) are permanent; PA emissions remain unchanged. Scenario 2 assumes that PADDD is "BAU" for PAs, resulting in increasing levels of emissions as a greater percentage of the PA estate is lost to PADDD. Scenario 3 assumes that PADDD is BAU, but that perverse incentives to accelerate PADDD lead to increased emissions above historic BAU levels. The difference between the solid green and dashed green lines represents the additional carbons emissions (additionality) that could be elminated through a REDD policy that effectively addresses PADDD.

Though PADDD challenges longstanding assumptions underlying local, national, and international conservation strategies, it does not diminish the importance of PAs to the conservation of biological diversity. As conservation policy, practice, and science all attest, PAs and other place-based strategies have an essential role to play in conservation, alongside regulatory regimes, market-based strategies, voluntary programs, and community action. Indeed, the conservation community cannot overlook, neglect, or abandon traditional place-based strategies like PAs, despite their known limitations. Rather, scientists and policymakers must redouble their efforts to learn from PAs and invest in them in ways that enhance both ecological sustainability and social equity. For many years the conservation community—and society as a whole—has taken PAs for granted, but the unrecognized history of PADDD makes clear that it cannot do so any longer.

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Supporting information

Additional Supporting Information may be found in the online version of this article:

Supplemental Methods

Table S1. Historic instances of protected area downgrading, downsizing, and degazettement (PADDD).

Table S2. Headlines illustrating social reaction to contemporary instances of PADDD.

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