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POLICY PERSPECTIVE

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Increasing disturbance demands new policies to conserve intact forest

Jörg Müller[1,2] | Reed F. Noss[3,4] | Simon Thorn[1] | Claus Bässler[2] | Alexandro B. Leverkus[5] | David Lindenmayer[6]

[1]Field Station Fabrikschleichach, Biocenter University of Würzburg, Glashüttenstraße 5, 96181 Rauhenebrach, Germany

[2]Bavarian Forest National Park, Freyunger Str. 2, 94481 Grafenau, Germany

[3]Florida Institute for Conservation Science, 2205 Sultan Circle, Chuluota, FL 32766, USA

[4]Nicholas School of the Environment, Duke University, Durham, NC 27708, USA

[5]Ecology Unit, Department of Life Sciences, University of Alcalá. Campus Universitario, 28805 Alcalá de Henares, Spain

[6]Fenner School of Environment and Society, the Australian National University, Canberra, ACT 2601, Australia

Correspondence
Jörg Müller, Field Station Fabrikschleichach, Biocenter University of Würzburg, Glashüttenstraße 5, 96181 Rauhenebrach.
Email: joerg.mueller@npv-bw.bayern.de

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Edward T Game

Abstract

Ongoing controversy over logging the ancient Białowieża Forest in Poland symbolizes a global problem for policies and management of the increasing proportion of the earth's intact forest that is subject to postdisturbance logging. We review the extent of, and motivations for, postdisturbance logging in protected and unprotected forests globally. An unprecedented level of logging in protected areas and other places where green-tree harvest would not normally occur is driven by economic interests and a desire for pest control. To avoid failure of global initiatives dedicated to reducing the loss of species, five key policy reforms are necessary: (1) salvage logging must be banned from protected areas; (2) forest planning should address altered disturbance regimes for all intact forests to ensure that significant areas remain undisturbed by logging; (3) new kinds of integrated analyses are needed to assess the potential economic benefits of salvage logging against its ecological, economic, and social costs; (4) global and regional maps of natural disturbance regimes should be created to guide better spatiotemporal planning of protected areas and undisturbed forests outside reserves; and (5) improved education and communication programs are needed to correct widely held misconceptions about natural disturbances.

KEYWORDS

anthropogenic disturbance, forestry, FSC, natural disturbance, protected area management, sanitary logging

1 | INTRODUCTION

Escalating controversy over logging the ancient Białowieża Forest in Poland after bark beetle attacks (Schiermeier, 2017) and the core zone of the Monarch Butterfly Biosphere Reserve in Mexico after windstorms (Leverkus, Jaramillo-López, Brower, Lindenmayer, & Williams, 2017) symbolizes a broader global crisis in forest policy. This crisis is spurred by the increasing proportion of earth's intact forest—unbroken expanse of natural forest ecosystem without signs of significant human activity, and large enough to maintain all native biodiversity (Kraxner et al., 2017)—that is subject to major high- or mixed-severity disturbance such as stand-replacing wildfires, windstorms, and insect attacks. While green forests have important symbolic and esthetic value for most people (O'Brien, 2006), forest disturbances are commonly perceived as chaotic, untidy, and catastrophic (Flint et al., 2009). Salvage logging—the removal of trees after natural disturbance—is often conducted for various reasons, often with little outcry from the public (Lindenmayer, Burton, & Franklin, 2008). However, the increasing frequency, severity, and extent of natural disturbances (Diffenbaugh & Field, 2013) over recent

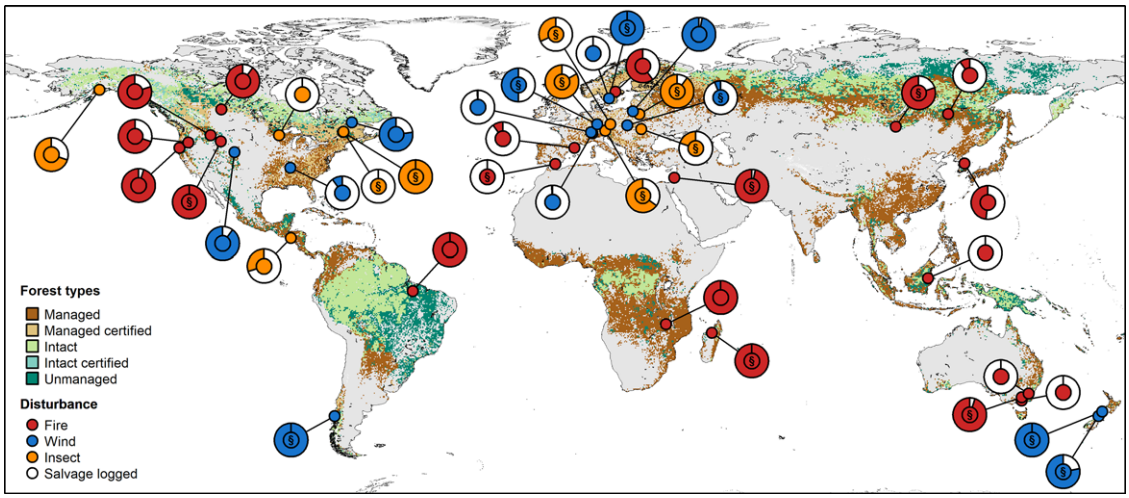

FIGURE 1 Reports of 42 case studies of major natural disturbances in protected (§) and unprotected forests since the 1970s (Table. S1), with the relative amount of salvage logging shown in the pie-chart (for a list, see Supplement); the background global forest map is colored according to Kraxner et al. (2017)

decades are triggering unprecedented levels of salvage logging in places where logging never occurred previously (such as ostensibly protected areas; Müller, Jarzabek-Müller, & Bussler, 2013; Schiermeier, 2017) and at unparalleled levels of intensity and extent (Leverkus & Castro, 2017; Thom & Seidl, 2016).

As a consequence of several global change factors, such as higher temperatures and more extreme weather events, past human disturbances, the suppression of natural fires, and the planting of fast-growing conifers, forests worldwide are increasingly subject to a combination of major natural disturbance (Seidl, Schelhaas, Rammer, & Verkerk, 2014) and high-intensity salvage logging (Lindenmayer et al., 2008; Lindenmayer, Thorn, & Banks, 2017). Salvage logging, along with shifts in the drivers of natural disturbance, can affect the mechanisms underlying ecosystem resilience and imperil natural regeneration, thus creating a need for active restoration (Ghazoul, Burivalova, Garcia-Ulloa, & King, 2015). This combination of disturbances creates substantial negative environmental effects and undermines important ecosystem functions and services, as well as threatening biodiversity (Koprowski, Alanen, & Lynch, 2005; Thorn et al., 2018). For example, in the World Heritage Site Białowieża Forest in Poland, Europe's last lowland ancient forest, logging is formally excluded (partial protection zones I-II) or is limited to low-intensity operations (zone IV). Logging intensity in the forest management plan was adjusted to meet the needs of local communities, but also to maintain forest biodiversity and ecological processes. Following an outbreak of bark beetles, however, widespread salvage logging has been occurring in partial protection zones with impacts on many species of conservation concern (Schiermeier, 2017), in spite of the interim measures, applied by the European Court of Justice, banning tree felling and removal from old-growth forest on Natura 2000 protected habitats. Despite a clear warning to policy makers in 2004 that widespread salvaging may produce long-lasting effects on biodiversity (Lindenmayer et al., 2004), not much has changed to salvage logging policies since then (Lindenmayer et al., 2017).

Here, for the first time, we compiled data on the prevalence of salvage logging within and outside protected areas (all national and international categories of protected areas without regular logging) by extending the databases compiled by two major recent reviews (Leverkus, Gustafsson, Benayas, & Castro, 2015; Thorn et al., 2018). We present information on the underlying motivation for salvage logging in each case study based on published information and following direct inquiries to regional experts. We find that salvage logging is occurring in places and at levels of intensity beyond those characteristic of conventional logging. Given this, we argue that at least five major policy reforms and extensively modified practices are needed not only for disturbed forests but also for undisturbed forests, including forests in both protected and unprotected areas.

2 | GENERAL FINDINGS

We found that salvage logging was applied in 21 of 23 cases studies from unprotected forests. The average proportion of disturbed area salvage logged across all 23 case studies was 55% (Figure 1, Table S1), which is beyond common logging practices in most forests. Salvage logging occurred in 13 out of 19 protected forests (68%), particularly in Europe and Asia (Figure 1), and the area salvage logged among the 19 studies was on average 32% of the disturbed forest area.

Our case studies show that in regions with a large amount of forest, like North America, protected areas are rarely salvage

logged. In addition, unprotected forests in such regions are generally subject to salvage operations on only part of the disturbed area. In contrast, in Europe and Asia, extensive salvage logging is widely implemented in unprotected forests, but it also often occurs in protected forests (Figure 1). Our analyses therefore suggest that particularly in Europe and Asia, natural disturbance now leads to salvage logging in many places where it never previously occurred and where conventional logging was formerly banned.

Examples of the many instances of salvage harvesting within protected areas include logging burned pines in the Sierra Nevada National Park in southeastern Spain (Leverkus, Puerta-Pinero, Guzman-Alvarez, Navarro, & Castro, 2012; Figure 2a), cutting veteran larch trees in the Khan Khentey Wilderness area in Northern Mongolia after wildfire (Müller et al., 2013; Figure 2b), and salvage logging after windstorms in the Bavarian Forest National Park in Germany (Thorn et al., 2016). Many detrimental impacts of these activities have been quantified, including a loss of native species (Thorn et al., 2018), a shift in community assembly processes (Thorn et al., 2016), reduced natural regeneration (Leverkus & Castro, 2017), and a loss of key structures, such as old, disturbance-surviving trees and otherwise abundant dead wood (Lindenmayer & Laurance, 2017; Müller et al., 2013).

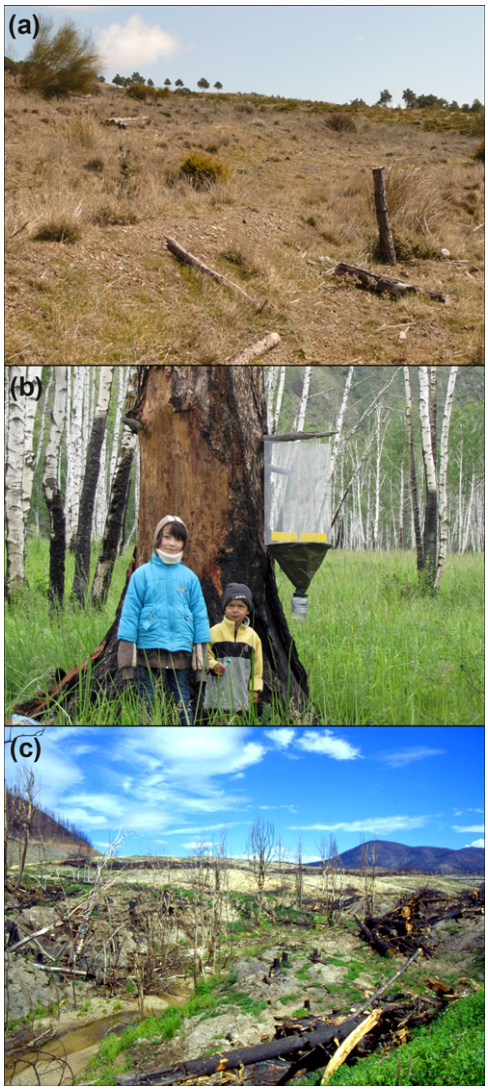

FIGURE 2 (a) Natural regeneration of woody species in burnt pine forests of the Sierra Nevada Natural Park in southern Spain was reduced by salvage logging 2 years after fire, and differences could still be observed after 8 years (b) veteran larch trees more than 400 years old in the Khan-Khentey Wilderness area in Northern Mongolia survive wildfires and would normally not be harvested by conventional logging. However, they are removed by postfire salvage logging (c) salvage logging in stream corridors after fires in the Australian Capital Territory, where conventional logging would not take place, leading to damaged riparian systems

3 | MOTIVATIONS FOR SALVAGE LOGGING

We found that the primary argument for salvage logging both in protected and unprotected forests was timber access before deterioration of wood. Thus, economic reasons predominantly motivate salvage logging globally (Figure 3a). Timber value often deteriorates rapidly after disturbance, due to falling market prices, infestation by fungi, physical damage to the timber, and higher extraction and processing costs (Akay, Kanat, & Tutus, 2007; Leverkus et al., 2012). The economic costs of salvage harvesting are often offset by public subsidies (e.g., €100m in 2017 for logging operations by the Bavarian government after the summer storm "Kolle" in southeastern Germany), or by budgets for development aid (Müller et al., 2013). These subsidies are often widely accepted by the public due to negative perception of natural disturbances. Without such large subsidies, postdisturbance logging would often be unprofitable (Akay et al., 2007). For example, after the 2005 Lanjarón fire in Spain, the sale of burnt wood roughly accounted for the cost of transportation to the mill, whereas the cost of cutting and extracting the wood (>2,000€/ha) was covered by public money (Leverkus et al., 2012).

In protected areas in Europe, pest control was the second main reason for salvage logging. Such actions ignore the role of insects in creating diverse forest habitats for threatened species (Beudert et al., 2015) as well as the often limited spatial extent of threats by pest species at elevations below some hundreds of meters (Kautz, Dworschak, Gruppe, & Schopf, 2011). The third most prevalent argument for salvage logging was fuel reduction to reduce subsequent risk of fires. This reason is also controversial because the scientific evidence for its effectiveness is limited and, conversely, it may lead to increases in fine fuel loads over certain time frames (Donato, Simard, Romme, Harvey, & Turner, 2013; Thompson, Spies, & Ganio, 2007).

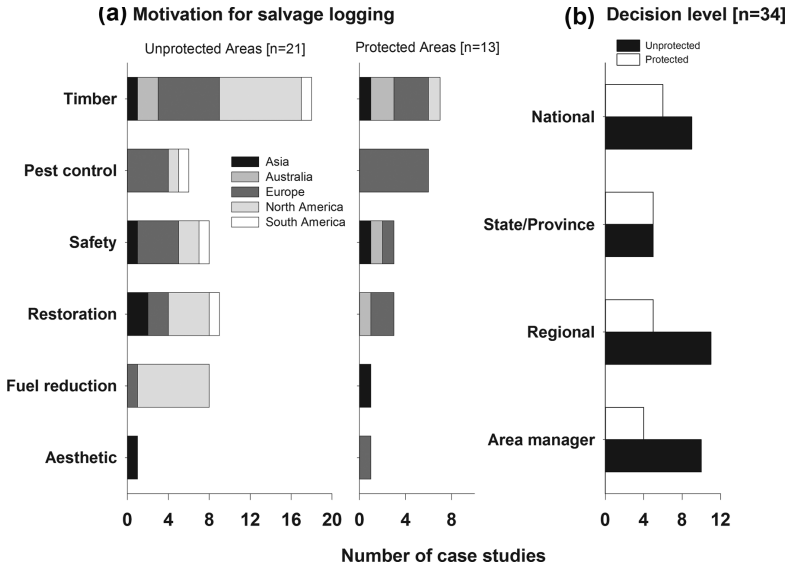

FIGURE 3 (a) Motivation for salvage logging in 34 protected and unprotected areas where salvage logging occurred (note, areas without logging not considered). Safety indicates human security, particularly along roads. Restoration indicates that salvage logging is aimed to restore forest habitats (i.e., tree planting) (b) Level of authority responsible for making decisions to salvage log in protected and unprotected areas. The level state/province was taken for countries organized in federal states, such as United States, Canada, and Germany. Protected areas include all types of protection where logging would not be conducted without disturbances

Note: More than one count per case study can occur.

4 | WHO MAKES THE DECISIONS TO SALVAGE LOG?

To log or not and the amount of area salvaged are often regulated by laws, ordinances, and management plans in the respective areas. The level of authority responsible for the decisions to salvage log unprotected forests was spread equally across political decision levels, ranging from local area managers to governments, indicating that reforms to salvage logging policies (see below) must target all administrational levels to achieve changes in forest management. In contrast, for protected areas the decision-making authority decreased from the national to the local level (Figure 3b), which highlights the need to target reforms at governments on national, state/federal, or state/provincial levels to promote new policies for addressing disturbances in protected forests.

5 | BEST AND WORSE PRACTICE FOR SALVAGE LOGGING IN A PROTECTED AREA

In 1970, the Bavarian Forest National Park—an old cultural landscape—was founded in the Bohemian Forest as the first national park in Germany. It took about a decade to convince decision makers of the advantages of a hands-off strategy, but finally a strictly protected core zone (~10K ha) was to be established by law and ordinances. Such zoning by law was successful to maintain nonintervention even under heavy disturbances by bark beetles and windstorms (Figure 4a). The park was expanded in 1997, but the management plan for the new area was created based on round-table deliberations with regional and federal stakeholders and forest authorities. Ecologically uneducated decision makers created an ordinance allowing salvage logging after bark beetle attack or windstorm until most of the area would be converted to a protected core zone in 2027. Heavy natural disturbances subsequently affected the area. Despite some minor corrections to the initial policy, stakeholder involvement in this case led to large-scale salvage logging of protected forests (Figure 4b) with negative effects on species richness of saproxylic taxa (Thorn et al., 2016).

6 | FIVE KEY POLICY REFORMS

Given increasing levels of high- and mixed-severity natural disturbance and other shifts in disturbance regimes, there is an urgent need to rethink policies and practices for naturally disturbed forests. Five key policy reforms for wood-production forests and protected areas are required.

1. Salvage logging must be banned from protected areas, except for relatively limited areas where there is a clear and immediate risk to humans (e.g., near roads, walking trails, other infrastructure) or private property (e.g., from pest species). There is a particular need for such reforms in Europe and Asia. Here, we urge the IUCN to expand

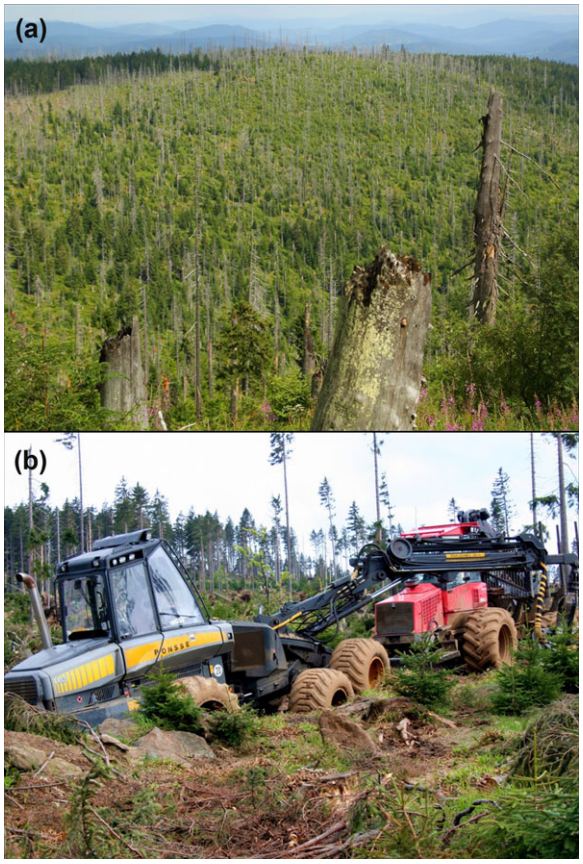

FIGURE 4 (a) Strictly protected core zone after natural disturbances with a heterogeneous and diverse forest in the Bavarian Forest National Park (b) salvage logging after bark beetle attack and windstorm in the future core zone of the extended part of the national park due to ecologically uniformed policy makers

their guidelines for protected area management by preparing explicit recommendations for management of naturally disturbed forests.

2. Integrated economic and ecological analyses must be conducted to better assess the potential economic benefits of salvage logging against its ecological, economic, and social costs, in particular with respect to timber values, alternatives for pest control, fuel reduction, recreation, and restoration. Methods such as economic and environmental accounting provide a highly transparent mechanism to do this. For example, the United Nations (2012) System of Economic and Environmental Accounting represents an increasingly widely adopted approach to compare the values of natural assets under different management regimes (Keith, Vardon, Stein, Stein, & Lindenmayer, 2017). There may be a need to eliminate public subsidies for salvage logging of areas that are difficult to access and would be unprofitable to log without such subsidies. Moreover, forest planners and area managers need better quantification of costs associated with losses of ecosystem services due to salvage logging (Leverkus & Castro, 2017).
3. Better forest management planning is needed for intact forests outside reserves to ensure large areas remain undisturbed by logging. This demands spatially explicit planning, funded by governments and conducted by regional planners well in advance of major natural disturbance events. This planning must highlight where and how much forest will be excluded from salvage logging (Schmiegelow, Stepnisky, Stambaugh, & Koivula, 2006) and why (e.g., breeding areas for species of conservation concern), and prescribe what kinds of biological legacies (e.g., dead trees, fallen dead wood) will be retained in those sites where salvage logging is permitted. Such new forest management planning at governmental and regional levels must include a recalculation of sustained yields of wood to account for the inevitable timber volume losses due to large-scale disturbances as well as for expanded logging-exclusion areas. Failure to do this will overcommit forest resources and accelerate depletion of undisturbed forest with consequent negative impacts on biodiversity and ecosystem integrity (Schiermeier, 2017). We thus urge prominent forest certification organizations such as the Forest Stewardship Council (FSC) and Program for the Endorsement of Forest Certification to make set asides of naturally disturbed forests a fixed standard for labeling forest management as ecologically sustainable. Similarly, management plans for Natura 2000 forest in Europe should explicitly implement ecologically improved guidelines for response to disturbance events.
4. Maps of natural disturbance regimes (e.g., Hansen et al., 2013) should be created by forest disturbance ecologists in collaboration with global earth observation institutes to guide better spatiotemporal planning of protected areas (and, conversely, areas available for logging). These maps should indicate the proportion and location of places in the landscape that will remain undisturbed by logging, both before and after natural disturbance.
5. Improved education and communication programs need to be implemented at all administrative levels from governments to local area managers and in university education of foresters and conservation scientists to correct widely held misconceptions about natural disturbances, such as the idea that disturbances have negative effects on biodiversity or ecosystem integrity or that active restoration is always needed after natural disturbances. These programs should highlight that: (a) naturally disturbed areas usually have substantial ecological and other values (Swanson et al., 2011), (b) naturally disturbed forests generally have a high capacity to recover without human assistance (Turner, Romme, & Tinker, 2003), and (c) the cumulative negative impacts of salvage logging on biodiversity can be significant (Thorn et al., 2018).

7 | NEW THEORY FOR MULTIPLE DISTURBANCES

Although much research has addressed ecosystem responses to individual disturbance events, we are still some way from understanding the complex interactive effects of multiple disturbances, particularly the combination of natural and anthropogenic disturbances (Lindenmayer, Hobbs, Likens, Krebs, & Banks, 2011; Thompson et al., 2007; Van Nieuwstadt, Sheil, & Kartawinata, 2001). It will therefore be critical to assess if the increasing frequency of combined natural and human disturbances will produce positive feedbacks (e.g., by shortening logging rotation cycles and salvage logging an ever-increasing amount of disturbed forest). New theory is needed to address the effects of multiple disturbances on coupled natural-human ecosystems and to ensure managers make well-informed decisions in a world of shifting disturbance regimes within protected and unprotected forests.

8 | CONCLUSIONS

The world's intact forests are under unprecedented levels of pressure as a result of increasing natural disturbances of high or mixed severity, a range of anthropogenic disturbances, and expanded salvage logging. The latter is unique in that it combines both natural and anthropogenic disturbances in rapid succession. Current forest policies are inadequate for responding to the substantial disturbance-related pressures facing forests and associated biodiversity. We argue that without appropriate development of new-generation forest policies, forest plans, and forest management practices for disturbed and undisturbed forests as well as protected and unprotected areas, large amounts of biodiversity will be lost and increasing numbers of forest ecosystems will be at elevated risk of collapse (Lindenmayer, Messier, & Sato, 2016). New policies limiting the amount, type, and location of salvage logging operations are urgently required ahead of disturbances to prevent significant and long-term negative impacts on the world's forest biodiversity and ecosystem services. This policy and management reform must become a priority to meet the Aichi targets and other global conservation goals.

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SUPPORTING INFORMATION

Additional Supporting Information may be found online in the supporting information tab for this article.

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