The Limits of Voluntary Environmental Certification

Kenneth Houngbedji[1], Liam Wren-Lewis[2],

Maria Plakhtieva[3], Johanna Isman[4]

[1]IRD, Université Paris Dauphine–PSL, Paris, France.

[2]Paris School of Economics & INRAE, Paris, France.

[3]University of Manchester, Manchester, UK.

[4]Assurance Services International, Bonn, Germany, & Bocconi University, Milan, Italy.

Voluntary certification schemes can theoretically encourage firms to meet environmental standards, but the limits of their effectiveness are unclear. To shed light on this, we study the impact of a major reform to the Forest Stewardship Council Standard, one of the world's leading voluntary environmental certification schemes[1,2]. The change aimed to encourage conservation by limiting private firms' activities in Intact Forest Landscapes[3,4]. This imposed substantial new constraints on some forestry concessions while leaving others unaffected. Combining certification records with spatial data on concessions and original data on annual changes in Intact Forest Landscapes, we use an event-study design to estimate effects on participation and conservation. We find that the reform reduced certification among concessions most exposed to the new rule, but there is no evidence of an overall improvement in IFL preservation. In general, these findings demonstrate an important trade-off in voluntary certification, with stricter standards substantially reducing participation without evidence of commensurate conservation benefits.

Environmental conservation is challenging when government institutions have limited capacity to monitor and enforce regulation[5,6], and when impacts arise within global supply chains[7,8]. In these contexts, international voluntary certification schemes offer a possible response. By establishing common standards across jurisdictions, they can allow firms to signal environmental requirements that may go beyond national regulation[8–10]. The extent to which such schemes change firms' behaviour, however, remains unclear. Because participation is voluntary, certification may simply allow firms that would otherwise meet the standards to demonstrate their good practices, rather than induce change.

This paper examines the consequences of making voluntary certification standards more stringent. We ask whether tighter requirements change firms' environmental practices, or instead reduce participation among the firms most affected. We examine this question through a major reform of the Forest Stewardship Council (FSC), one of the world's leading voluntary environmental certification schemes[1,2]. In 2014, FSC members voted to restrict the activities that concessionaires could undertake in Intact Forest Landscapes (IFLs)[3]. IFLs are large areas of high conservation value without remotely detectable signs of human intervention, representing many of the most biodiversity rich environments in the world[4,11,12]. The reform therefore imposed substantial new constraints on concessions containing IFLs while leaving concessions without IFLs largely unaffected. The policy was controversial: supporters argued that it would strengthen conservation[13], whereas critics warned that the restrictions could discourage firms from obtaining or maintaining certification[14].

To examine these consequences, we assemble a new dataset linking annual FSC certification records to georeferenced boundaries for forestry concessions across eleven countries. We then construct annual measures of changes in IFL extent within each concession, and use these data to answer two questions. First, did concessions most exposed to the new restrictions become less likely to obtain or maintain certification? Second, did concessions certified before the reform subsequently preserve more of their IFLs than uncertified concessions? In each case, we use event-study comparisons to examine the trajectories of the relevant groups before the reform and

how these changed afterwards.

For the first question, we compare changes in certification rates between concessions with high IFL coverage and concessions with no or low IFL coverage. This comparison requires that certification rates in the two groups would have followed similar trends in the absence of the reform. This assumption is plausible because concessionaires were unlikely to know the share of their concessions that would subsequently be classified as IFL. The IFL concept was relatively new, and its boundaries depended on remotely sensed criteria and somewhat arbitrary thresholds concerning size, fragmentation and evidence of human activity[15–18]. It is therefore unlikely that earlier certification decisions responded to the precise measure of IFL exposure used in our analysis. Reassuringly, the two groups followed similar certification trends before the reform was announced. For the second question, we classify concessions according to their certification status in 2016, the final year before the new restrictions were implemented, and compare changes in IFL loss with those in concessions that were not certified at that point. This comparison requires that IFL loss in the two groups would have followed similar trends in the absence of the reform. The annual data show similar trends before implementation. Because certification status in 2016 could itself have responded to earlier discussions of the reform, we also verify that the results are similar when concessions are classified according to their certification status in 2012, before those discussions began.

We find that the stricter standard reduced participation among the concessions most exposed to it. This reduction in participation was not accompanied by improved IFL preservation overall: our estimates rule out substantial reductions in IFL loss. Together, the results reveal a central limitation of voluntary certification: making standards more stringent can discourage participation without generating commensurate environmental gains.

Forestry concessions, the FSC and IFLs

Governments allocate substantial areas of public forest as concessions, principally for timber extraction[10,19,20]. These concessions include large areas of primary forest, particularly in developing countries. Although governments regulate forest management, concessionaires retain discretion over their harvesting and conservation practices. Some may not comply fully with national rules where enforcement is weak, while others adopt more demanding environmental standards, including to obtain voluntary certification[20,21].

The Forest Stewardship Council (FSC) is one of the world's leading voluntary forest-certification schemes[1,2]. Founded in 1993 by environmental organizations and companies, it aims to ensure forestry operations are managed in a sustainable manner. In 2018, FSC-certified forests supplied approximately one-tenth of global wood production, and FSC was the most common certification scheme in tropical forests[22]. Its requirements include limiting harvesting to sustainable rates, using logging practices that reduce forest degradation and protecting workers[23,24]. Companies apply through accredited certification bodies, which audit their operations annually and identify violations that must be corrected for certification to be obtained or maintained.

Intact Forest Landscapes (IFLs) are unfragmented ecosystems of at least 500 km^2 within a forest zone, without remotely detected signs of human activity[4,11,12]. They are important for biodiversity and climate-change mitigation[25]. The concept and methodology for mapping IFLs were developed in the 2000s using advances in satellite imagery. Global IFL area declined by 7% between 2000 and 2013, and the annual rate of loss increased further between 2013 and 2020[26,27]. Figure 1 shows IFLs and forestry concessions across the countries in our study, illustrating both their extensive overlap and the large variation in the share of individual concessions covered by IFLs.

FSC has long required companies to identify and maintain areas of 'high conservation value' in forests[28]. However, these areas were defined relatively subjectively, making it difficult for third parties such as NGOs to monitor compliance or to compare outcomes with those in uncertified forests, where no equivalent areas were defined[29]. In autumn 2014, following discussions that

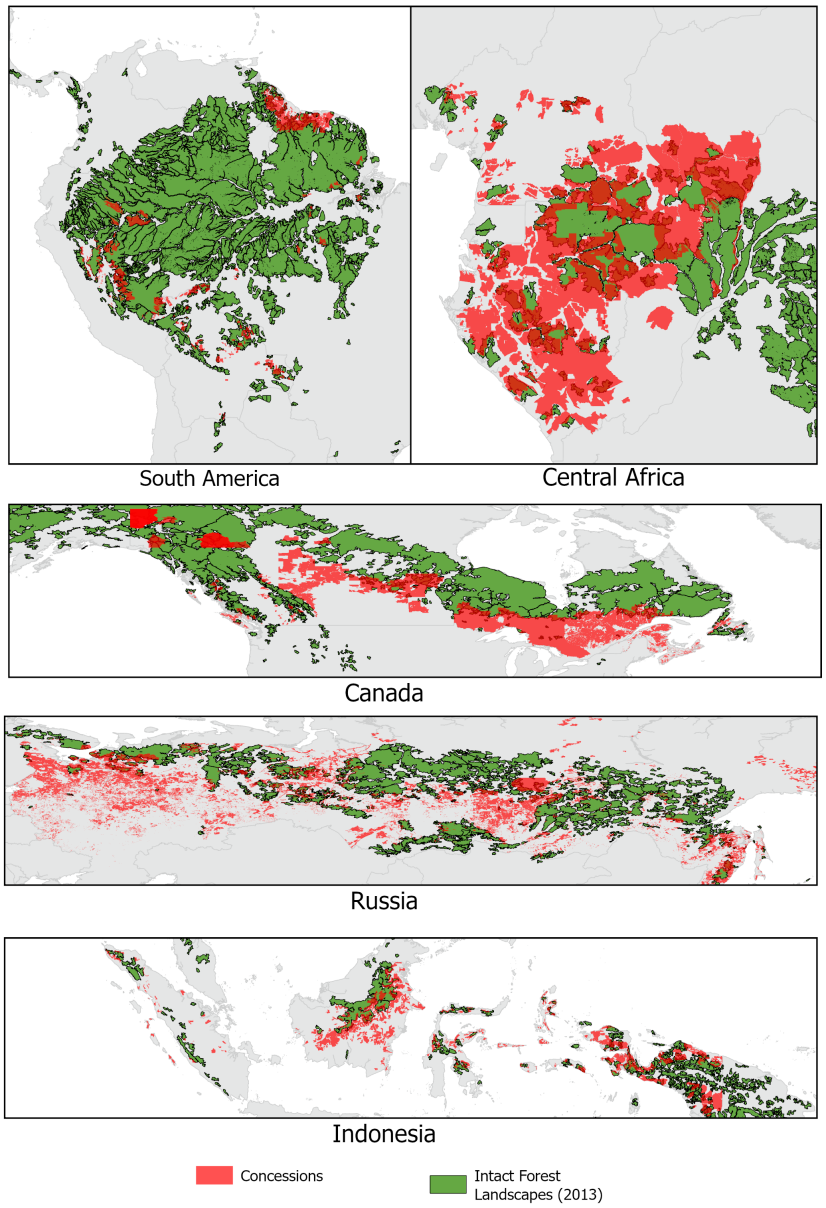


Figure 1: Forestry concessions and Intact Forest Landscapes. Green areas show Intact Forest Landscapes in 2013, while red areas show the forestry concessions included in our data. The maps illustrate both the geographical coverage of the study and the substantial variation in the extent to which concessions overlap with IFLs.

began the previous year, the FSC General Assembly voted to include IFLs explicitly among the categories of high conservation value and to protect their 'core areas' so that their intactness was maintained[3]. The policy officially came into effect on 1 January 2017 and, by default, required each certified forest management unit to protect at least 80% of the IFL remaining within its boundaries on that date[30,31].

The reform was welcomed by environmental organizations but generated substantial concern among firms and industry commentators. Contemporary accounts warned that the restrictions could reduce timber supply and cause certificate holders to withdraw from FSC[16,32]. Reflecting the potential tension between the new standard and commercial forestry, Kleinschroth et al.[29] concluded that the IFL definition "collides with forestry practices in several regions". It was therefore uncertain whether the reform would strengthen IFL protection, reduce participation in certification, or both.

During our study period, FSC adjusted the implementation of the rule while broadly retaining the substantial restrictions on activity within IFLs. In 2018, it allowed limited industrial activity within a very small part of the protected core area where this generated clear, additional conservation and social benefits[30]. From 2021, national standards in Cameroon, the Republic of Congo, Gabon, and Russia allowed the protected share to fall to 50% or 30%, subject to additional conservation measures[33–36]. Finally, in late 2025, after our study period, FSC members voted to move from fixed thresholds towards an 'outcome-based approach'[37]. The decision reflected continued disagreement over how restrictions on activities in IFLs should be designed and implemented.

Data and study design

We construct a new large-scale dataset linking georeferenced boundaries for forestry concessions in Bolivia, Brazil, Cameroon, Canada, the Republic of Congo, Gabon, Guyana, Indonesia, Peru, Russia, and Suriname to FSC certification records. The sample covers all countries in which forestry concessions overlap substantially with IFLs and for which suitable georeferenced concession data were available. We then use concession start dates, together with dates of FSC certification and withdrawal, to construct an annual panel of each concession's certification status. Certificates are matched to concessions using company names, geographical information, and FSC audit reports. Russian observations cover 2011–2021, ending before FSC suspended certification and controlled-wood sourcing from the country in 2022[38]. The resulting dataset contains 7,276 concessions

covering 375.9 million hectares across eleven countries (Extended Data Table 1).

We also construct annual maps of IFL extent. Existing global IFL maps are available only for selected benchmark years[11]. To measure changes in the intervening years, we combine these maps with annual satellite-based measures of tree-cover loss[39] and information identifying losses caused by fire[40]. We exclude fire-related loss and apply the spatial criteria underlying the IFL definition to update IFL boundaries from year to year. Intersecting these annual maps with concession boundaries yields measures of the area of IFL remaining and lost within each concession, allowing us to trace outcomes before and after the FSC reform.

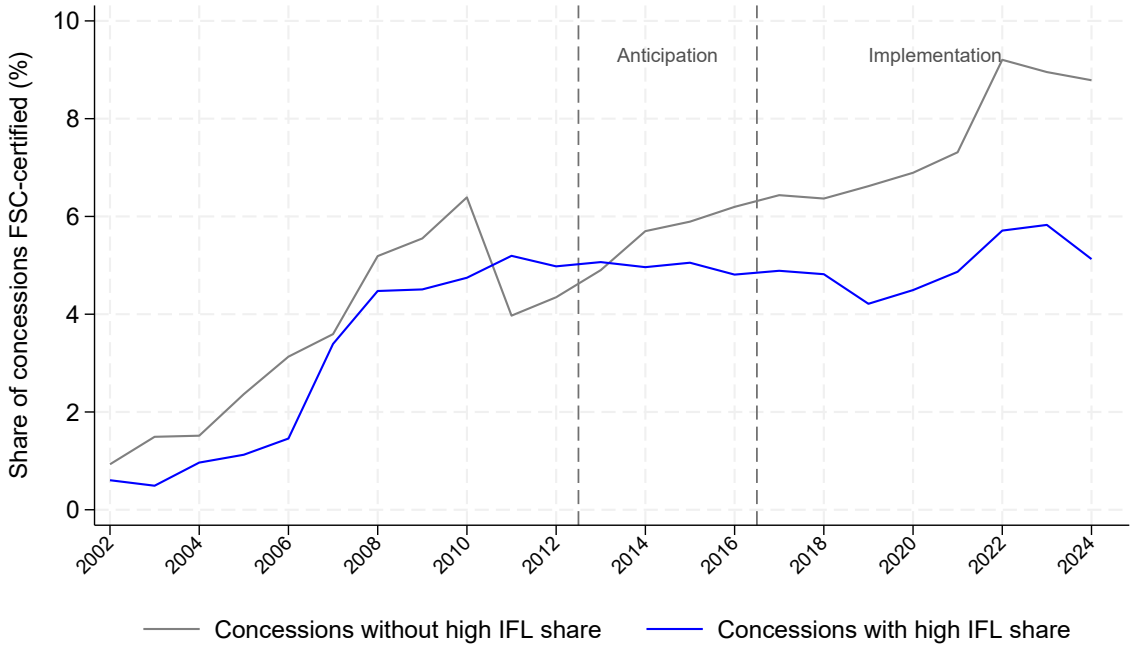
To estimate the effect of the reform on FSC participation, we classify concessions as highly exposed when IFLs covered more than 50% of their area in 2013 and compare them with concessions containing no or lower shares of IFL. This yields 1,068 highly exposed concessions and 6,208 less-exposed concessions. We estimate an event-study model of annual FSC certification status with concession and country-by-year fixed effects, reporting differences relative to 2012, the final year before public discussion of the reform began.

To estimate the effect of the reform on IFL preservation, we restrict the sample to concessions containing IFL in 2016 and compare those that were FSC-certified in 2016 with those that were not. Defining certification status in the final year before implementation identifies the concessions directly subject to the new restrictions when they took effect. Because certification decisions between the announcement and implementation of the reform could themselves have responded to the new policy, we also report estimates using certification status in 2012, before discussions of the reform began, as a robustness check. The resulting sample contains 1,620 concessions encompassing 53.5 million hectares of IFL in 2016, of which 132 were FSC-certified in 2016. The outcome is the annual share of the IFL area remaining at the beginning of each year that is lost during that year. Concessions are weighted by their IFL area in 2016 so that the estimates give greater weight to losses occurring in concessions containing more IFL at the time the new restrictions were implemented.

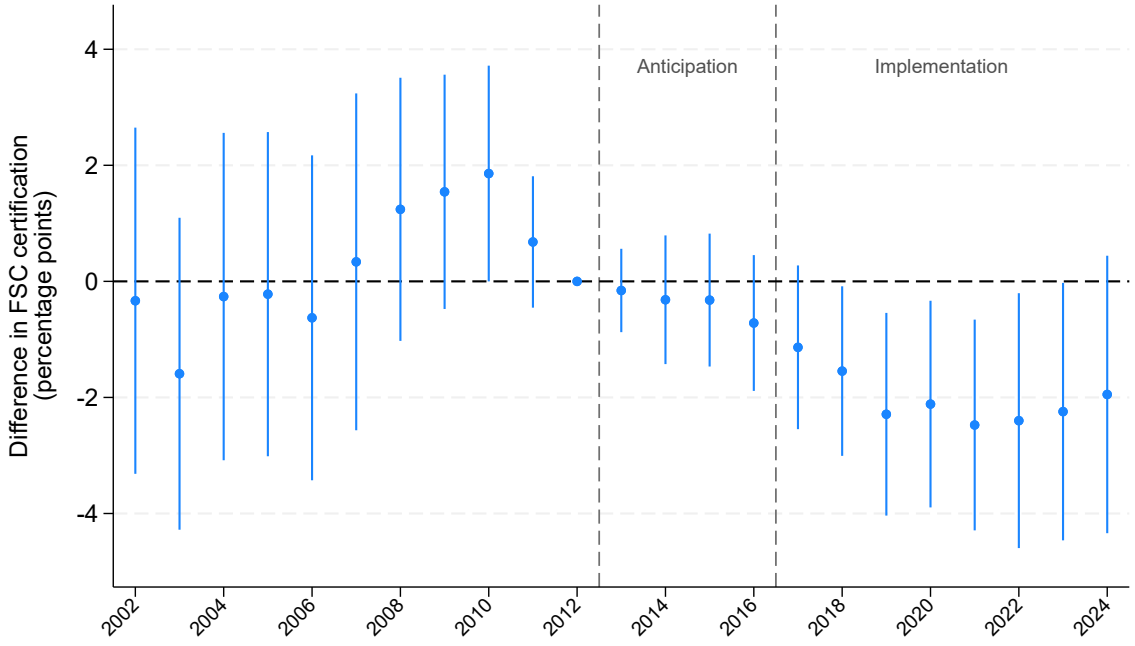
Highly exposed concessions certified less

Concessions most exposed to the reform became less likely to be FSC-certified after discussions of the new policy began (Fig. 2). Before 2013, certification rates in concessions with more than 50% IFL coverage followed similar trends to those in concessions with no or lower IFL coverage, with no systematic movement in the annual event-study estimates (Fig. 2b). The estimates became modestly negative while the reform was being developed and became larger after its implementation. In the pooled specification, highly exposed concessions were 0.7 percentage points less likely to be certified during 2013–2016 and 2.3 percentage points less likely to be certified during 2017–2025. The latter corresponds to around 40 % of the mean certification rate in the estimation sample. The result is robust to alternative definitions of exposure and estimation methods (Extended Data Table 2), and is not driven by any single country (Extended Data Fig. 1).

The reduction in certification is at least partly because highly exposed concessions became less likely to enter certification, and not only because existing certificate holders systematically withdrew. Among concessions that were not certified in the previous year, high exposure reduced the annual probability of obtaining certification by around 0.4 percentage points after implementation, relative to a mean transition rate of 0.6% (Extended Data Table 3). The estimated effect on losing an existing certificate is positive but much less precise, so some contribution from increased exit cannot be ruled out. Consistent with this distinction, the unadjusted certification rate among highly exposed concessions did not fall markedly after the reform; instead, it failed to increase alongside certification among less exposed concessions (Fig. 2a). Among existing certificate holders, we also find no detectable increase in major non-conformities recorded by FSC audits, although the estimate is imprecise (Extended Data Table 3). Thus the effect of the stricter standard would be difficult to detect by examining only what happened to concessions already participating in FSC: an important part of the response occurred through concessions that did not enter certification.



(a)



(b)

Figure 2: Highly exposed concessions became less likely to be FSC-certified. **a**, Annual share of concessions that were FSC-certified, separately for concessions in which Intact Forest Landscapes (IFLs) covered more than 50% of concession area in 2013 and concessions containing no or lower shares of IFL. These descriptive series are unadjusted and may reflect changes in the composition of concessions observed in each year. **b**, Event-study estimates comparing the same two groups. Estimates are expressed in percentage points relative to 2012. Points show coefficient estimates and error bars show 95% confidence intervals. Vertical dashed lines mark the beginning of discussions of the reform in 2013 and its implementation in 2017.

No evidence of improved IFL preservation

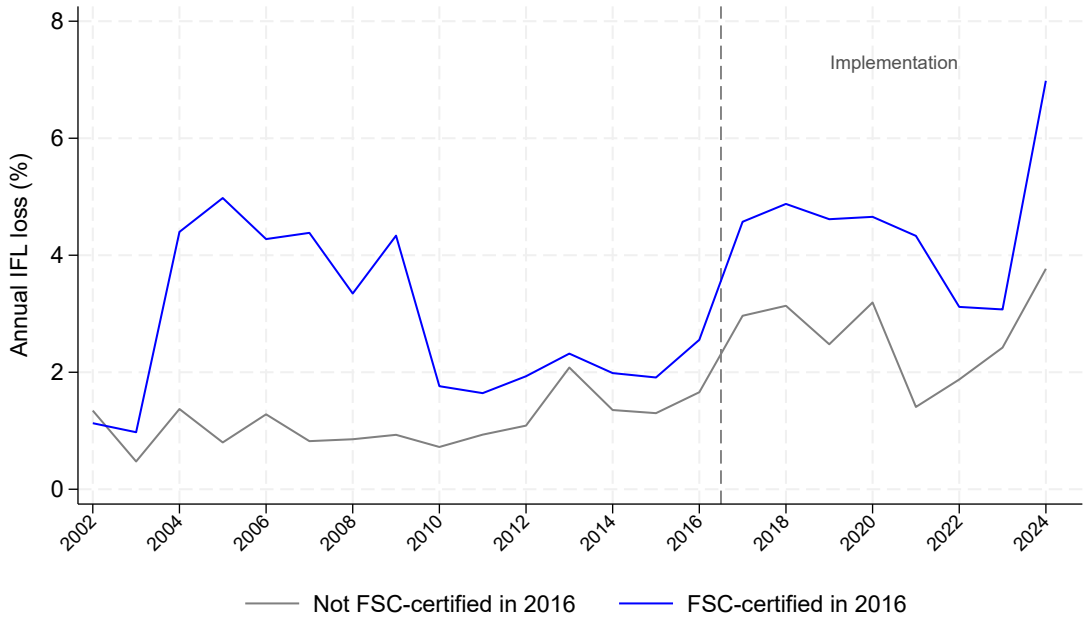
We find no evidence that FSC certification reduced IFL loss following implementation of the new restrictions (Fig. 3). Descriptively, weighted average annual IFL-loss rates for concessions that were and were not FSC-certified in 2016 show no clear divergence after implementation (Fig. 3a). In the event-study estimates, differences in IFL loss between the two groups show no systematic trend in the years leading up to implementation, and after 2017 the annual estimates remain centred around zero and are generally positive rather than negative (Fig. 3b).

Pooling the post-implementation years, FSC-certified concessions experienced an estimated 0.8 percentage point greater annual IFL loss rate relative to the change in uncertified concessions, with a standard error of 0.7 percentage points (Extended Data Table 4). The 95% confidence interval is approximately -0.6 to 2.2 percentage points, compared with a mean annual IFL loss rate of 2.1%. Thus, although modest conservation gains cannot be ruled out, the estimates provide no evidence that the new requirements generated substantial reductions in IFL loss.

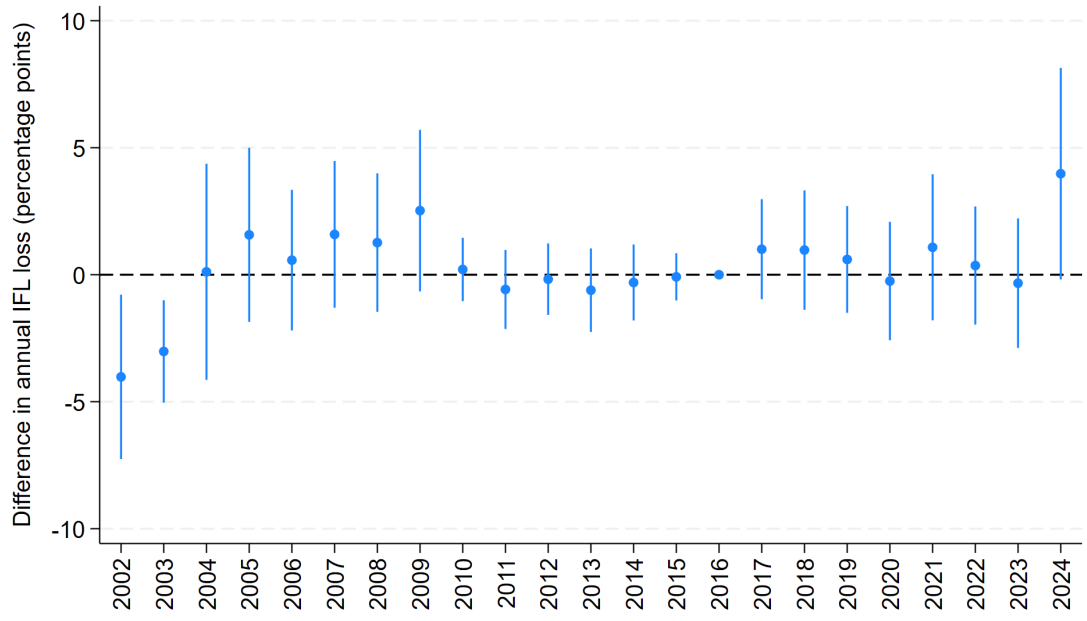
The result is robust to alternative specifications (Extended Data Table 4). In particular, defining certification status in 2012, before discussions of the reform began, yields a very similar estimate. Alternative outcome definitions and weighting schemes likewise provide no evidence of substantial reductions in IFL loss - for instance, we still find no impact when we simply consider whether each concession was certified in the precise year in question. Taken together, the results indicate that the reduction in participation associated with the stricter standard was not accompanied by commensurate improvements in IFL preservation.

Discussion

Our results reveal an important tension in the operation of voluntary environmental standards. The FSC reform made certification less attractive to the concessions most exposed to the new IFL requirements, yet we find no commensurate improvement in IFL preservation among concessions



(a)



(b)

Figure 3: We find no evidence that FSC certification reduced IFL loss following the reform. **a**, Annual weighted mean Intact Forest Landscape (IFL) loss rates, separately for concessions that were and were not FSC-certified in 2016. The outcome is the share of the IFL area remaining at the beginning of each year that is lost during that year. The series use the event-study estimation sample and are weighted by each concession's IFL area in 2016. **b**, Event-study estimates comparing changes in annual IFL loss between concessions that were FSC-certified in 2016 and concessions that were not certified in 2016. Estimates are expressed in percentage points relative to 2016, the final year before the new IFL requirements were implemented. Points show coefficient estimates and error bars show 95% confidence intervals. All specifications include concession fixed effects and country-by-year fixed effects, with standard errors clustered by company/concession. The vertical dashed line marks implementation of the new IFL requirements in 2017.

certified when the requirements came into effect. At first sight, these findings may seem difficult to reconcile. If the new standard was sufficiently constraining to discourage certification, why did it not also produce a clear reduction in IFL loss among firms that remained within the scheme ?

Two features of voluntary certification may help us to understand these apparently contradictory results. First, firms for which the new requirements would have been most costly could respond by avoiding or leaving certification rather than by changing their practices. This may be a particularly viable option in a context where there exist other certification schemes (such as PEFC) which place no explicit restrictions on IFL preservation. Second, firms faced uncertainty over how strictly the new requirements would ultimately be implemented. Although the headline rule required protection of at least 80% of IFL area, implementation involved audit judgements and evolved over time. According to our estimates, there were 28 concessions that were FSC-certified in 2016 and lost more than 20% of their 2016 IFL area by 2020. While such a loss would seem to be incompatible with FSC certification, 18 remained certified in 2020 (Extended Data Table 5). Audit reports show examples both of apparent violations followed by certificate termination and of continued certification where auditors used different IFL delineations, interpreted the requirements differently, or applied standards that had changed over time (Supplementary Note 1). Thus, firms may have been deterred by the prospect of a stringent new standard even though, in practice, its application was not always mechanical.

Our findings therefore demonstrate a fundamental limit to voluntary environmental certification. Certification schemes can impose demanding standards on firms that choose to participate, but their leverage is constrained by the fact that firms can instead remain outside or leave the scheme. The FSC reform illustrates this constraint particularly clearly. A large increase in formal environmental stringency reduced participation growth among the firms most exposed to it, without generating commensurate improvements in the environmental outcome the reform targeted. Certification schemes can be important tools to transmit information to consumers, but their ability to induce costly behavioural change is inherently constrained by the voluntary nature of participation and, thus, the degree to which buyers are willing to pay a sufficient premium for such changes.

Methods

Forestry concessions and FSC certification

We assembled georeferenced boundaries of forestry concessions in Bolivia, Brazil, Cameroon, Canada, the Republic of Congo, Gabon, Guyana, Indonesia, Peru, Russia and Suriname. The data come from national forestry authorities and international forest-data repositories; country-specific sources, dataset vintages and processing are reported in Supplementary Table 1. In Canada, the source data describe forest tenures granting industrial forest users rights to extract timber within defined areas, which we treat as concessions. In Russia, the underlying data are government records of forest rental agreements at the forest-quarter level; we define a concession as the set of quarters managed by the same company within the same geographical region.

We combine these concession boundaries with records of Forest Stewardship Council (FSC) certification. Certificate and audit data for 2014–2020 were assembled from FSC audit reports[41], supplemented with certification records from the FSC database for earlier and later years[42,43]. Certificates were manually matched to concessions using company names, geographical information and information contained in the audit reports. A single certificate can cover several concessions, but concessions are rarely only partly certified or covered by more than one certificate. Where a concession was only partly covered by a certificate, we classify it as FSC-certified if more than 50% of its area was certified. For Russia, maps of certified concessions for several years were kindly provided by WWF Russia.

Using concession start dates together with the dates at which FSC certification was obtained and withdrawn, we construct an annual concession-level panel of certification status. The resulting dataset contains 7,276 concessions covering 375.9 million hectares across the eleven countries (Extended Data Table 1). For Russia, observations end in 2021, since FSC suspended certification and controlled-wood sourcing from the country in 2022.

Construction of annual IFL maps

The IFL Mapping Team maintains a series of benchmark global maps of Intact Forest Landscape (IFL) extent for 2000, 2013, 2016, 2020 and 2025[11,26,44]. The first global IFL map represented IFL extent in 2000 and was subsequently revised as improved satellite imagery and other information became available. The 2013 map was constructed using the same methodology and a revised 2000 baseline, with further updates subsequently produced for 2016, 2020 and 2025. We use these maps as benchmark measures of global IFL extent, and then fill in the intervening years to construct annual measures of IFL loss.

Starting from the 2000 IFL map, for each subsequent year we identify forest-loss pixels within the preceding year's IFL boundaries using global satellite-based tree-cover-loss data[39]. We restrict attention to areas with at least 30% initial tree cover and exclude losses attributed to fire using a global 30-m dataset of annual fire-related forest loss[40]. We then identify groups of at least five connected forest-loss pixels (0.45 ha), including diagonal connections. Because linear infrastructure such as roads can appear as spatially fragmented loss, we place a 1-km buffer around these groups and merge overlapping buffers. We classify a buffered area as sufficient disturbance to generate IFL loss when it contains at least 50 non-fire forest-loss pixels (4.5 ha).

After removing these disturbed areas, we reapply the spatial criteria used to define IFLs. In particular, IFLs must not contain narrow appendages or corridors less than 2 km wide and must have a minimum area of 500 km^2. We implement the width criterion using a morphological opening: the remaining IFL polygons are first eroded by 1 km, then expanded by 1.5 km and intersected with the original geometry. We subsequently retain only connected areas of at least 500 km^2. The procedure is applied recursively, with each year's IFL map obtained from the preceding year's map after subtracting newly identified loss. In years for which a benchmark IFL map is available, we reset our map to the corresponding map produced by the IFL Mapping Team before continuing the annual procedure. We also apply the corridor and minimum-area criteria to each benchmark map before restarting the sequence, preventing changes caused solely by these geometric criteria from being recorded as new annual IFL loss.

We intersect each annual IFL map with the concession boundaries to measure the area of IFL remaining and the area lost within each concession in each year. These measures form the basis of the IFL-preservation outcomes described below.

Effect of IFL exposure on FSC certification

To estimate the effect of the new IFL requirements on participation in FSC certification, we exploit variation across concessions in their exposure to the restrictions. Our baseline exposure measure is the share of each concession covered by IFL in 2013, the last available benchmark map before public discussion of the reform began. We classify a concession as highly exposed if IFL covered more than 50% of its area in 2013. This gives 1,068 highly exposed concessions and 6,208 concessions with lower or no IFL coverage, most of which contain no IFL. The outcome is an indicator equal to one if concession i is FSC-certified in year t.

We estimate the following event-study specification:

$$FSC_{it} = \sum_{\substack{\tau \in [2002,2024], \\ \tau \neq 2012}} \beta_\tau \left(HighIFL_i \times \mathbb{1}\{t = \tau\} \right) + \alpha_i + \phi_{ct} + \varepsilon_{it}, \tag{1}$$

where $HighIFL_i$ indicates that more than 50% of concession i was covered by IFL in 2013, α_i are concession fixed effects and ϕ_{ct} are country-by-year fixed effects. We omit 2012, the final year before public discussion of the reform began, so that each β_τ measures the change in the certification-rate difference between highly and less-exposed concessions relative to 2012. Country-by-year fixed effects absorb shocks to certification that affect concessions within the same country in a given year. Standard errors are clustered at the company level, or at the concession level for countries where we don't have information on the operating company.

To summarise the effects, we also estimate a pooled difference-in-differences specification:

$$FSC_{it} = \gamma_A HighIFL_i \times \mathbb{1}\{2013 \leq t \leq 2016\} + \gamma_I HighIFL_i \times \mathbb{1}\{t \geq 2017\} + \alpha_i + \phi_{ct} + \varepsilon_{it}. \tag{2}$$

Here, γ_A measures the change in relative certification during 2013–2016, after discussion of the reform began but before implementation, and γ_I measures the corresponding change from 2017 onwards, when the new IFL requirements were in force.

The identifying assumption is that, in the absence of the IFL reform, certification rates in highly and less-exposed concessions within the same country would have followed similar trends. The event-study coefficients before 2013 allow us to assess whether the groups exhibited systematic differences in trends before the reform was discussed. Measuring exposure using the 2013 IFL map also limits the possibility that the treatment measure itself reflects changes in forest management undertaken in anticipation of the new standard. We assess robustness by replacing the binary exposure measure with the continuous share of concession area covered by IFL, using a 25% rather than 50% threshold, defining exposure from the 2016 IFL map, and estimating the effect using the Callaway–Sant'Anna difference-in-differences estimator (Extended Data Table 2).

Effect of FSC certification on IFL preservation

To estimate whether FSC certification improved IFL preservation after the new requirements were implemented, we restrict the sample to concessions containing IFL in 2016. Our baseline treatment measure is an indicator for whether a concession was FSC-certified in 2016, the final year before the new IFL requirements took effect. Fixing certification status before implementation avoids defining treatment using subsequent certification decisions that may themselves have responded to IFL loss or to compliance with the new standard.

The outcome is the annual proportion of IFL remaining at the beginning of each year that is lost during that year. Specifically, if $IFL_{i,t-1}$ denotes the IFL area remaining in concession i at the beginning of year t, and $Loss_{it}$ denotes the area lost during that year, the outcome is

$$IFLLoss_{it} = \frac{Loss_{it}}{IFL_{i,t-1}}. \tag{3}$$

Thus, the dependent variable measures the annual rate of loss from the IFL area still remaining,

rather than loss as a share of a fixed baseline area. In the baseline specification, concessions are weighted by their IFL area in 2016, giving greater weight to losses occurring in concessions containing more IFL when the new requirements were implemented.

We estimate the event-study specification

$$IFLLoss_{it} = \sum_{\substack{\tau \in [2002,2024], \\ \tau \neq 2016}} \beta_\tau \left(FSC2016_i \times \mathbb{1}\{t = \tau\} \right) + \alpha_i + \phi_{ct} + \varepsilon_{it}, \tag{4}$$

where $FSC2016_i$ indicates that concession i was FSC-certified in 2016, α_i are concession fixed effects and ϕ_{ct} are country-by-year fixed effects. We omit 2016, so each β_τ measures the change in the difference in annual IFL loss between concessions that were and were not FSC-certified immediately before implementation, relative to the difference between the groups in 2016. Standard errors are clustered at the company level, or at the concession level for countries where we don't have information on the operating company.

To summarise the post-implementation effect, we also estimate

$$IFLLoss_{it} = \gamma \left(FSC2016_i \times \mathbb{1}\{t \geq 2017\} \right) + \alpha_i + \phi_{ct} + \varepsilon_{it}, \tag{5}$$

where γ compares the change in IFL loss from the pre-2017 period to 2017–2024 between concessions that were and were not FSC-certified in 2016. The identifying assumption is that, in the absence of the new IFL requirements, IFL loss in these two groups would have followed similar trends. We use the event-study estimates before implementation to examine whether there were systematic differences in trends leading up to 2017.

Certification status in 2016 could itself have been affected by discussions of the reform between 2013 and 2016. We therefore repeat the analysis using certification status in 2012, before those discussions began. We additionally consider specifications using contemporaneous FSC status, the annual area of IFL lost rather than the proportional loss rate, weights based on the IFL area remaining in each year rather than IFL area in 2016, and a shorter pre-implementation period beginning in 2010 (Extended Data Table 4).

Certification transitions and audit outcomes

To investigate the margins underlying the effect on FSC participation, we repeat the pooled analysis using separate measures of entry into and exit from certification. For entry, we restrict the sample to concessions that were not FSC-certified in the preceding year and define the outcome as an indicator for obtaining certification in the current year. This specification includes concession fixed effects and country-by-year fixed effects. For exit, we restrict the sample to certificates that were active in the preceding year and examine whether certification is lost in the current year. This analysis is conducted at the certificate level and includes certificate fixed effects and country-by-year fixed effects.

We additionally examine whether exposure to the IFL reform affected the probability that FSC audits recorded a major non-conformity. Audit outcomes for 2014–2020 are taken from FSC audit reports[41]. The outcome is an indicator equal to one when an audit records at least one major non-conformity. Because these data begin in 2014, we estimate the change in this outcome after implementation in 2017 relative to 2014–2016. The analysis is conducted at the certificate level with certificate fixed effects and country-by-year fixed effects. Standard errors are clustered by company/concession in the entry specification and by certificate in the exit and audit specifications.

Data availability

The global Intact Forest Landscape maps are publicly available from the IFL Mapping Team, and the global tree-cover-loss and fire-related forest-loss datasets are publicly available from their original sources[39,40,44]. Forestry concession boundaries were assembled from the country-specific sources reported in Supplementary Table 1. FSC certification and audit information was obtained from publicly available FSC records and the audit-report dataset compiled by Isman[41]. The processed concession-level data used to reproduce the analyses in this study will be made publicly available upon publication. These data are available to editors and reviewers for the purposes of peer review upon request.

Code availability

All code used to construct the annual IFL maps, process the spatial and certification data, perform the statistical analyses, and reproduce the figures and tables in this paper will be made publicly available upon publication. The code is available to editors and reviewers for the purposes of peer review upon request.

Acknowledgements

We are grateful to comments from numerous conference and seminar participants, as well as from Mathieu Auger Schwartzenberg, Emmanuelle Auriol, Philippe Delacote, Caroline Duhesme, Vladislav Kheinonen, Francois Libois, Anouch Missiran, Daniela Miteva, Subhrendu Pattanayak, Erin Sills, Eduardo Souza Rodrigues, Stéphane Straub, and Julie Subervie. We are grateful to Marcelo Gantier, Florian Kraxner, and Erin Sills for sharing data, and Franck Trolliet at FSC for helpful feedback and agreeing to data sharing, as well as to Iddo Glass, William Koscher, and Alonso Venegas for excellent research assistance. The views expressed in this article are those of the authors and do not necessarily reflect the views of Assurance Services International.

Funding

This project has benefited from support by grants ANR-17-EURE-0001, ANR-24-CE26-2254, INRAE CLIMAE ForRoads, INRAE EXPLOR'AE (ANR-24-RRII-000), and CEPREMAP.

Author contributions

All authors contributed to the conception and design of the study, data collection and analysis, interpretation of the results, and writing and revision of the manuscript. All authors approved the final version of the manuscript. The order of all authors' names have been randomized using the AEA randomization tool, reference: 4otXTIjcD7-Q.

Competing interests

J.I. is employed by ASI Assurance Services International GmbH, an organization involved in assurance and oversight of sustainability certification systems. The remaining authors declare no

competing interests.

Additional information

Correspondence and requests for materials should be addressed to Liam Wren-Lewis.

References

[1] Moog, S., Spicer, A. & Böhm, S. The politics of multi-stakeholder initiatives: The crisis of the Forest Stewardship Council. *Journal of Business Ethics* **128**, 469–493 (2015).

[2] Gutierrez Garzon, A. R. *et al.* A comparative analysis of five forest certification programs. *Forests* **11**, 863 (2020).

[3] FSC. History of a motion: Intact Forest Landscapes (IFLs). FSC General Assembly 2017 News (2017). URL https://ga2017.fsc.org/history-of-a-motion-intact-forest-landscapes-ifls/. Accessed: 2025-03-05. Document recounts the initiation of IFL protection discussions by the FSC Environmental Chamber in 2013.

[4] FSC. Intact Forest Landscapes Guidance for Forest Managers (FSC-GUI-30-010 V1-0 EN). https://connect.fsc.org/document-centre/documents/resource/424 (2020).

[5] Greenstone, M. & Jack, B. K. Envirodevonomics: A research agenda for an emerging field. *Journal of Economic Literature* **53**, 5–42 (2015).

[6] Duflo, E., Greenstone, M., Pande, R. & Ryan, N. The value of discretion in the enforcement of regulation: Experimental evidence and structural estimates from environmental inspections in India. *Econometrica* **86**, 2123–2160 (2018).

[7] Lambin, E. F. *et al.* The role of supply-chain initiatives in reducing deforestation. *Nature Climate Change* **8**, 109–116 (2018).

[8] Lambin, E. F. & Thorlakson, T. Sustainability standards: Interactions between private actors, civil society, and governments. *Annual Review of Environment and Resources* **43**, 369–393 (2018).

[9] Amacher, G. S., Koskela, E. & Ollikainen, M. Environmental quality competition and eco-labeling. *Journal of Environmental Economics and Management* **47**, 284–306 (2004).

[10] Ulybina, O. & Fennell, S. Forest certification in Russia: Challenges of institutional development. *Ecological Economics* **95**, 178–187 (2013).

[11] Potapov, P. *et al.* Mapping the World's Intact Forest Landscapes by Remote Sensing. *Ecology and Society* **13** (2008).

[12] Zhuravleva, I. *et al.* Satellite-based primary forest degradation assessment in the Democratic Republic of the Congo, 2000–2010. *Environmental Research Letters* **8** (2013).

[13] Greenpeace. Protecting Intact Forests & FSC's Motion 65: Getting the facts straight. Greenpeace Canada Blog (2015). URL https://www.greenpeace.org/canada/en/story/644/protecting-intact-forests-fscs-motion-65-getting-the-facts-straight/. Accessed: 2026-03-05.

[14] Karsenty, A. Certification of tropical forests: A private instrument of public interest? A focus on the Congo Basin. *Forest Policy and Economics* **106** (2019).

[15] Lee, P. G. Caution against using Intact Forest-Landscapes Data at Regional Scales. *Ecology and Society* **14**, resp1 (2009).

[16] Haurez, B. *et al.* A look at Intact Forest Landscapes (IFLs) and their relevance in Central African forest policy. *Forest Policy and Economics* **80**, 192–199 (2017).

[17] Venier, L., Walton, R., Thompson, I., Arsenault, A. & Titus, B. A review of the Intact Forest Landscape concept in the Canadian boreal forest: Its history, value, and measurement. *Environmental Reviews* **26**, 369–377 (2018).

[18] Zwerts, J. A. *et al.* Feasibility and effectiveness of global intact forest landscape protection through forest certification: the conservation burden of Intact Forest Landscapes. *Frontiers in Forests and Global Change* **Volume 7 - 2024** (2024). URL https://www.frontiersin.org/journals/forests-and-global-change/articles/10.3389/ffgc.2024.1335430.

[19] Tritsch, I. *et al.* Do forest-management plans and FSC certification help avoid deforestation in the Congo Basin? *Ecological Economics* **175** (2020).

[20] Williams, J., Lapointe, U., Paixao, C., Zanotta, D. & Clark, T. Assessing the impact of implementing FSC's protection measures for Intact Forest Landscapes in Canada. Tech. Rep. (2021). https://fsc.org/sites/default/files/2021-10/FSC%20CA%20_%20FINAL_M34Report.IFL%20impact%20assessment.pdf.

[21] Ptichnikov, A. Impact assessment research of Motion 65 implementation for boreal forests of the Russian Federation. https://fsc.org/sites/default/files/2021-10/Motion%2034%20Russia%20report%20TC%20FSC%20Russia.pdf (2021).

[22] FAO. State of the world's forests 2018 - Forests pathways to sustainable development. Tech. Rep., FAO, Rome (2018).

[23] Cerutti, P. O., Tacconi, L., Nasi, R. & Lescuyer, G. Legal vs. certified timber: Preliminary impacts of forest certification in Cameroon. *Forest Policy and Economics* **13**, 184–190 (2011).

[24] FSC. FSC Principles and Criteria for Forest Stewardship (FSC-STD-01-001 V5-2 EN) (2015).

[25] Watson, J. E. M. *et al.* The exceptional value of Intact Forest Ecosystems. *Nature Ecology & Evolution* **2**, 599–610 (2018).

[26] Potapov, P. *et al.* The last frontiers of wilderness: Tracking loss of Intact Forest Landscapes from 2000 to 2013. *Science Advances* **3** (2017).

[27] Greenpeace International *et al.* Intact Forest Landscapes. https://www.intactforests.org/index.html (2021).

[28] FSC. FSC Principles and Criteria for Forest Stewardship. Tech. Rep. FSC-STD-01-001, Forest Stewardship Council (2004).

[29] Kleinschroth, F., Garcia, C. & Ghazoul, J. Reconciling certification and Intact Forest Landscape conservation. *Ambio* **48**, 153–159 (2019).

[30] FSC. International Generic Indicators (FSC-STD-60-004 V2-0 EN). https://fsc.org/en/document-centre/documents/retrieve/2a0d35e7-2707-43ad-a493-3192b3daea6a?mode=view#viewer.action=download (2018).

[31] Greenpeace International. Destruction: Certified. Tech. Rep. (2021). https://www.greenpeace.org/static/planet4-international-stateless/2021/04/b1e486be-greenpeace-international-report-destruction-certified_finaloptimised.pdf.

[32] Rotherham, T. Forest Management Certification in Canada and Around the World. *The Forestry Chronicle* **92**, 142–146 (2016).

[33] FSC. The FSC National Forest Stewardship Standard of Cameroon - FSC-STD-CMR-02-2020 EN (2020).

[34] FSC. The FSC National Forest Stewardship Standard of The Republic of Congo - FSC-STD-COG-02-2020 EN (2020).

[35] FSC. The FSC National Forest Stewardship Standard of The Gabonese Republic - FSC-STD-GAB-02-2020 EN (2020).

[36] FSC. The FSC National Forest Stewardship Standard of Russian Federation - FSC-STD-RUS-02.1-2020 EN (2020).

[37] FSC. Motion 45/2025: Moving beyond fixed thresholds to outcome-based conservation for Intact Forest Landscapes (IFLs). FSC General Assembly (2025). Motion passed in October 2025.

[38] FSC. No FSC material from Russia and Belarus until the invasion ends (2022). URL https://fsc.org/en/newscentre/general-news/no-fsc-material-from-russia-and-belarus-until-the-invasion-ends. Published 8 March 2022.

[39] Hansen, M. C. *et al.* High-resolution global maps of 21st-century forest cover change. *Science* **342**, 850–853 (2013).

[40] Tyukavina, A. *et al.* Global trends of forest loss due to fire from 2001 to 2019. *Frontiers in Remote Sensing* **3**, 825190 (2022).

[41] Isman, J. Auditor leniency and participation in voluntary forest certification (2024). URL https://johannajoyobst.isman.fr/wp-content/uploads/Isman-ForestCertRigor-JMP.pdf. Job Market Paper.

[42] FSC. FSC Search. https://search.fsc.org/en/ (2023).

[43] FSC. Certification Issue and Termination dates from the FSC database shared through Assurance Services International GmbH with approval of the FSC (2025).

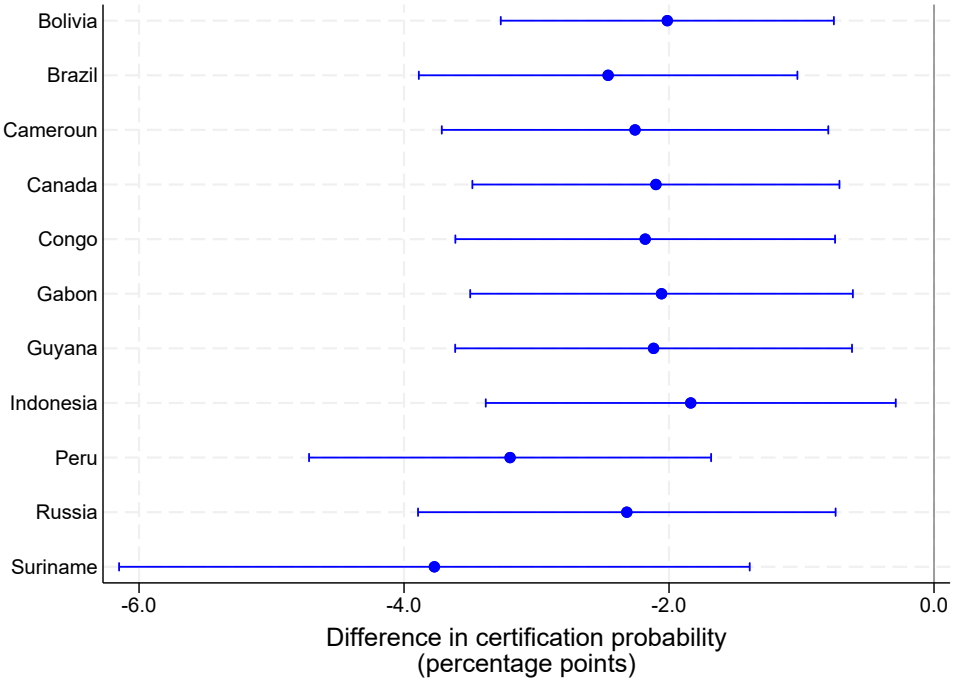
[44] Potapov, P. *et al.* Intact Forest Landscapes extent and change, 2000–2025 (2025).

Extended Data

Extended Data Table 1 — Forestry concessions and analysis samples by country.

	Area in concessions (Mha)		Number of concessions in certification analysis				Number of concessions in IFL-preservation analysis		
Country	All	IFL in 2016	All	No IFL	0–50% IFL	> 50% IFL	All	Not FSC-certified	FSC-certified
Bolivia	5.00	1.89	64	18	19	27	53	46	7
Brazil	1.51	1.16	26	5	1	20	20	14	6
Cameroon	6.50	0.93	106	59	32	15	34	27	7
Canada	106.91	11.21	121	65	49	7	54	31	23
Congo	9.92	3.23	18	2	12	4	29	25	4
Gabon	12.26	4.61	61	12	27	22	91	85	6
Guyana	2.64	1.48	231	115	35	81	109	109	0
Indonesia	27.44	4.61	318	143	141	34	156	148	8
Peru	8.77	5.68	550	41	47	462	419	401	18
Russia	189.88	17.46	5,223	4,390	623	210	526	483	43
Suriname	5.02	1.25	558	291	81	186	129	119	10
Total	**375.85**	**53.52**	**7,276**	**5,141**	**1,067**	**1,068**	**1,620**	**1,488**	**132**

Notes: Areas are reported in million hectares (Mha). For the certification analysis, concessions are classified according to the share of their area covered by Intact Forest Landscapes (IFLs) in 2013. The IFL-preservation sample comprises concessions containing IFL in 2016 and is divided according to FSC certification status in 2016. Russian observations cover 2011–2021.



Extended Data Fig. 1: The estimated effect on certification is not driven by any single country. Points show pooled implementation-period estimates obtained after excluding the country named on the vertical axis. Error bars show 95% confidence intervals based on standard errors clustered by company/concession. The solid vertical line marks zero and the dashed vertical line shows the estimate from the full sample. All specifications include concession fixed effects and country-by-year fixed effects.

Extended Data Table 2 — Robustness of the estimated effect of IFL exposure on FSC certification.

	Baseline	Continuous IFL share	25% threshold	2016 IFL map	Callaway & Sant'Anna
	(1)	(2)	(3)	(4)	(5)
Treatment × 2013	-0.007	-0.001	-0.004	-0.008	-0.016***
- 2016	(0.008)	(0.010)	(0.007)	(0.009)	(0.004)
Treatment × 2017	-0.023***	-0.018**	-0.016**	-0.020***	-0.028***
- 2025	(0.007)	(0.009)	(0.007)	(0.008)	(0.009)
Observations	86334	86334	86334	86334	86334
Outcome mean	0.056	0.056	0.056	0.056	0.056

*Notes:*The dependent variable is an indicator equal to one when a concession is FSC-certified. The baseline specification defines concessions as highly exposed when Intact Forest Landscapes (IFLs) covered more than 50% of their area in 2013. Column 2 replaces this binary indicator with the share of concession area covered by IFL, measured from zero to one; its coefficients are therefore not directly comparable in magnitude with those from the binary exposure specifications. Column 3 defines concessions as highly exposed when IFLs covered at least 25% of their area. Column 4 applies the baseline 50% threshold using IFL coverage measured in 2016 rather than 2013. Column 5 reports estimates obtained using the Callaway and Sant'Anna estimator. Columns 1–4 include concession fixed effects and country-by-year fixed effects, with standard errors clustered by company/concession. Inference in column 5 follows the implementation of the Callaway and Sant'Anna estimator. Standard errors are reported in parentheses. $^{*}P < 0.10$, $^{**}P < 0.05$, $^{***}P < 0.01$.

Extended Data Table 3 — Effects of IFL exposure on certification transitions and major non-conformities.

	Gained FSC certification	Lost FSC certification	Audit noted major non-conformity
	(1)	(2)	(3)
Treatment ×	-0.00261	-0.0433	
2013 - 2016	(0.00177)	(0.0944)	
Treatment ×	-0.00415**	0.148	-0.0185
2017 - 2025	(0.00170)	(0.109)	(0.161)
Observations	81872	2465	1311
Dep. var. mean	0.00616	0.0442	0.301

Notes: Column 1 examines the probability that a concession not certified in the previous year gains FSC certification. Column 2 examines the probability that a concession certified in the previous year loses its certification. Column 3 examines whether an FSC audit recorded at least one major non-conformity. Audit data are available for 2014–2020, so this column reports only the implementation-period coefficient, corresponding to 2017–2020. High exposure indicates that Intact Forest Landscapes (IFLs) covered more than 50% of concession area in 2013. The anticipation period covers 2013–2016 and the implementation period covers 2017–2025. The anticipation period covers 2013–2016 and the implementation period covers 2017–2025. For column 3, audit data are available only for 2014–2020, so the implementation-period estimate corresponds to 2017–2020. Column 1 includes concession fixed effects and country-by-year fixed effects. Columns 2 and 3 are at the FSC certificate level and include certificate fixed effects and country-by-year fixed effects. Columns 2 and 3 are at the FSC certificate level and include certificate fixed effects and country-by-year fixed effects. Standard errors are clustered by company/concession in column 1 and by certificate in columns 2 and 3. Outcome means are calculated over the estimation sample of each column. Standard errors are reported in parentheses. $^{*}P < 0.10$, $^{**}P < 0.05$, $^{***}P < 0.01$.

Extended Data Table 4 — Robustness of the estimated effect of FSC certification on IFL loss.

	Baseline	Treatment = FSC in 2012	Treatment = FSC in year	Dep. var. = IFL area lost	Weight = remaining IFL area	Pre-period = 2010–2016
	(1)	(2)	(3)	(4)	(5)	(6)
FSC-certified × 2017–2024	0.008	0.006	0.009*	461.178	0.002	0.011*
	(0.007)	(0.007)	(0.006)	(1062.644)	(0.004)	(0.006)
Observations	20854	20854	20854	20854	20634	17532
Outcome mean	0.021	0.021	0.021	3411.792	0.014	0.023

Standard errors in parentheses

* $p < .10$, ** $p < .05$, *** $p < .01$

Notes: The baseline specification in column (1) compares concessions that were FSC-certified in 2016, the final year before implementation of the new IFL requirements, with concessions that were not certified in 2016. The coefficient reports the change in the difference between the two groups in 2017–2024 relative to all pre-2017 years. The dependent variable is annual IFL loss as a share of the IFL area remaining at the beginning of the year. Concessions are weighted by their IFL area in 2016. Column (2) instead defines certification status in 2012, before discussions of the reform began. Column (3) uses each concession's contemporaneous FSC certification status. Column (4) uses the annual area of IFL lost as the dependent variable rather than the proportional loss rate. Column (5) weights observations by the IFL area remaining in each year rather than by IFL area in 2016. Column (6) restricts the sample to 2010–2024, so that the pre-implementation comparison period is 2010–2016. All specifications include concession fixed effects and country-by-year fixed effects. Standard errors are clustered by company/concession and reported in parentheses. FSC denotes the Forest Stewardship Council and IFL denotes Intact Forest Landscape. $^{*}P < 0.10$, $^{**}P < 0.05$, $^{***}P < 0.01$.

Extended Data Table 5 — FSC status in 2020 among concessions with apparent breaches of the IFL protection requirement.

	FSC-certified in 2020		
Country	No	Yes	Total
Bolivia	1	3	4
Cameroon	3	0	3
Canada	1	1	2
Congo	0	1	1
Indonesia	1	1	2
Peru	0	4	4
Russia	3	7	10
Suriname	1	1	2
Total	**10**	**18**	**28**

Notes: The table includes concessions that were FSC-certified in 2016 and, according to our spatial measures, lost more than 20% of their 2016 Intact Forest Landscape (IFL) area by 2020. Such losses exceed the amount permitted under a mechanical application of the original default requirement to protect at least 80% of IFL area. We refer to these as apparent breaches because the IFL delineation, timing and standard applied in FSC audits can differ from those used in our spatial measure. Of the 28 concessions identified, 18 (64%) remained FSC-certified in 2020 and 10 (36%) did not.

Supplementary Information

Supplementary Tables

Supplementary Table 1 — Sources of forestry concession data by country.

Country	Source
Bolivia	ABT, Autoridad de Fiscalización y Control Social de Bosques y Tierras (2016). Autorizaciones Transitorias Especiales Bolivia.
Brazil	Ministry of Agriculture
Cameroon	Congo Basin Forest Atlases; data assembled by Tritsch et al.[19] from official OFAC and World Resources Institute land-tenure data
Canada	Global Forest Watch; data provided by Global Witness
Republic of Congo	Congo Basin Forest Atlases; data assembled by Tritsch et al.[19] from official OFAC and World Resources Institute land-tenure data
Gabon	Congo Basin Forest Atlases; data assembled by Tritsch et al.[19] from official OFAC and World Resources Institute land-tenure data
Guyana	Guyana Forestry Commission forestry concession data, accessed through the Cadasta Foundation ArcGIS Online platform
Indonesia	Global Forest Watch; originating from the Ministry of Forestry
Peru	National Service of Forestry and Wildlife, Ministry of Agriculture
Russia	WWF Russia; government records of forest rental agreements
Suriname	Food and Agriculture Organization (FAO)

Notes: The table reports the sources used to construct the georeferenced forestry concession dataset. Where necessary, source data were supplemented or validated using additional information from national authorities. In Canada, for example, the Global Forest Watch tenure data were compared with datasets from several provincial governments, and information on tenure dates was supplemented from provincial sources where available. We sought concession data for countries in which forestry concessions overlap substantially with IFLs, but suitable data were not available in all cases. For example, we were unable to obtain suitable concession boundaries for Colombia, while available data for Honduras lacked information required to link concessions to FSC certificates, including company names. OFAC denotes the Central African Forest Observatory.

Supplementary Note 1: Implementation of the IFL protection requirement

The original FSC requirements implied that, by default, at least 80% of the IFL area present when the requirements were implemented should be protected. To examine how this requirement operated in practice, we identified all concessions that were FSC-certified in 2016 and that, according to our spatial measures, had lost more than 20% of their 2016 IFL area by 2020. We identify 28 such concessions. Ten were no longer FSC-certified in 2020, whereas 18 remained certified (Extended Data Table 5). We refer to these cases as "apparent breaches" because the IFL delineation, timing and standard applied in FSC audits need not correspond exactly to those used in our spatial analysis.

We examined the available FSC audit documentation for these concessions to understand how apparent losses exceeding the original 20% allowance were treated in practice. Audit reports for this period are drawn from the dataset compiled by Isman[41], supplemented where necessary by the underlying FSC audit documents. The cases show that remotely measured losses above the threshold did not have uniform consequences for certification.

In some cases, auditors explicitly identified activities affecting intact forest and certification was subsequently terminated. For example, audits of two Russian certificate holders in 2018 reported cutting and fragmentation in areas treated as intact forest, and both certificates were terminated in 2019. These cases show that the new IFL requirements could have substantive consequences for certificate holders. However, most of the concessions that we identify as having apparent breaches remained certified in 2020.

The available audit reports suggest several reasons why remotely measured losses above 20% did not necessarily result in certificate withdrawal. Auditors did not always use the same delineation of IFL as the global maps used in our analysis. In some cases, audit documentation questioned whether areas classified as IFL in those maps met the definition on the ground, including because of evidence of earlier human use. In other cases, the relevant interpretation of the permitted area of activity or the standard applicable to the certificate holder differed from a mechanical application of the original 80% rule. The requirements also evolved over time, including through national standards that subsequently allowed lower protected shares subject to additional conservation measures.

These cases therefore do not provide a direct measure of formal non-compliance. Rather, they illustrate that implementation of the IFL requirement was not mechanical. Remotely measured IFL loss exceeding 20% could lead to serious audit findings and loss of certification, but did not necessarily do so. Differences in spatial definitions, audit judgements, timing and the standard applicable to individual certificate holders all affected how the requirement operated in practice.