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# Feasibility and effectiveness of global intact forest landscape protection through forest certification: the conservation burden of intact forest landscapes

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Intact Forest Landscapes (IFLs) are defined as forested areas of at least 500 km2 that show no signs of remotely sensed human activity. They are considered to be of high conservation value due to their role in maintaining biodiversity and mitigating climate change. In 2014, the members of the Forest Stewardship Council (FSC), one of the major global certification schemes for responsible forest management, took a conservation stand by restricting logging in FSC-certified IFLs. However, this move raised concerns about the economic viability of FSC-certified logging in these areas. To address these challenges, in 2022, FSC proposed an integrated landscape approach, considering local conditions and stakeholders' needs to balance IFL protection, economic sustainability, and community interests. Here, we leverage publicly available management unit (MU) data, to provide a global quantitative overview of IFLs designated for timber production. We use the concept of 'conservation burden' for the extent that MUs overlap with IFLs, representing the impact that IFL protection has on forest management operations if logging is disallowed. Our data indicates that currently FSC-certified MUs affect 0.6% of global IFLs. Too restrictive policies for logging in IFLs may discourage FSC-certification in global IFLs. Considering the environmental and social benefits of FSC certification, it warrants careful examination whether the benefits of protecting a limited subset of FSC-certified IFLs outweighs the cost of potentially reduced growth of the total FSC-certified area. Our data can provide a basis to facilitate stakeholder engagement for landscape-level IFL management.

KEYWORDS

**Intact Forest Landscapes (IFLs), fragmentation, forest certification, Forest Stewardship Council (FSC), forest management, environmental impact, logging, biodiversity conservation**

## Introduction

Forests cover an approximate 31% of the Earth's terrestrial surface (FAO and UNEP, 2020). Some 12 million km$^2$ of these forests consists of Intact Forest Landscapes (IFLs), defined as forests and natural treeless areas of at least 500 km$^2$ without remotely detectable signs of human activity, such as roads, settlements, or agriculture (Potapov et al., 2008). This definition and its emphasis on remote sensing does not totally exclude human use (Savilaakso et al., 2023). A significant proportion of the world's IFLs is concentrated in Russia, Canada, Brazil, the Democratic Republic of the Congo, and Indonesia, accounting for over 70% of global IFLs. IFLs are distributed over various forest types, with 50% in boreal forests, 46% in equatorial regions, and 3% in temperate zones (Mackey et al., 2015). Large natural forest areas like IFLs are more resilient against disturbance than disturbed forests (Lindenmayer et al., 2017), and are important due to the comparatively high level of ecosystem services they provide such as biodiversity conservation, carbon storage, and water and air purification (Potapov et al., 2008; Watson et al., 2018). For example, risks to vertebrate biodiversity are disproportionately high in fragmented forests, even with minimal forest loss (Betts et al., 2017). Intactness, however, does not always ensure the presence of species or ecological functionality. This is evident as many of the areas presumed to be intact exhibit a scarcity of species or sustain low population densities, revealing the limits of the concept as a proxy for integrated conservation strategies (Plumptre et al., 2019).

Between 2000 and 2013, 7.2% of the IFLs were lost due to industrial timber extraction (37%), agricultural expansion (27.7%), and the spread of wildfires from infrastructure and logging sites (21.2%) (Potapov et al., 2017). Notably, 60% of this reduction took place in tropical regions. Protected areas lost comparatively less IFLs than non-protected areas, highlighting the importance of implementing formal conservation measures such as the establishment of International Union for Conservation of Nature (IUCN) protected areas falling under categories I–III (IUCN, 2020). However, only 12% of IFLs are protected, highlighting the need to focus on the impact of other land-use strategies if the value and services that IFLs provide are to be maintained (Potapov et al., 2017).

The Forest Stewardship Council (FSC) is one of the most influential organizations regarding forest management (Romero et al., 2018), and is generally regarded as maintaining the highest forest management standard (Kleinschroth et al., 2019; Zwerts et al., 2024). IFLs have been integrated into FSC Principles and Criteria for Forest Stewardship (FSC-STD-01-001) through motion 65 adopted in 2014, calling for the protection of IFLs located inside FSC-certified forest management units (MUs) (Haurez et al., 2017). The motion specifically demanded the strict conservation of the vast majority of IFLs inside certified management units – the threshold being set at 80% of the original area mapped in the scientific publication defining IFLs (Potapov et al., 2008). The implementation of this new requirement created considerable difficulties not foreseen by the participants of the general assembly that voted for the motion.

Firstly, FSC-certified logging companies were unable to continue logging in IFLs while complying with FSC's requirements, putting them at risk of losing their FSC-certificate (COMIFAC, 2016; FSC, 2016; Karsenty, 2019). This created a comparative disadvantage for FSC-certified companies against both uncertified companies and the informal logging sector, which was also likely to deter non-FSC forest operators from seeking FSC certification (Haurez et al., 2017). Secondly, Indigenous peoples were not part of the decision-making process and many IFLs that are classified as intact, by means of satellite imagery, are in fact used or inhabited (Morin-Rivat et al., 2017). This is perceived as undermining the rights and interests of Indigenous communities and local communities who have longstanding rights and knowledge related to these forests (Zanotti and Knowles, 2020). The paradox is that the exclusion stems from the fact that small scale human settlements, swidden agriculture and non-industrial timber harvesting are not considered as IFL alterations or fragmentation factors (Potapov et al., 2008, 2017) and are therefore not excluded from the IFL zoning. Thirdly, sovereign nations would lose the planned benefits of economic development and tax revenues from the forestry industry should these forests designated for logging be protected rather than exploited. This potential lost revenue creates a financial disincentive for nations to support the FSC certification process (Kleinschroth et al., 2019). Overall, the motion wording created a situation that would potentially weaken the appeal and growth of forest certification, which might impact the long-term prospects of responsible forest management.

In October 2022, the Forest Stewardship Council (FSC) adopted motion 23/2020, calling for an improvement of FSC normative requirements by emphasizing adaptive management of IFLs in accordance with local conditions in a bottom-up process, instead of a blanket rule prohibiting logging in large parts of FSC-certified IFLs (FSC, 2022b). This rule considers the integration of IFLs within the broader landscape while fostering collaboration among key stakeholders, such as the private sector, national and regional governments, Indigenous groups, and conservation NGOs, to preserve high conservation values.

The extent of IFLs in individual MUs will be an important factor for the implementation of motion 23/2020, as local and regional conditions will direct the dialogues required to attain workable solutions for IFL protection. We refer to the extent of the percentage overlap between an MU and IFLs as the "conservation burden." This measure represents the impact that IFL protection has on forest management operations if logging is disallowed in the IFL encompassed by an MU. Conservation burden is a concept that has emerged within the discourse of conservation and land management, referring to the impact or responsibility that arises for preserving and safeguarding natural areas (Renwick and Archibald, 2018). It highlights the potential trade-offs and challenges faced when balancing conservation objectives with other land uses or economic activities. From the point of view of the forest operator, setting aside the IFL area within the management unit under its responsibility represents an opportunity cost – the timber not harvested – and possibly also a direct cost – in the form of taxes or royalties the operator is bound to pay to the State or to the local communities irrespective of the fact they log the area or not.

The concept of the conservation burden serves to evaluate the responsibilities of forest managers for the conservation of IFLs. Making it visible and transparent aligns with the concept of clarification of rights and responsibilities that is central to landscape approaches (Sayer et al., 2013) and allows for the creation of alliances should the burden need to be shared. Our assessment aids in determining the need for additional engagement from stakeholders such as governments, conservation NGOs and downstream supply chain actors. Departing from simplistic approaches, the quantification of the conservation burden facilitates tailored strategies that align with specific contexts. Furthermore, it offers a unified global framework for understanding conservation allocation worldwide. Our study involved a comprehensive global analysis, quantifying conservation burdens for publicly mapped MUs and assessing IFL fragmentation within them. Through this quantification, we aim to inform dialogues among stakeholders and provide initial insights into the challenges of meeting conservation burdens, enhancing IFL protection and securing the rights and needs of local communities.

## Materials and methods

We collected and collated all publicly available MU and IFL data of Central Africa, Southeast Asia, the Amazon, and of the boreal forests in Canada and Russia (Praamstra et al., 2024). As such, we included MU data from Cameroon, Canada, the Central African Republic, the Democratic Republic of Congo, Equatorial Guinea, Gabon, Indonesia, Malaysia, the Republic of Congo and Russia. Together, these forests comprise the majority of all IFLs (Potapov et al., 2017). We utilized the 2020 intact forest landscape (IFL) dataset generated by Potapov et al. (2017). Both FSC-certified and non-FSC MUs were considered and FSC-certification status data was collected using the FSC public dashboard (FSC, 2023). All data was collected in March 2023. Our dataset is not exhaustive. To our knowledge, not all MU data is publicly available. For Southeast Asia no public MUs are available for Papua New Guinea and Peninsular Malaysia. For the Amazon, insufficient public MU data was available to create an accurate representation of the situation. This area was excluded from the main analysis, yet we have included a separate overview for the Amazon in the Supplementary material. We included a distinction between FSC-certified and non-FSC MUs in Russia, even though the FSC has withdrawn all certificates in Russia in April 2023 following the invasion of Ukraine. We chose to retain the distinction between FSC-certified and non-FSC MUs for the Russian data because of the uncertainty of the current situation and the significant influence of FSC-certification in the Russian management of IFLs. The overlap between MUs and IFLs was determined with ArcGIS Pro 3.0.0 and analyzed in R version 4.3.2 using the WGS_1984_Web_Mercator_Auxiliary_Sphere coordinate system.

## Results

Our study examined the overlap between forest Management Units (MUs) and Intact Forest Landscapes (IFLs), expressed as the conservation burden, to understand the challenges and opportunities of IFL protection in areas designated for logging. We present a global overview of all publicly available MUs that we were able to collate for this study (Figure 1). We show data for both FSC-certified and non-FSC MUs (Figure 2), and (Table 1; Supplementary Table S1), for a log scaled version of Figure 2 see Supplementary Figure S1 and for FSC-certified MUs only Supplementary Figure S2. Forest MUs have a wide range of overlaps with IFLs, ranging from conservation burdens of 0 to 100%, each warranting a different collaborative approach to IFL protection.

Stakeholders can use Supplementary Table S1 to explore MUs with comparable conservation burdens, to learn from and streamline collaborative efforts. We provide region specific figures for comparisons of conservation burdens, as each region faces different socioeconomic contexts (Figure 3 and Table 1), for a log scaled version of figure 3 see Supplementary Figure S3 and for only FSC-certified MUs divided per region see Supplementary Figure S4. In Central Africa, a substantial proportion of IFLs, ranging from 42 to 74% based on previous work (Karsenty and Ferron, 2018), are situated within MUs (Figure 1). Three countries contain FSC-certified MUs which overlap with IFLs: Cameroon, the Republic of Congo and Gabon, of which the majority have conservation burdens of less than 30%. Low conservation burdens may still affect large areas of IFL if the respective MU is large. For instance, MU 24 in the Republic of Congo is the largest African MU and despite its relatively low conservation burden of 34%, it contains the second largest absolute IFL area in Africa (Figure 3; Supplementary Figures S3, S4 and Supplementary Table S1). A large group of sizable non-FSC MUs contain high conservation burdens. Country specific characteristics can also be distinguished. Cameroon and Equatorial Guinea have on average smaller MUs (<56,000 ha, Table 1), with lower average conservation burdens than the Republic of Congo. Moreover, only Congo, the DRC and Gabon have MUs with an IFL size above 200,000 ha. Southeast Asian MUs are generally smaller than those located in Central Africa. Only Indonesia contains FSC-certified MUs overlapping with IFLs and Malaysia harbors fewer and smaller MUs than Indonesia. Given their number and size, non-FSC MUs are highly relevant for an integrated IFL conservation strategy, despite the lack of declarations of intent to mind fragmentation in their management. Size differences between MUs in the tropical and boreal biomes are striking, as MUs in Canada and Russia have much higher limits than those in the tropics. Lastly, Brazil, for which spatial data of only a fraction of the existing MUs was publicly available, showed high conservation burdens for all included MUs, owing to the vast expanse of IFL in the Amazon Basin (Supplementary Figure S5).

Grouping the total IFL area per country emphasizes the differences in IFL scale between the tropical and boreal biomes, particularly in Canada, as well as the limited footprint of FSC on global IFLs (Figure 4). Figure 4 also highlights the substantial number of small-sized MUs in Canada. Likewise, Indonesia has significantly more MUs (212), compared to the DRC (48) and Gabon (86), despite a comparable overall IFL area. Russia had, before the war in Ukraine, the largest percentage of IFL area within MUs being FSC-certified (55.1%), followed by the Republic of Congo (17.9%), Cameroon (8.6%), Indonesia (7.0%) and Gabon (6.4%).

MUs also vary in the degree of fragmentation of IFLs and many MUs contain multiple fragments of 100 ha or larger (Figure 5).

## Discussion

### A shared burden

We set out to explore the spatial distributions of IFLs and MUs, seeking patterns that could help design tailored approaches for conservation and management of IFLs. Our quantification and visualization of the percentage overlap of IFLs within MUs, expressed as the conservation burden, showed that there is a large overlap between IFLs and MUs, a limited overlap between IFLs and FSC-certified MUs compared to non-FSC MUs, and that there is a wide variation of overlap among MUs. We do not observe any meaningful relationship between the conservation burden and the area of the management units. This is not surprising considering the lack of direct causal relation between these two variables. The substantial overlap between IFLs and MUs emphasizes the need for proactive measures to ensure the conservation of these ecologically valuable areas while strengthening the prospects for responsible forest management globally. The Forest Stewardship Council (FSC) plays a pioneering role in navigating this challenge by promoting stakeholder engagement and encouraging the development of region-specific solutions (FSC, 2022b). Our data provides insights into the implications and complexities of FSC's approach to IFL protection, and raises questions about the feasibility of a whole or partial ban on logging to protect IFLs. Simplistic blanket rules have proven challenging to implement for their lack of consideration for local conditions. The overview we present will

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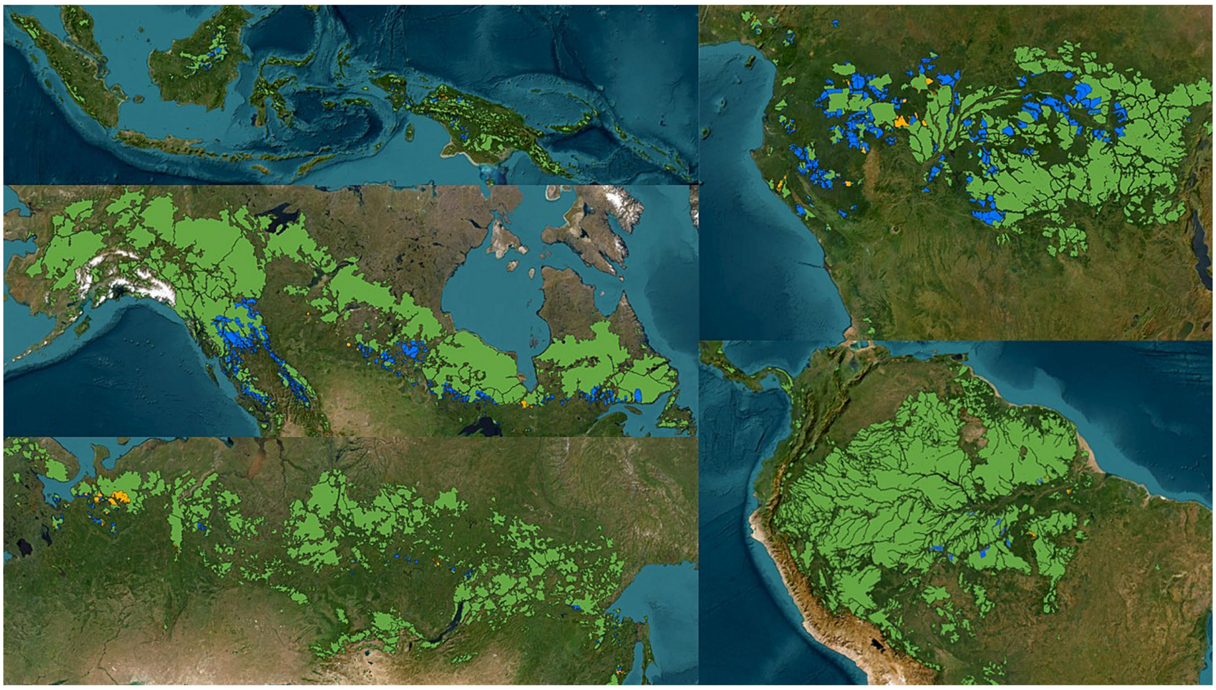

FIGURE 1
Overlap of intact forest landscapes (IFLs) and forest management units (MUs), FSC-certified or non-FSC, included in this study. Starting from the top left in clockwise direction: Southeast Asia, Central Africa, Latin America, Russia, Canada. IFLs (Green), overlap with FSC-certified MUs (orange), overlap with non-FSC MUs (blue). Note that non-public MU data was not included in our dataset but may also overlap with IFLs.

help develop a more balanced approach, highlighting the situations that will require strong collaboration between stakeholders to successfully balance conservation, development and the respect of local needs and aspirations.

Conservation burdens vary widely among MUs, and the capacity of the certificate holder can be exceeded, shifting the responsibilities for IFL protection to other stakeholders. Consider a conservation burden of 100%, the MU overlapping totally with IFLs. To what extent can such a certificate holder be held solely responsible for the IFL protection? When should national government agencies, local and Indigenous communities, NGOs, and other interest groups intervene to share, alleviate or take over the conservation burden? This in turn raises questions about effective methods for IFL conservation and management. What does protection entail and how will it affect other stakeholders in the landscape? How can intactness be recovered? The literature indicates that timber stock and carbon recovery depends on logging intensities and practices (Rutishauser et al., 2015; Roopsind et al., 2017; Piponiot et al., 2019). This last question in particular is seldom if ever addressed, yet the concept as defined by the scientific community accommodates time limits of 30 to 70 years for its recovery (Potapov et al., 2008, 2017). Other sectors of the economy might find it challenging but surely forestry can cope with these time frames. Why is this not part of the solution space?

## Defining the IFL concept

It has been suggested that the IFL concept requires redefining to include elements beyond simple forest connectivity, such as under-canopy usage and community rights. However, the definition of intactness put forward by Potapov et al. (2017) is clear, simple, and transparent. The IFL is fundamentally a topological indicator that informs ecological processes, specifically designed to quantify and address forest fragmentation. Its strength lies in its clarity and precision in measuring this specific aspect of forest ecosystems. Attempts to redefine the concept of what an IFL is, therefore run the risk of missing the point. The integration of social indicators and the involvement of communities are critical in the context of forest management. Nevertheless, these aspects relate to the principles and priorities that guide the application of the IFL concept in practical conservation strategies, rather than to the definition of IFLs themselves. In other words, the social considerations do not call for a modification of the definition of what an IFL is, they call for a redefinition of the priorities to be considered alongside ecological integrity and fragmentation. In this regard, the discussion is not ontological but axiomatic. It revolves around how the principles or priorities in forest management should align with the existing definition of IFLs. The calls for redefinition of IFLs to include social aspects might be more accurate if understood as calls for a different prioritization within forest management strategies, where ecological, social, and economic considerations are integrated in a balanced manner. The IFL concept has been useful but needs to be applied in parallel to degradation/intactness indicators in the context of forestry. The conservation of environmental and social values found in IFLs, and the maintenance of the intactness requires more strategic depth in the design of policies (Garcia et al., 2022). We recommend that future research explores the level of forestry-related disturbances that can be sustained while maintaining the environmental, socio-cultural, and economical values of intact forest landscapes.

TABLE 1 Descriptive statistics of management units (MUs) included in our dataset, including conservation burden in percentages and hectares and concession sizes in hectares, per country, region and globally.

| Region | Country | *n* | Conservation burden (%) | | | Conservation burden (ha) | | | Concession size (ha) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Mean | SD | Median | Mean | SD | Median | Mean | SD | Median |
| | Cameroon | 49 | 38 | 32 | 31 | 20,359 | 23,201 | 13,617 | 55,367 | 29,590 | 53,355 |
| | Central African Republic | 6 | 9 | 9 | 8 | 27,451 | 30,480 | 16,776 | 297,215 | 115,932 | 251,127 |
| | Congo (DRC) | 48 | 50 | 27 | 49 | 99,905 | 61,632 | 99,170 | 205,322 | 64,703 | 212,121 |
| | Equatorial Guinea | 4 | 43 | 35 | 41 | 3,186 | 403 | 3,057 | 16,692 | 19,006 | 8,859 |
| | Gabon | 86 | 42 | 32 | 38 | 50,578 | 61,020 | 22,067 | 144,797 | 138,382 | 104,879 |
| | Congo (RoC) | 28 | 28 | 27 | 24 | 116,232 | 141,242 | 42,396 | 396,870 | 266,114 | 333,053 |
| Africa | Total | 221 | 40 | 31 | 36 | 61,424 | 77,827 | 28,761 | 171,870 | 168,371 | 133,631 |
| | Indonesia | 212 | 35 | 29 | 27 | 21,318 | 36,798 | 8,026 | 68,714 | 76,680 | 45,400 |
| | Malaysia | 24 | 7 | 10 | 3 | 6,614 | 9,961 | 2,454 | 76,007 | 59,677 | 68,339 |
| Asia | Total | 236 | 32 | 29 | 22 | 19,822 | 35,289 | 7,312 | 69,456 | 75,051 | 46,559 |
| Canada | Canada | 601 | 41 | 36 | 31 | 60,757 | 198,092 | 2,363 | 252,294 | 705,173 | 20,062 |
| Russia | Russia | 74 | 15 | 15 | 10 | 106,910 | 182,734 | 58,045 | 737,210 | 590,646 | 665,571 |
| Global | | 1,132 | 37 | 33 | 26 | 55,370 | 157,700 | 9,065 | 230,174 | 562,263 | 56,606 |

From this perspective, it is possible that the decision to establish forest intactness as a management objective during the 2014 general assembly by FSC members might have benefitted from a more comprehensive examination of its related implications. This scenario serves as a classic illustration of an attempt to tame a wicked problem with an overly simple approach. The frustration many stakeholders have experienced with the long and protracted discussions that led to Motion 23 and its future implementation should not discourage further dialogues, as the current biodiversity and climate urgency leave little space for failure.

As currently defined and without consideration for the possibility of recovery, responsible logging operations are incompatible with the conservation of forest intactness embodied by the IFLs. Given the stated objective, the rule of motion 65 rightly asked for logging to be discontinued in "the vast majority of" IFLs entirely. What the "vast majority" means has been the subject of heated debates within FSC, ranging from 80 to 50% in the rules and interim decisions, and to 20% and even 0% in some of the requests put forward to the general assembly by some of the members. It is not surprising that forestry companies with high conservation burdens are unwilling or even unable to abandon a significant portion of their core-business activities without alternative business models. Government support is also lacking since sovereign nations fail to benefit from the economic development, job creation and tax revenues of the forestry industry (Wanders and Hout, 2020). Should a compromise be struck for forestry companies to partially stop logging in IFLs, the loss of revenues, taxes, and jobs would need to be compensated as well (FSC, 2022a). The aphorism 'use it or lose it' has persistently underscored the importance of responsible forest management, attributing value to standing forests outside protected areas. This valuation not only fosters incentives for conservation but also provides a viable counterbalance to the prevailing trend of agro-industrial land-use conversion. The adage, echoed by our findings, underscores the fundamental recognition that safeguarding IFLs must be accompanied by a pragmatic acknowledgment: protecting and conserving IFLs requires inventing alternative ways to generate value if exploitation is to be avoided.

Finally, currently defined IFLs are based on Landsat data (Potapov et al., 2008). Remote sensing is however a rapidly developing field, and improved methods that are better at detecting below the canopy disturbance, e.g., LiDAR or radar interferometry, can significantly alter the extent of what is currently determined as intact (Lei et al., 2018; De Almeida et al., 2019; Sloan et al., 2024). Improved methods may provide better insight in past disturbances and can thereby assist landscape level solutions.

## Alternative approaches to protecting IFLs

Payment for Ecosystem Services (PES) presents a potential solution for IFL protection. PES operates by maintaining the flow of ecosystem services in exchange for economic value (Wunder, 2007; Engel et al., 2008; Alix-Garcia and Wolff, 2014). This could be applied to bridge the gap in opportunity costs associated with IFL protection. By exploring PES as a means of conserving IFLs within MUs, stakeholders can work towards a more responsible and mutually beneficial approach to forest management that recognizes and values the ecosystem services provided by IFLs, while fostering collaboration between conservation NGOs, local communities, and logging companies (Thies et al., 2011). In practical terms, it could involve logging companies receiving stable funds from third parties for not logging inside IFLs within their concession, making conservation a positive contribution to their business plan. These funds would need to be shared with the local communities having rights over the IFLs. It is important to note that indirect beneficiaries of the industry affected by changes down the processing chain, e.g., the closure of mill

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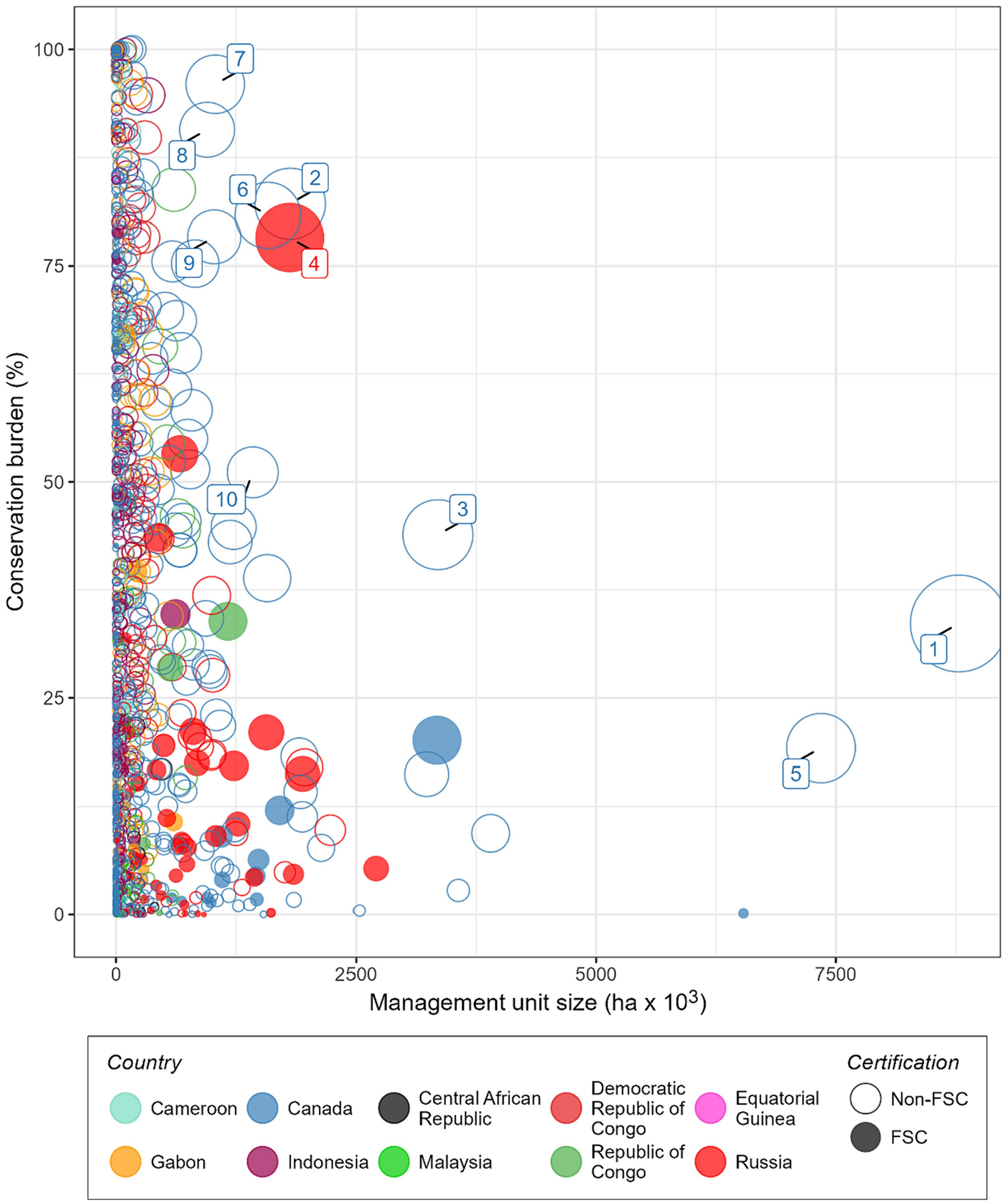


FIGURE 2
Global overview of the conservation burden, management unit (MU) size and Intact Forest Landscape (IFL) size within MUs. Conservation burden represents the percentage overlap of MUs with IFLs. A conservation burden of 100% means the totality of an MU is inside an IFL. Datapoints are scaled to the absolute IFL area encompassed by an MU. The 10 largest MUs are labelled with corresponding numbers in Supplementary Table S1.

and reduced logistical activities, should also be considered in PES models. Other forms of collaboration that do not involve financial transactions would need to be designed as per the conditions on site.

The possibility of third-party funding was contemplated alongside Motion 23 at the 2022 FSC general assembly but was surprisingly rejected by the economic chamber representing the interests of the logging companies. The observed effectiveness of PES programs in terms of preventing forest loss (Salzman et al., 2018), however, has been limited and given the area of MUs overlapping with IFLs, it is doubtful whether such an approach will provide sufficient relief to compensate for the vast opportunity costs of a partial or whole logging moratorium in IFLs as contemplated under current FSC rules (FSC, 2022b). Moreover, even if such funds could be made available, it will prompt the question whether they should be utilized to conserve IFLs through the cessation of FSC-certified forest management – a practice recognized for its stringent environmental and social standards and its


FIGURE 3
Conservation burden, management units (MUs) and intact forest landscape (IFL) size within MUs in **(A)** Central Africa, **(B)** Southeast Asia, **(C)** Canada, and **(D)** Russia. FSC has suspended all certificates in Russia in April 2023 (FSC, 2023). Conservation Burden represents the percentage overlap of MUs with IFLs. A conservation burden of 100% means the totality of an MU is inside an IFL. Datapoints are scaled to the absolute IFL area encompassed by an MU. The 10 largest MUs are marked with corresponding numbers in Supplementary Table S1.

positive social (Cerutti et al., 2014; Panlasigui et al., 2018; Karsenty, 2019) and ecological impacts (Zwerts et al., 2024), or whether it might be more effective to direct these resources towards protecting IFLs outside of FSC-certified concessions. One could argue that, considering the constant financial constraints the conservation sector faces, it might be more prudent to allocate these resources to alternative conservation initiatives, such as enhancing protected area management (Wilson et al., 2007). Based on another study, only 0.6% of IFLs in Brazil are FSC-certified, while 65% of IFLs in Brazil are in protected areas, where funds of compensating forestry companies might thus be better used (FSC, 2022a). One of the benefits of the 'use it or lose it' forestry approach for conservation is that forestry ensures active management, while formally protected forests may still become victim to illegal logging and settlement, which would again require funds for protection measures on top of the compensation of companies. Lastly, even if companies could be compensated for missed revenues, they would require fewer employees, leading to higher unemployment which may further exacerbate illegal activities. Given these considerations

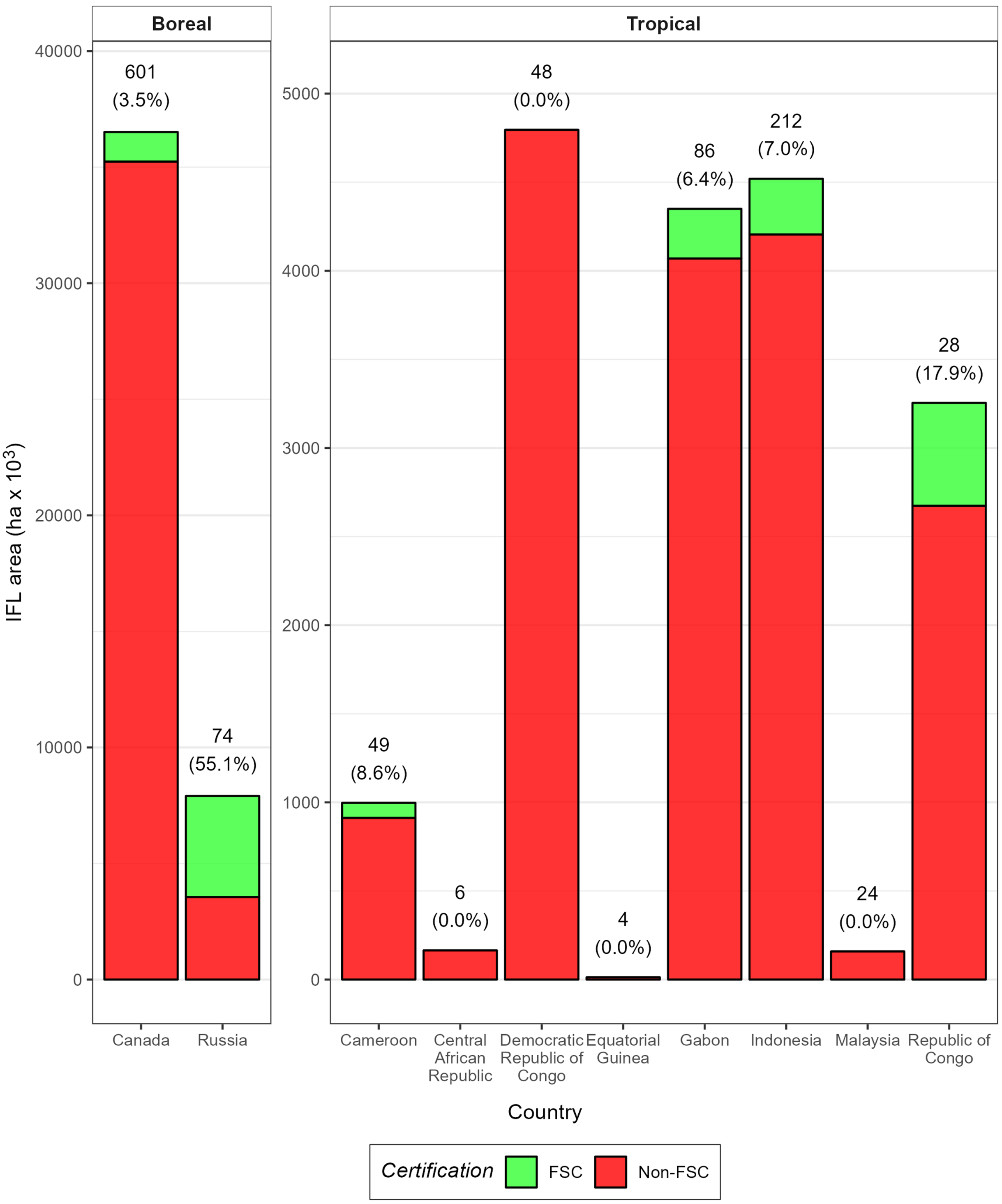


FIGURE 4
Cumulated Intact Forest Landscape (IFL) area per country for FSC-certified and non-FSC Management Units (MUs). IFL size (in ha × $10^3$) for FSC-certified and non-FSC MUs in Cameroon, Canada, the Central African Republic, the Democratic Republic of Congo, Equatorial Guinea, Gabon, Indonesia, Malaysia, the Republic of Congo and Russia. Numbers above the bars represent the total number of MUs per country. Percentages represent the FSC-certified IFL area.

we seriously question the feasibility of blanket protection of IFLs within the FSC system as currently designed by the motions in place. There are valid justifications to include fragmentation as one of the Principles and Criteria of FSC certification, but for some MUs this implies that it will be a main management objective, which seems increasingly straying away from socio-economic realities.

As we have discussed, fragmentation and IFLs do not have to be the only component of management as spatial intactness cannot

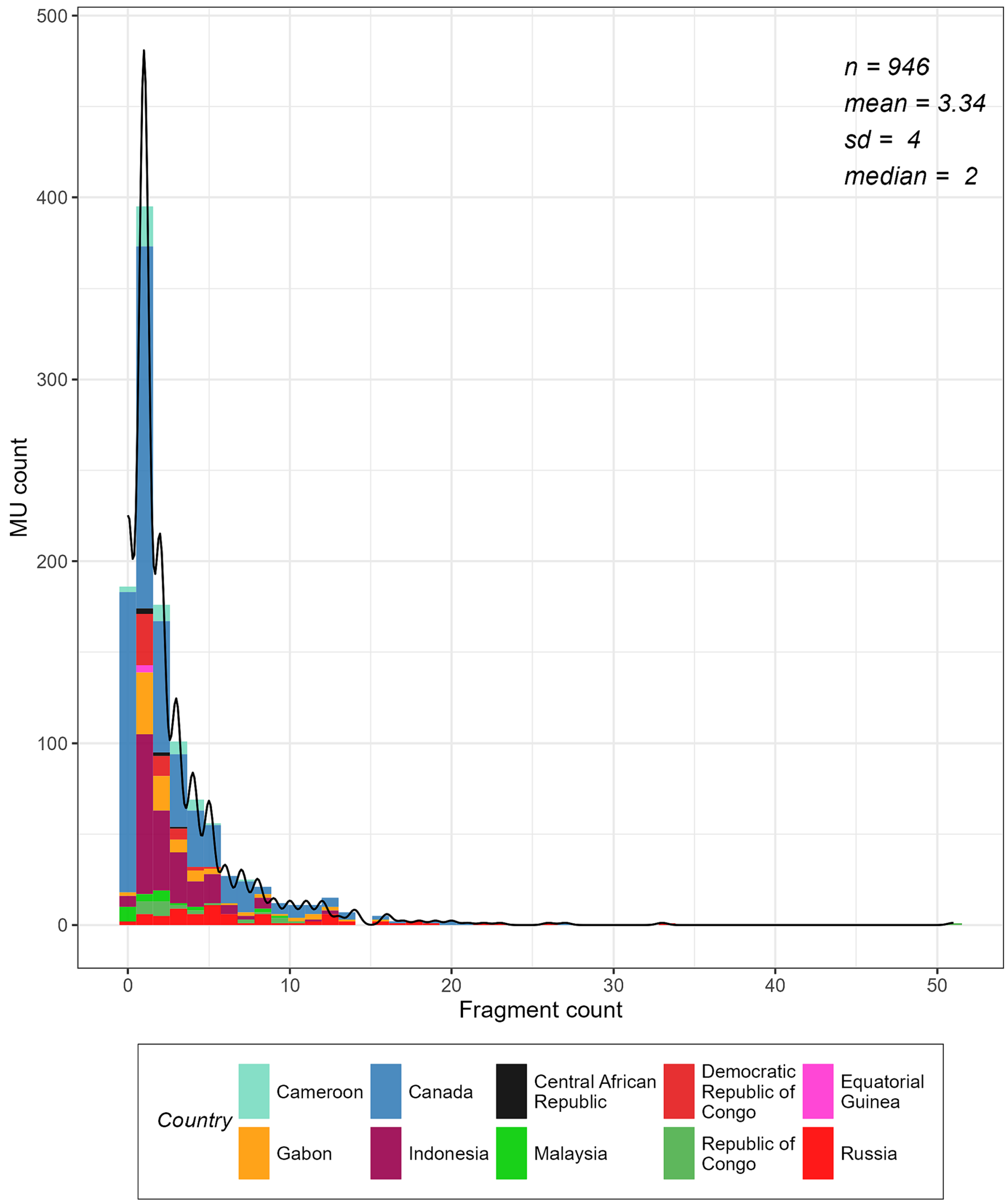


FIGURE 5
Intact forest landscape (IFL) fragment count per forest management unit (MU). The number of IFL fragments larger than 100 hectares per MU. Descriptive statistics include only the concessions with at least 1 fragment larger than 100 ha.

serve as a proxy for conserving ecological function and services. IFLs do not always contain intact wildlife communities (Plumptre et al., 2019) and might be more susceptible to megafires than other forests due to a lack of access to fire prevention (Stephens et al., 2013). Therefore, the conservation of environmental values is not necessarily ensured by the strict conservation of IFLs. Integrated approaches that consider fragmentation and intactness as among the multiple elements to account for, alongside a solid understanding of landscape dynamics, pressures and time horizons are required for global forest fragmentation to stop. In such a model, consensus needs to be reached on what it entails to protect IFLs on the ground. In areas where strict protection is not feasible because of opportunity costs or lack of alternative funds, less invasive methods of forestry could be considered. In tropical forests this can for example be a form of very low impact logging whereby the ecological impact of logging is reduced to its minimum and forest recovery is actively promoted (Putz et al., 2008; Breukink and Terrana, 2017; FSC, 2022a; Banin et al., 2023). This includes limiting extraction volumes or tree felling quantities, careful road design, mapping and tracking trees before and after logging, minimizing and setting limits to forest gap sizes, applying special felling techniques to minimize residual damage to the forest stand and the use of more rigorous Reduced Impact Logging measures known as RIL-plus (Wanders and Hout, 2020), which can also reduce carbon emissions (Ellis et al., 2019). There should be careful consideration of road and camp placement to avoid fragmentation, and stringent post-harvest infrastructure management like the active destruction of roads after exploitation to facilitate regrowth and obstruct illegal trespassers. If logging road networks are managed well, i.e., closed off after use, canopies closure takes between 4 and 20 years (Kleinschroth et al., 2015). Such measures may be more pertinent and feasible than a ban on logging all together. Boreal forests on the other hand are exploited with clear-felling techniques which will require again other context specific approaches to maintain connectivity and ecological integrity, especially when considering climate change (Girona et al., 2023). For both the tropical and boreal biomes, IFLs should not be replaced by plantations, as mere forest cover is insufficient to ensure biodiversity conservation in these forests (Castano-Villa et al., 2019). Stringent management requirements for IFLs can be combined with increased monitoring efforts in an outcome-based approach that links environmental indicators to locally relevant threats and pressures. This could be accomplished using a biome specific set of indicators to quantify spatial and temporal impacts of logging operations in IFLs, to assess and guarantee the environmental values that IFLs provide.

## IFLs and the growth of the FSC

Only a fraction of global IFLs is currently FSC-certified: 0.6% based on our data, and 7% in Canada, 2.3% in Russia, 1.4% in Central Africa, 0.6% in Brazil, based on other datasets, while these percentages were not available for other countries (FSC, 2022a). While the intention behind FSC's efforts to preserve IFLs is commendable, the small percentage of IFLs managed under FSC certification warrants careful examination about whether the rigorous policies aimed at enhancing protection for IFLs within FSC-certified MUs justify the potential loss of certified logging companies. Motion 65 was partially justified because the loss of IFL area was reported to be higher in FSC-certified MUs than in non-FSC MUs (Potapov et al., 2017). Together with Kleinschroth et al. (2019) we question this rationale because it seems to lack the long-term perspective that makes responsible forest management a potent component of landscape conservation strategies. Too stringent requirements for IFL protection will negatively impact FSC's global strategy of sustained growth of the global acreage of FSC-certified forests (FSC, 2023), as it will deter non-FSC forest managers from opting for FSC certification and may prompt FSC-certified companies to discontinue their certificates (Karsenty and Ferron, 2018; FSC, 2022a). Hence, a plausible contention emerges: For optimizing the protection of IFLs, prioritizing the expansion of the total FSC-certified area, along with associated environmental (Burivalova et al., 2017; Zwerts et al., 2024) and social benefits (Cerutti et al., 2014; Karsenty, 2019), might hold more significance for environmental preservation compared to imposing stringent management obligations exclusively on a limited subset of FSC-certified IFLs. To our knowledge, other certification schemes have not taken a specific pledge on the issue of global forest fragmentation. The Programme for the Endorsement of Forest Certification (PEFC) for example, the other large forest certification scheme besides FSC, has a country level decentralized decision-making system. To our knowledge to this date no PEFC country decision-making group has taken decisions regarding IFL management. This isolation of FSC on the issue creates an additional risk to global forest intactness since high conservation burdens do not guarantee the maintenance of FSC-certified MUs, and non-FSC logging does not guarantee protection of IFLs.

This manuscript focused on MUs in IFLs, but over one-third of IFLs are located within Indigenous territories (Fa et al., 2020). Motion 23/2020 highlights the importance of recognizing the territories of Indigenous peoples as Indigenous Cultural Landscapes (ICLs). The lack of recognition of Indigenous rights, including land tenure insecurity, has resulted in the loss of IFLs without their consent. The overlaps between government sanctioned Management Units, Indigenous cultural landscapes and IFLs need to be identified and clarified before progress can be achieved.

# Conclusion

The range of overlap between MUs and IFLs, spanning conservation burdens from 0 to 100%, underscores the need for diverse collaborative strategies in safeguarding intact forest landscapes. Our analysis included both FSC-certified and non-FSC MUs, providing insights into the challenge of IFL protection in different biomes and political contexts. If FSC's approach to IFL protection is too strict, compensation of companies, tax revenues, and jobs would result in unrealistically high costs that may make abandoning FSC-certification a distinct possibility for FSC-certified companies. This is likely to negatively impact the overall area of certified forests, affecting the environmental and social benefits associated with FSC-certification. Future decisions need more careful consideration of the counterfactuals, while differentiating between IFL protection as defined per remote sensing, and IFL protection for the conservation of environmental values inside IFLs.

Logging and the opening of logging roads is incompatible with the conservation of the IFL status – by definition. Opening roads fragments the forest. If logging takes place, no matter how responsibly, the area of IFL will shrink in the short term and it will require 30 to 70 years to recover. The question is rather, under which conditions is this acceptable? FSC Motion 23/2022 called for the "use [of] landscape-wide approaches adapted to local conditions and to strengthen Standard Development Groups (SDGs) to improve protection of Intact Forest Landscapes." The motion was passed with 95% of members voting to support it, the strongest support for any FSC motion so far. With only one year after the resolution was passed it is too early to say what its impacts on the ground are, but it has initiated a policy process within FSC to include landscape approaches within its Policies and Standards.

For FSC-certified companies that will embark on collaborative, landscape approaches to find long-lasting solutions, proactive measures can be taken to facilitate collaborative efforts (Nikolakis and Wood, 2022). These include creating mechanisms to foster shared goals and increase goal specificity, addressing divisions and fostering a sense of shared identity among stakeholders, promoting transparent and effective communication, establishing accountability structures that consider the interests of both NGOs and companies, and recognizing and appropriately rewarding contributions. Strategy games that help develop counterfactuals and build agreement on how a landscape works have been proposed as an innovative approach for these discussions (Garcia et al., 2022). By implementing these measures, FSC stakeholders can actively promote meaningful collaboration between NGOs and businesses, leading to the achievement of shared objectives in IFL protection and responsible forest management.

## Data availability statement

The original contributions presented in the study are included in Praamstra et al., 2024/Supplementary material, further inquiries can be directed to the corresponding author.

## Author contributions

JZ: Conceptualization, Formal analysis, Investigation, Methodology, Supervision, Visualization, Writing – original draft, Writing – review & editing. CL: Investigation, Writing – original draft. GP: Data curation, Formal analysis, Investigation, Methodology, Visualization, Writing – original draft. JS: Formal analysis, Investigation, Methodology, Visualization, Writing – original draft. FT: Writing – review & editing. PW: Writing – review & editing. CG: Conceptualization, Methodology, Writing – review & editing.

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## Conflict of interest

JZ is an individual member of the FSC North Environmental chamber. FT is an FSC International employee. CG and PW are part of the Focus Forest project aimed at developing a framework for dialogue on Intact Forest Landscape Management within FSC membership (https://connect.fsc.org/stakeholder-engagement/focus-forests).

The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.



## Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/ffgc.2024.1335430/full#supplementary-material

SUPPLEMENTARY FIGURE S1
Global overview of the conservation burden, log scaled Management Unit (MU) size and Intact Forest Landscape (IFL) size within MUs. Conservation Burden represents the percentage overlap of MUs with IFLs. A conservation burden of 100% means the totality of an MU is inside an IFL. Datapoints are scaled to the absolute IFL area encompassed by an MU. The 10 largest are labelled with corresponding numbers in Table S1.

SUPPLEMENTARY FIGURE S2
Global overview of the conservation burden, Management Unit (MU) size and Intact Forest Landscape (IFL) size within FSC-certified MUs. Conservation Burden represents the percentage overlap of MUs with IFLs. A conservation burden of 100% means the totality of an MU is inside an IFL. Datapoints are scaled to the absolute IFL area encompassed by an MU. The 10 largest are labelled with corresponding numbers in Table S1.

SUPPLEMENTARY FIGURE S3
Conservation burden, log scaled Management Unit (MU) size and Intact Forest Landscape (IFL) size within MUs in **(A)** Central Africa, **(B)** Southeast Asia, **(C)** Canada, and **(D)** Russia. Note: FSC has suspended all certificates in Russia in April 2023 (FSC 2023). Conservation Burden represents the percentage overlap of MUs with IFLs. A conservation burden of 100% means the totality of an MU is inside an IFL. Datapoints are scaled to the absolute IFL area encompassed by an MU. The 10 largest are labelled with corresponding numbers in Table S1.

SUPPLEMENTARY FIGURE S4
Conservation burden, Management Unit (MU) size and Intact Forest Landscape (IFL) size within FSC-certified MUs in **(A)** Central Africa, **(B)** Southeast Asia, **(C)** Canada, and **(D)** Russia. Note: FSC has suspended all certificates in Russia in April 2023 (FSC, 2023). Conservation Burden represents the percentage overlap of MUs with IFLs. A conservation burden of 100% means the totality of an MU is inside an IFL. Datapoints are scaled to the absolute IFL area encompassed by an MU. Up to 10 of the largest are labelled with corresponding numbers in Table S1.

SUPPLEMENTARY FIGURE S5
Conservation burden, Management Unit (MU) size and Intact Forest Landscape (IFL) size within MUs in Brazil. Conservation Burden represents the percentage overlap of MUs with IFLs. A conservation burden of 100% means the totality of an MU is inside an IFL. Datapoints are scaled to the absolute IFL area encompassed by an MU. The 10 largest are labelled with corresponding numbers in Table S1.

SUPPLEMENTARY TABLE S1
All analyzed Management Units (MUs) with their names and associated company, classified per country and FSC certification-status. The MU size (in hectares), the IFL percentage (%) and surface area (in hectares), amount of IFL fragments (minimum size 1 hectare) and amount of IFL fragments larger than 100 hectares within the MU are given for each MU. All MUs are ranked and numbered according to the IFL size.

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