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LETTER

Conservation responsibility for bird species in tropical logged forests

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Abstract

Unprotected lands can help prevent the extinctions of species if managed carefully. Over half of the tropical forest is leased by logging companies, whereas only 6%–18% is protected. This makes the timber industry, institutions that regulate it, and consumers of its products important actors in conservation. We assessed the conservation responsibility, the proportion of a species' range that tropical timber industry concessions overlap with, for bird species that decline after selective logging. Up to 32% of the global range and up to 100% of the national range of sensitive species within our study countries are leased by logging companies. Individual concessions overlap with the ranges of up to 25 sensitive and more than 500 total bird species, with a particularly high density in Borneo. Our results can inform governments, forest managers, sustainability certifiers, and consumers so that they can turn this responsibility into a conservation opportunity through interventions at multiple scales.

KEYWORDS

avifauna, forest certification, IUCN Red List, range refinement, selective logging, threatened species

1 | INTRODUCTION

Forestry is a major land use in tropical regions worldwide. With over 400 million hectares designated for timber production, accounting for 50%–60% of all tropical forests (Blaser et al., 2011; Curtis et al., 2018), the area held in forestry concessions far exceeds the 6%–18% coverage of tropical forests by protected areas (Brooks et al., 2004). Selective logging—the principal method of timber extraction in tropical forests—causes smaller declines in biodiversity than more intensive land uses, such as clearing for monoculture plantations (Gibson et al., 2011). Selectively logged forests can act as important wildlife corridors and retain levels of biodiversity and carbon similar to unlogged forests if managed well (Burivalova et al., 2014; Feldpausch et al., 2011; Putz et al., 2012; Philipson et al., 2020).

The magnitude of the effects of selective logging on biodiversity depends on the timber harvesting methods, road density, logging intensity, length of the logging cycle, and the amount of illegal logging, hunting, and animal capture for pet trade (Bicknell et al., 2014; Benítez-López et al., 2017; Burivalova et al., 2015; Finer et al., 2014; Kleinschroth & Healey, 2017; Putz, Dykstra, et al., 2000). Importantly,

selective logging is sometimes followed by deforestation for agriculture, whereas under other conditions, it can prevent deforestation by providing a profitable use of the standing forest (Fisher et al., 2011). Given the large footprint, the tropical timber industry and related institutions can therefore tip the balance toward the survival or extinction of many species, depending on the quality of forest management and the ability to maintain forests.

To maximize the contributions of selective logging as a land use to biodiversity conservation, it is important to apportion the "conservation responsibility" to stakeholders at multiple levels, such as individual timber companies, national governments, international institutions responsible for trade regulations and best practices, and consumers. Conservation responsibility, typically used in the context of countries, is measured via the proportion of a species' geographical range that lies within a given country (Keller & Bollmann, 2004; Munteanu et al., 2018; Schmeller et al., 2014). Conservation responsibility makes abstract goals such as "biodiversity protection" tangible; for instance, "a concession is responsible for 34% of the range of the Rhinoceros Hornbill (*Buceros rhinoceros*) in a country."

In the conservation literature, there is a void between global studies revealing important trends that are rarely actionable at national scales and local studies with deep understanding at a site level that may not be generalizable at the global scale (Jarvis et al., 2020; Williams et al., 2020). Our goal is to quantify the global conservation responsibility for tropical forest bird species threatened by degradation in a way that is actionable at the international institution, national government, and individual company levels. We identify all tropical forest bird species for which published field studies consistently report a significant decline in abundance due to selective logging. For each of these species, we quantify the proportion of its global and national range that overlaps with logging concessions, taking into account the remaining habitat's quality.

2 | METHODS

2.1 | Identifying species of concern

To identify vulnerable bird species, we analyzed a pantropical database on the responses of individual species to selective logging (Burivalova et al., 2015). The database consists of studies that measured the abundance or density of species in selectively logged forests and control forests that had not been logged in recent history. Studies were included only if they fulfilled criteria such as the availability of data on logging intensity, location, and time since logging (Burivalova et al., 2015). We updated this database to include all literature published until the end of 2020 using the same search protocol (Table S1). The updated database consisted of 4469 responses for 1154 species. A publication could yield multiple responses for a particular species if it measured the responses to logging for the same species in two different countries or under two logging treatments.

The species' responses to selective logging are coded as −1, 0, or 1, respectively, signifying that the abundance of a given species in the logged forest was lower, the same, or higher than that in the control forest. In our subsequent analyses, we focused on species that always declined in abundance with logging (all entries were −1). We assigned each species a confidence value corresponding to the number of data points: a species reported by three entries had a confidence value of 3. We limited our analyses to species with a confidence value ≥2. Consequently, rare species, regardless of their response to logging, were less likely to be included in our database. We further reduced our list to species with "forest" as their primary habitat according to the IUCN Red List of Species (IUCN, 2018). Our final list contained 104 consistently declining forest bird species (i.e., about 10% of species in the database) (Tables S2 and S3).

2.2 | Spatial analyses

Spatial data on timber concessions were available for nine countries from the online platform Global Forest Watch (Table S4): Cameroon, Central African Republic, Democratic Republic of the Congo (DRC), Equatorial Guinea, Gabon, Indonesia, Liberia, Malaysia, and Republic of the Congo. No spatial data were available for South and Central American countries. We obtained the geographical ranges for our 104 species from the BirdLife International database for 2019 (Table S4). For each species that had at least 1 km^2 of its geographical range within any of the nine countries, we calculated the following:

- The proportion of the species' global range within each of the nine countries.
- The proportion of the species' range in a given country that falls within logging concessions.
- The proportion of the species' forested range in a given country that falls within logging concessions.
- The proportion of the species' intact forest landscape (IFL, Table S3) range in a given country that falls within logging concessions. IFL is defined as "forest and naturally treeless ecosystems within the zone of current forest extent, which exhibit no remotely detected signs of human activity or habitat fragmentation and is large enough to maintain all native biological diversity, including viable populations of wide-ranging species."

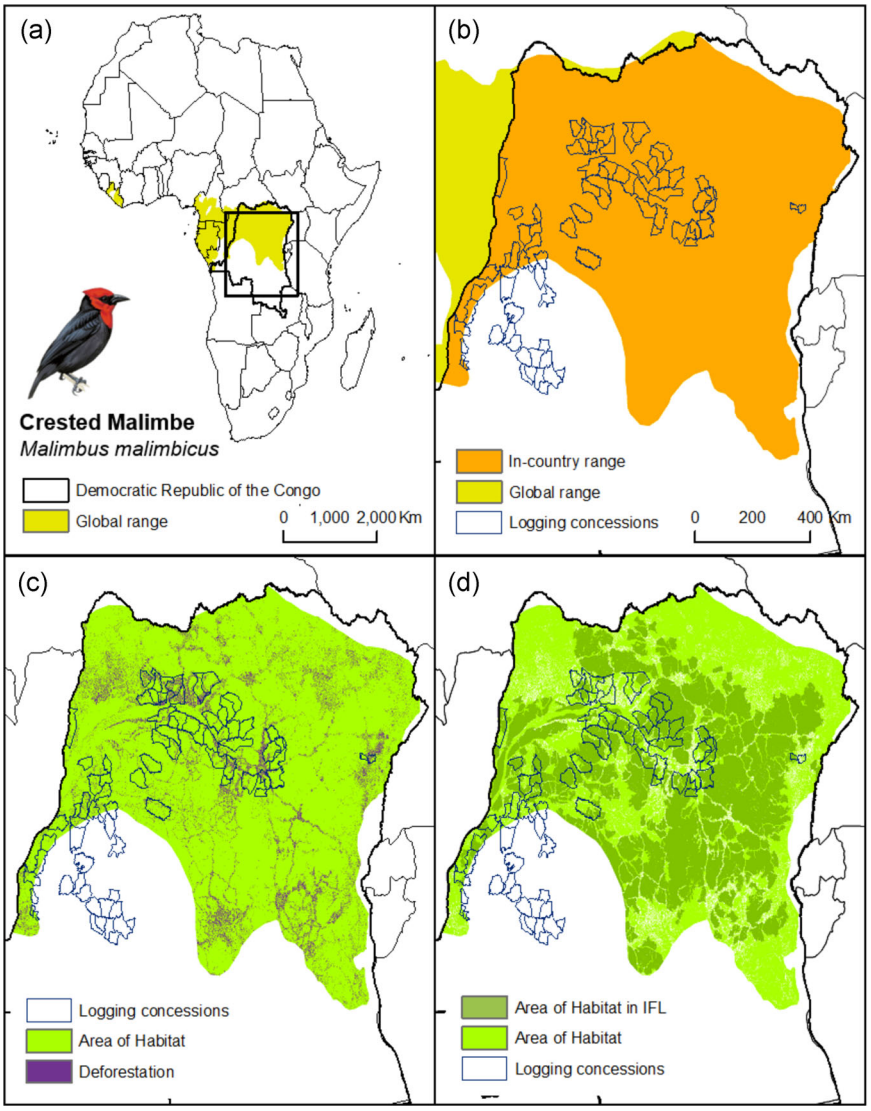

FIGURE 1 Calculation of the conservation responsibility for species that decline with logging. For each species, we calculated (a) the proportion of its global range that falls within our study countries; (b) the overlap of its in-country range with logging concessions; (c) the areas of concession overlap that have already been deforested and are unlikely to be suitable habitat; and (d) the areas of concession overlap that fall within intact forest landscapes. Example illustration of the crested malimbe (*Malimbus malimbicus*) reproduced from del Hoyo et al. (1992)

Some species may require IFL for long-term survival, and this measure can inform the debate on selective logging within them (Kleinschroth et al., 2019).

- Additionally, we quantified the total number of bird species' ranges derived from the BirdLife International database (not limited to those in our database) that overlapped with concessions to identify areas of potential geographical bias in our database. Such bias could result if some concessions overlapped with species not measured by the studies we analyzed.

To select the portion of each species' range that had forest cover, we used 30-m resolution global tree cover data, derived from Landsat (Hansen et al., 2013). We used a threshold of >60% of tree crown cover density to classify a pixel as forest to quantify the areas of forest cover within each species' range and logging concessions (Ocampo-Peñuela et al., 2016). We used the IFL layer to calculate the overlap with the species ranges and IFL within logging concessions (Figure 1). All datasets were projected to Eckert IV Equal area projection, and analyses were performed using Arc Map 10.5.

3 | RESULTS

We identified 104 tropical forest bird species that consistently declined in abundance with selective logging, 55 of which occurred within logging concessions in our study countries (Table S2 and S3). Of these 55 focal species, 15 are classified as near threatened (NT, e.g., Rufous-tailed Shama, *Copsychus pyrropygus*) and five as vulnerable (VU, e.g., Great Argus, *Argusianus argus*) in the IUCN Red List (IUCN, 2018), with the remainder classified as least concern (LC, Table S2). We found that the nine countries collectively accounted for up to 100% and on average 71 ± 32% of the 55 species' global ranges (Table S2, Figure 2). Indonesia had the highest overall conservation responsibility,

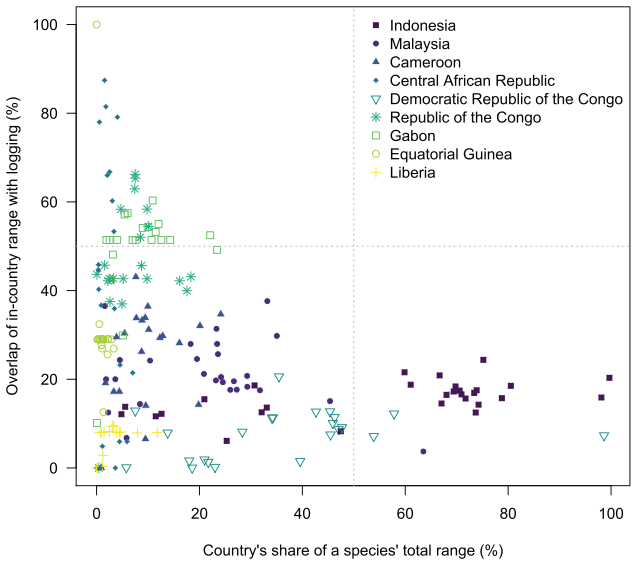

FIGURE 2 The global conservation responsibility that each country (colors and shapes) has for a particular species (*x*-axis) and the proportion of that species' forested range that falls under logging concessions within that country (*y*-axis). See Table S2 and Figure 3 for species names

encompassing ≥60% of the global range of 19 species sensitive to logging, followed by the Democratic Republic of the Congo and Malaysia (Figure 2).

In 2020, the nine study countries allocated on average 21% of their land to timber concessions, with up to 50% in Gabon and 44% in DRC. On average, 26% of a species' in-country forested range overlapped with a logging concession, with 32 species having >50% and 5 species >75% of their national range within a logging concession, respectively (Figures 2–3). The five species with the highest proportion of their national range within logging concessions were fork-tailed drongo (*Dicrurus adsimilis*) in Equatorial Guinea and Icterine Greenbul (*Phyllastrephus icterinus*), Xavier's Greenbul (*Phyllastrephus xavieri*), White-tailed Greenbul (*Baeopogon clamans*), and Crowned Eagle (*Stephanoaetus coronatus*) in the Central African Republic. Our estimates of overlap varied by up to four percentage points when we considered only the forested part of the range and up to 100 percentage points when considering only the IFL part of the species' range (Figure 3).

In Southeast Asia, the highest concentration of species that declined with logging was in Indonesian and Malaysian Borneo, with up to 25 susceptible species' ranges overlapping within a single logging concession (Figure 4). In terms of all bird species (not only those sensitive to logging), Indonesian and Malaysian concessions in Borneo also had the highest number of overlapping ranges (Figure 5). The Indonesian provinces Papua and West Papua had concessions with >323 total bird species' range overlap (Figure 5). Within the Afrotropics, Gabon, Equatorial Guinea, and Cameroon had particularly high concentrations of susceptible species within their logging concessions (Figure 4). In terms of total avifauna, all countries had at least one concession that overlapped with the ranges of >400 bird species (Figure 5).

4 | DISCUSSION

The loss of biodiversity from tropical forests is a complex socioecological issue with no simple solutions. Deforestation due to industrial food production is the most important driver of the extinction of tropical forest species (Curtis et al., 2018); forest degradation due to selective logging and the resulting loss of biodiversity is, in comparison, less severe and more reversible (Gibson et al., 2011). However, due to the large geographical footprint of selective logging (Blaser et al., 2011), even subtle changes in selective logging can have large impacts on biodiversity, presenting a major conservation opportunity. Where and how selective logging happens is a result of an interplay between timber availability and societal, political, criminal, and economic factors. We introduce spatially explicit, quantitative estimates of conservation responsibility for bird species so that biodiversity can be factored into these decisions. We note that transparent information on biodiversity is necessary but insufficient for effective conservation: ultimately, to make selective logging a land use that is as biodiversity-friendly as possible requires addressing both the demand and supply-side issues in the timber trade at a scale that remains elusive.

4.1 | Global responsibility

Countries that are globally important tropical timber producers hold large portions of the ranges of many bird species susceptible to selective logging, presenting an opportunity for improved forest management to contribute to biodiversity conservation (International Tropical Timber Organization, 2021). Indonesia, for example, harbors the majority of the global range of 20 sensitive species (Figures 2–4). Similarly, the DRC holds >1/3 of the global range of 14 sensitive species. In countries that have the largest share of global responsibility for the negatively affected species (bottom-right quadrant in Figure 2), up to 25% of the national range of these species overlaps with selective logging. If the remainder of the national ranges overlapped with protected or otherwise undisturbed forests, there might be little cause for concern. This is unlikely though—much of the remainder of Borneo, for example, is allocated to other, far more detrimental land

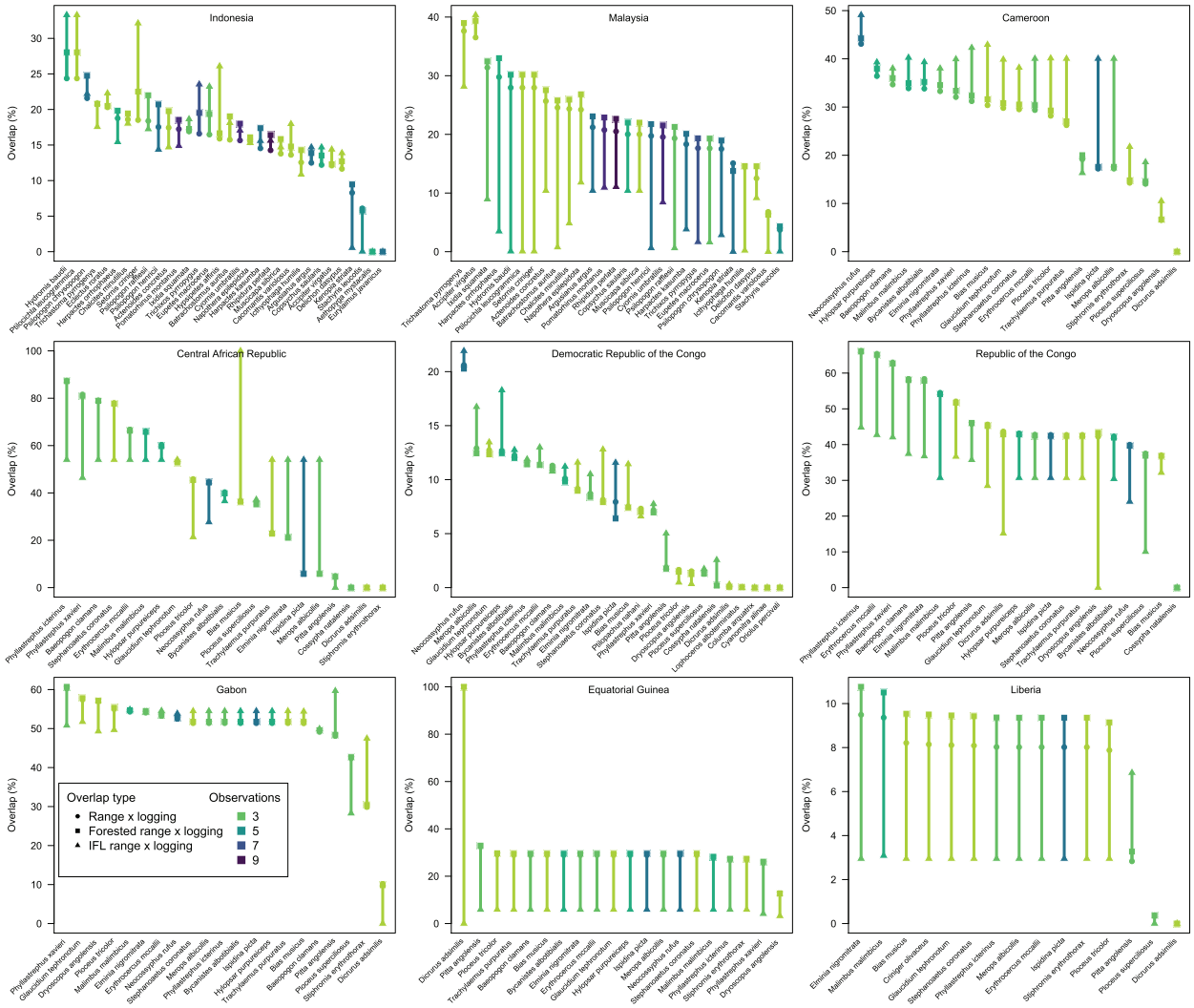

FIGURE 3 Species that consistently decline with selective logging and the overlap of (i) their range with logging concessions (circle); (ii) their forested range and logging concessions (square); and (iii) their intact forest range and logging concessions (triangles). Note that 100% represents the entire range of a species within a given country. Darker colors represent a higher number of studies associated with the species. See Table S3 for species that do not overlap with our study countries

uses, such as mining or monoculture plantations (Abood et al., 2015; Gaveau et al., 2014).

The logging industry, those involved in the international timber supply chain, national and regional governments, international bodies operating in these countries, and consumers have therefore a substantial global responsibility toward the survival of these bird species. An example of such a species is Red-tailed Ant-thrush (*Neocossyphus rufus*), currently evaluated as LC, but with a decreasing population trend (IUCN, 2018). Our study countries encompassed 85% of its global range; we found six pieces of evidence that this species declines (no evidence indicating otherwise) with selective logging—a land use that covers 34% of the 85% of its global range. For this globally declining species, at least 29% of its global range is thus in a land use that is conclusively harmful to it under conventional management (Table S2). We suggest that in future IUCN assessments, selective logging should be explicitly considered a threat to species that substantially overlap with logging concessions (Figure 3). Our analyses could serve as an early warning of declining conservation status, similar to the area of habitat metric (Brooks et al., 2019). For the 25 species in our study, selective logging might already be implicitly accounted for given their status as NT or VU.

4.2 | National responsibility

Individual countries invest resources in preventing the extirpation of species within their boundaries, in addition to contributing to the survival of a species globally. Making

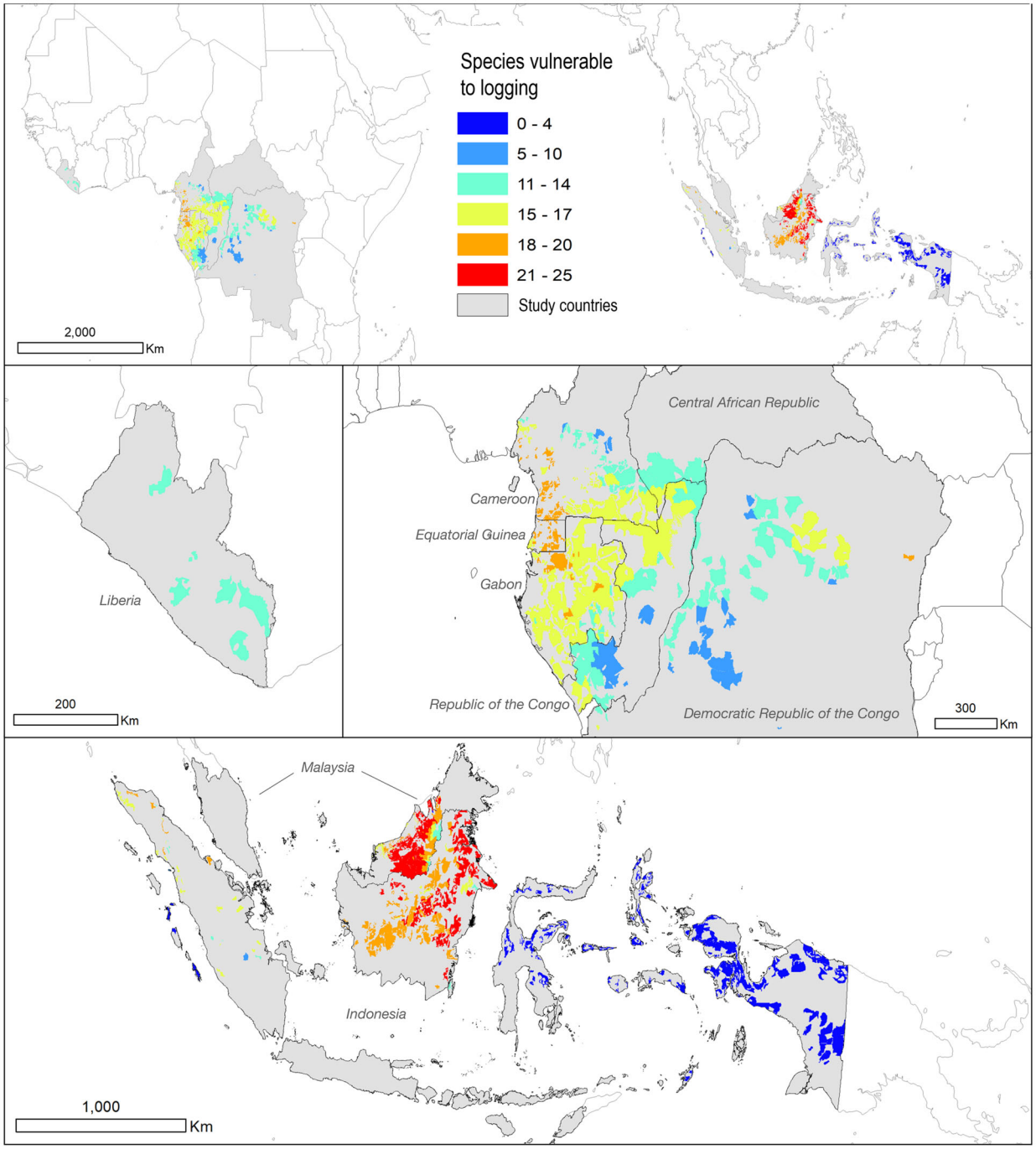

FIGURE 4 The map of study countries' logging concessions with the number of overlapping ranges of bird species that consistently decline with selective logging. Study countries (in gray) are those with publicly available logging concession extents

small changes in the logging industry has the potential to help achieve this goal; in several countries, more than half of the susceptible species' national range is within logging concessions (upper-left quadrant in Figure 2). For example, in Gabon, 13 species that consistently decline with logging have >50% of their range within logging concessions. In Equatorial Guinea, 100% of the national range of the fork-tailed drongo (*D. adsimilis*) overlaps with logging concessions (Figure 3).

Countries with a large logging sector could pioneer sector-wide regulations to mitigate threats to these sensitive species by including spatially explicit biodiversity information (Figures 4–5) in their decisions on the size, placement, and management of logging concessions

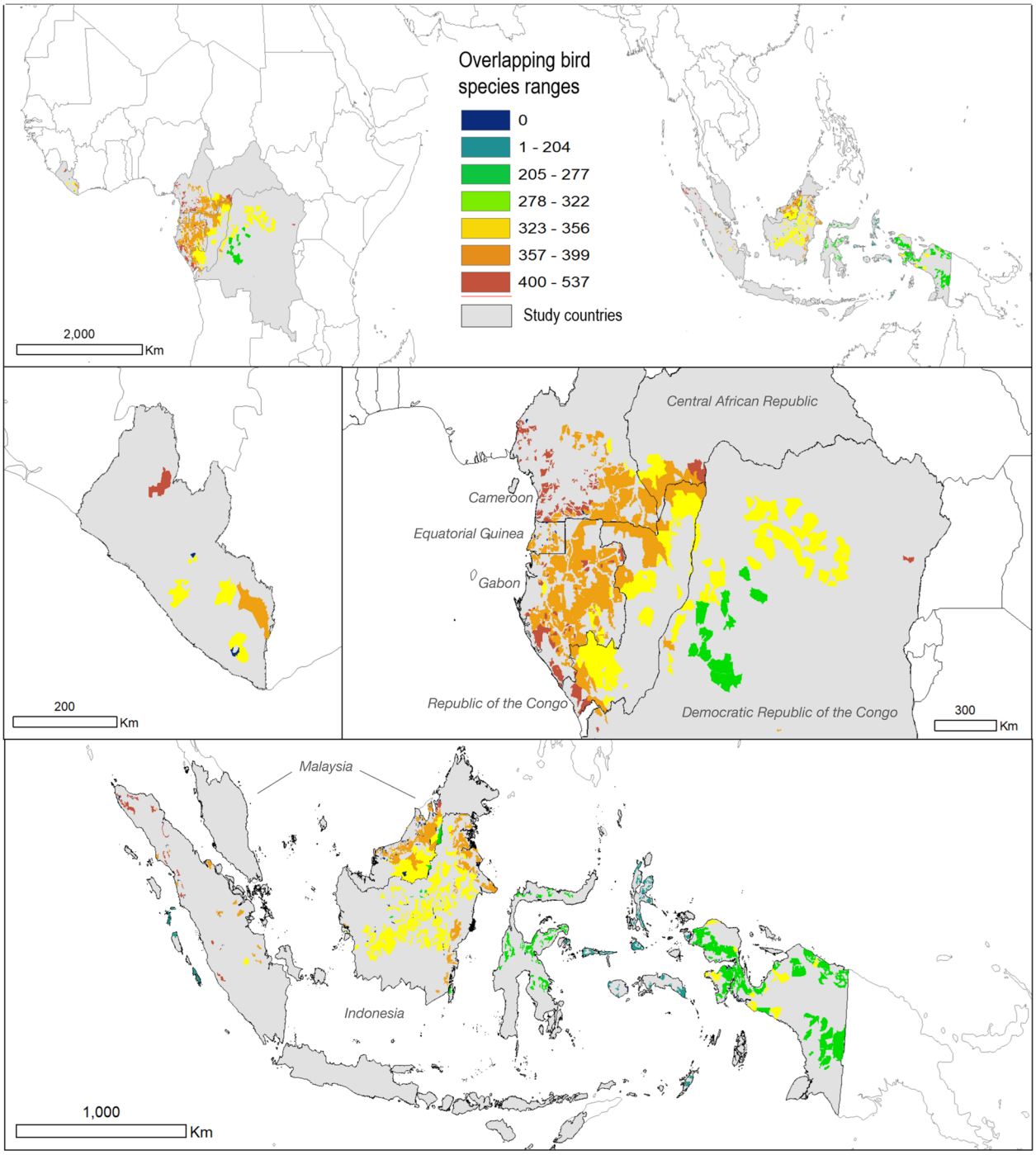

FIGURE 5 The map of study countries' logging concessions with the total number of overlapping ranges of bird species, including species whose response to logging is unknown. Study countries (in gray) are those with publicly available logging concession extents

(Griscom et al., 2018; Runting et al., 2019). Using data on conservation responsibility to their advantage, countries could offset no-extraction zones or lowered logging intensities by accessing international funds for biodiversity conservation. This could complement the sale of carbon credits, which can be generated by reduced impact logging for climate change mitigation (Ellis et al., 2019; Griscom et al., 2017; Koh et al., 2021).

Countries can also seize conservation opportunities resulting from situations where selective logging is currently not profitable at a commercial scale (Shearman et al., 2012). In Indonesian Borneo, many logging concessions important for Bornean Orangutan (*Pongo pygmaeus*) and Clouded Leopard (*Neofelis nebulosa*) populations were identified as no longer actively extracting timber (Burivalova et al., 2020). Of these, several concessions also

hold the highest overlap with bird species negatively affected by logging (Figure 4). Although such inactivity does not automatically lead to reduced biodiversity loss, it could be turned into a conservation gain if these inactive concessions were reallocated, in an equitable way, to conservation, such as through protected areas, ecosystem restoration, or other conservation measures.

4.3 | Company responsibility

At a local level, selective timber harvest can be made more wildlife-friendly by adopting low logging intensities, longer logging cycles, reduced impact logging, protecting ecological legacies such as hollow trees, and creating narrower and fewer roads (Bicknell et al., 2014; Putz, Redford, et al., 2000). Setting aside permanent conservation areas within each logging concession and avoiding logging in IFL that overlap with logging concessions also benefits biodiversity and simultaneously reduces carbon emissions (Griscom et al., 2014; Kleinschroth et al., 2017).

However, some of these interventions reduce profit margins, and price premiums from certified products are often too low to offset such losses (Araujo et al., 2009). As consumers become more aware of their environmental footprint, and if willing to pay price premiums to reduce it, companies wishing to move toward responsible management could use our results to highlight their conservation goals. With new biodiversity monitoring techniques such as bioacoustics, which are particularly suitable for tropical forest birds, such goals can become verifiable (Campos-Cerqueira et al., 2019).

Selective logging is often accompanied by increased rates of hunting and poaching, which can have more severe impacts on avifauna than the logging itself and even result in low regeneration of commercially important tree species (Rosin, 2014). It is crucial for logging companies to be proactive against the poaching of bird species for the pet trade, especially prevalent in Indonesia (Harris et al., 2016). This is challenging, as loggers sometimes resort to poaching to supplement their income or diet. Although fair wages are required under certification schemes, this requirement is not always sufficient (Cerutti et al., 2017). Poaching for pet trade is even harder to address, requiring both demand- and supply-side interventions (Challender et al., 2015; Jepson et al., 2011), but logging companies can make poaching more difficult, such as by closing logging roads after harvest (Laurance et al., 2009).

4.4 | Limitations and caveats

We only analyzed countries in Africa and Asia because spatial data on logging concessions were unavailable for Neotropical countries. However, it is clear that selective logging is also widespread in the Neotropics: Brazil produced 142,989,000 m^3 of roundwood in 2020 alone (compared to 81,300,000 m^3 produced by Indonesia in 2020), much of which comes from selective logging in tropical forests (International Tropical Timber Organization, 2021). The fact that we identified 41 species from the Neotropics that consistently decline with selective logging highlights the importance of the conservation responsibility of the timber sector in the region. We urge countries and the Forest Stewardship Council to make publicly available the boundaries of their logging concessions to increase the transparency of conservation responsibility (Schmeller et al., 2014). In many countries, such as Mexico, Nepal, or Indonesia, selective logging is practiced through community forest management (Klooster & Masera, 2000; Pagdee et al., 2006). If the spatial extent of community-managed forests becomes available, our approach could be used to apportion their conservation responsibility.

The nonuniform location of studies that documented the responses of individual bird species to logging introduced some geographical bias in our results (Table S1). For example, the provinces of Papua and West Papua in Indonesia lack studies on bird responses to logging and have substantially different avifauna from the better-studied Borneo. This results in seemingly low numbers of species vulnerable to logging there (Figure 3), which is likely an underestimate, given the high overall number of species ranges overlapping with the concessions (Figure 4).

5 | CONCLUSIONS

We quantified the conservation responsibility for tropical bird species that decline with selective logging at the company, national, and global scales. While the drivers of poor logging practices must be addressed in the long run, concessions with particularly high concentrations of susceptible bird species could be prioritized by assistance programs that can help achieve responsible forest management certification and reduced impact logging. Countries that allocate large portions of their land to selective logging could take negatively affected bird species into account when renewing logging permits and conducting environmental impact assessments. At a global scale, organizations such as the IUCN can engage with forest certification standards to include threats and potential solutions for species sensitive to logging. Transparent biodiversity metrics can inform decisions at all scales to change the large conservation responsibility of the tropical timber industry from a cause for concern to a conservation opportunity.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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