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Figure 1 | Forest elephants (*Loxodonta cyclotis*).

Ecology

Sustainable certification of forests boosts wildlife

Julia E. Fa

Is there a conservation benefit if tropical forests that are affected by logging gain certification from the Forest Stewardship Council? An analysis of the biodiversity outcomes in such tropical forests provides answers. **See p.563**

Tropical forests stand out as being the most biodiverse terrestrial ecosystems[1]. They provide essential ecosystem services, such as supplying wild meat for consumption by millions of forest dwellers[2], and they sequester carbon – some estimates suggest that tropical forests store 25% of global carbon and host 96% of the world's tree species[3]. Despite their ecological importance, tropical forests face severe threats as a result of human activities, including deforestation by small farmers, the conversion of forest to industrial agriculture and unregulated commercial logging. On page 563, Zwerts *et al.*[4] provide insights into the consequences of managing timber from tropical forests in a sustainable manner through a certification process.

According to the International Tropical Timber Organization, more than 25% of the world's remaining tropical forests are designated for timber extraction[5], and more than 3.9 million square kilometres have been allocated to selective timber harvests[6]. Licences for 'concessions' that permit selective logging – a widely used forestry practice in which only specific trees of high commercial value are harvested – are estimated[6] to have been issued for at least 20% of these forests between 2000 and 2005.

Uncontrolled logging can disrupt the composition of trees and vegetation in a forest; for example, by felling trees that provide canopy cover, and by establishing pathways through the forest. These activities contribute to the expansion of disturbed areas along the edges of the forest, which can have negative effects on biodiversity and on ecosystem health[7]. Furthermore, the presence of logging roads facilitates access for hunters, which exacerbates habitat degradation and negatively affects biological communities, particularly the large-bodied species that tend to be hunting targets[8]. Developing a comprehensive strategy to tackle the challenges presented by logging concessions in tropical forests entails advocating sustainable logging practices, backing conservation initiatives and fostering community engagement.

Various forest certification systems have been developed to address the environmental and socioeconomic challenges posed by

conventional logging, and to promote sustainable forest management. Among these schemes is one run by the Forest Stewardship Council (FSC) (see go.nature.com/43swmuc), which was founded in 1993. FSC certification aims to counteract deforestation and environmental degradation through a range of strategies; for example, closing old logging roads; prohibiting the transport of wild meat and hunting materials; offering alternative sources of protein to the employees of logging concessions; and using rangers for surveillance.

The FSC has become a globally recognized leader in forest certification. However, its achievements are a source of debate. This controversy stems, in part, from concerns that some certified forests are still managed by companies that are involved in unsustainable activities, or that have questionable human rights records (see go.nature.com/3mqewq6). For instance, a report from the environmental organization Greenpeace International[9] identified links between certain certified companies — including some bearing the FSC label — and issues such as forest loss, land conflicts and human rights violations. In this context, the term land conflicts refers to disputes or disagreements about land ownership, use or management, which might involve competing claims from parties such as local communities, Indigenous groups, governments or corporations. Other critics argue that the effect of FSC certification on tropical deforestation has been modest, and point to instances in which companies holding FSC certificates have been alleged to serve only as a cover for the illegal timber trade (see go.nature.com/3pm8tmn).

Zwerts and colleagues set out to measure the effectiveness of FSC certification in terms of protecting biodiversity across seven FSC-certified concessions and seven paired non-FSC sites in Gabon and the Republic of Congo. The authors set up motion-detecting camera 'traps' in systematic one-kilometre-spaced grids to capture animal sightings, and focused their effort on mammalian populations.

Camera traps are a valuable tool for ecological research and wildlife conservation, because they enable researchers to observe animals in their natural habitats without causing disturbance. The non-intrusive nature of the cameras also allows scientists to study elusive or nocturnal species, to monitor the effectiveness of conservation efforts and to assess the effects of human activities on wildlife.

Zwerts *et al.* gathered nearly 1.3 million photos from 474 camera-trap locations. They found that there was a notable positive relationship between FSC certification and the number of mammal encounters detected, indicating that images of mammals were captured more frequently in FSC-certified concessions than in non-FSC areas. Furthermore, fewer indications of hunting activity were observed in camera images from FSC-certified forests than in those from non-FSC ones. The estimated total biomass of mammals in FSC-certified concessions was 4.5 times higher than it was in non-FSC sites, underscoring the conservation benefits of sustainable logging practices.

The positive trends associated with FSC certification were found to be particularly pronounced for large mammals that weighed more than 10 kilograms. Encounter rates for these species were 2.5–3.5 times higher in FSC-certified concessions than they were in non-FSC areas. This highlights the effectiveness of FSC measures in protecting medium- to large-sized mammals, which have crucial roles in maintaining the health of ecosystems.

The authors also observed higher encounter rates for mammal species categorized under the Red List of the International Union for Conservation of Nature as 'critically endangered', 'near threatened' and 'least concern' in FSC-certified concessions than in non-certified sites. This suggests that FSC certification not only positively influences the overall abundance of mammals, but also benefits species that have a relatively high risk of extinction.

An analysis of encounter rates across taxonomic groups revealed specific successes for FSC-certified concessions. Forest elephants (Fig. 1), primates, even-toed ungulates (for example, forest antelopes and wild pigs) and carnivores had higher encounter rates in FSC-certified areas than they did in uncertified regions, providing evidence of the widespread positive effects of FSC certification on mammalian species. However, pangolins and rodents did not show statistically significant differences, and the explanations for this warrant further investigation.

"The positive trends associated with FSC certification were found to be particularly pronounced for large mammals."

The study highlights the beneficial outcomes of FSC certification on mammalian encounter rates and biodiversity conservation in the tropical forest sites examined. However, it remains to be determined whether similar patterns are typical of other FSC-certified sites. It is particularly noteworthy that large mammalian species, such as the critically endangered forest elephant, were found to be more abundant in FSC-certified concessions. The presence of intact communities of mammals in FSC areas allows these groups to perform crucial roles in ecological processes, such as seed dispersal, nutrient cycling and predator–prey interactions. Moreover, Zwerts and colleagues suggest that the decreased exploitation of wild meat in FSC-certified concessions, compared with in non-certified ones, could help to mitigate the risk of diseases being spread from animal species to nearby human populations (zoonotic transmission).

By harmonizing sustainable practices with rigorous conservation measures, FSC-certified concessions not only safeguard wildlife but also have a key role in promoting broad ecological stability. As we navigate the delicate equilibrium between resource use and conservation, FSC certification could be a promising driver of the sustainable future of tropical forests, and could complement the conservation efforts of protected areas.

At present, FSC-certified forests constitute around 11% (5.8 million hectares) of the total surface area of harvested tropical timber in the Congo Basin, spanning the Republic of Congo (2.9 million hectares), Gabon (2.2 million hectares) and Cameroon (0.69 million hectares). Through initiatives aimed at fostering collaboration between public and private enterprises, the FSC aims to expand its certification label to encompass all forest concessions in Gabon. This would amount to a total of 15 million hectares of forest by 2030, a substantial increase from the current 2.2 million hectares. Gabon, with a total of 22 million hectares of forests, holds the distinction of being the most forested country in the Congo Basin. When combined with the roughly 22.6 million hectares of protected rainforests in Central Africa (equivalent to 14% of its surface area), the FSC-certified forests would make a key contribution to meeting the targets laid out in the Kunming–Montreal Global Biodiversity Framework during the COP15 international biodiversity summit in Montreal, Canada. Among the agreed goals of this conference, which brought countries together to discuss and establish targets for conserving biodiversity, was to ensure that a minimum of 30% of the world's land and oceans is protected by 2030, to preserve biodiversity and maintain the health of ecosystems.

It should be noted that the conclusions of this study, compelling as they are, relate specifically to the comparison between FSC-certified and non-certified forests. The findings do not provide insights into how operations in FSC-certified regions compare with those in other types of protected habitat. Therefore, although the study can be used to make broad arguments in favour of the conservation benefits of FSC certification, it is not an excuse to open untouched, formerly unprotected areas of tropical rainforests to certified logging.

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Condensed-matter physics

Light makes atoms behave like electromagnetic coils

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Microscopic magnetic fields form in non-magnetic materials when light makes the atoms rotate. A similar macroscopic effect has long been known, but proof of its atomic equivalent could give rise to ultrafast data processing. **See p.534 & p.540**

Many electronic devices require precise control of the intrinsic angular momentum of electrons — their 'spin', a property that can point either up or down. Future computers will probably also rely on spin, and their effectiveness will depend on how fast the spins can be flipped. Modern technologies achieve such switching using current-induced magnetic fields on a timescale of nanoseconds, but ultrashort laser pulses could, in theory, flip spins a million times faster, in a matter of femtoseconds. On pages 534 and 540, respectively, Basini *et al.*[1] and Davies *et al.*[2] report that laser pulses can be used to make the atoms in a material orbit around their positions in a crystal lattice, inducing magnetic fields that could aid rapid spin switching.

Magnetizing an object by applying a magnetic field can make it rotate — a phenomenon known as the Einstein–de Haas effect[3]. This is because the spins in the constituent material initially point in different directions, and the field magnetizes the material by making most of its spins point in the same direction, thereby changing the total angular momentum of the system. But the laws of physics dictate that momentum is always conserved, and this requirement results in a rotation of the sample.

This much has been known for more than a century[3], but it wasn't until a decade ago that physicists proposed that collective circular atomic vibrations, known as chiral phonons, could have a key role in the mechanism on ultrashort timescales[4,5]. These vibrations have an inherent chirality (or handedness) because the circular motions of atoms create a helical pattern as a phonon propagates through the material. Experiments soon confirmed that chiral phonons are indeed involved in the Einstein–de Haas effect: demagnetizing a magnetic material by means of a high-intensity laser pulse was shown to induce chiral phonons and mechanical strain[6,7].

The flip side of the Einstein–de Haas effect is that manually rotating a disordered magnetic material can generate a magnetization inside the material (Fig. 1a), a phenomenon, known as the Barnett effect[8], which was first described in the same year that the Einstein–de Haas effect came to light. Basini *et al.* and Davies *et al.* revisited the Barnett effect to investigate whether chiral phonons could also lead to magnetization. The teams studied different materials, and both found spectroscopic evidence that chiral phonons produce a macroscopic magnetization arising from the circular motions of atoms — giving rise to a phenomenon that can be thought of as a phonon Barnett effect (Fig. 1b).

Basini *et al.* used an approach called a pump–probe experiment, in which laser pulses are used to excite (or 'pump') phonons in a material, and then a second set of pulses 'probes' the material's response. The authors excited chiral phonons in strontium titanate, a non-magnetic insulator, using light that was circularly polarized, meaning that its electromagnetic field rotated in a plane perpendicular to its direction of motion. They then measured the extent to which the polarization of femtoscale probe pulses was rotated when these pulses interacted with the induced magnetization of the strontium titanate. The team found that a transient magnetization developed on a timescale of a few picoseconds (1 ps is 10^{-12} seconds), corresponding roughly to the lifetime of the excited phonons.

Davies *et al.* also performed pump–probe experiments, using circularly polarized pump pulses to generate chiral phonons in non-magnetic insulating substrates made from synthetic sapphire and a silicate-based

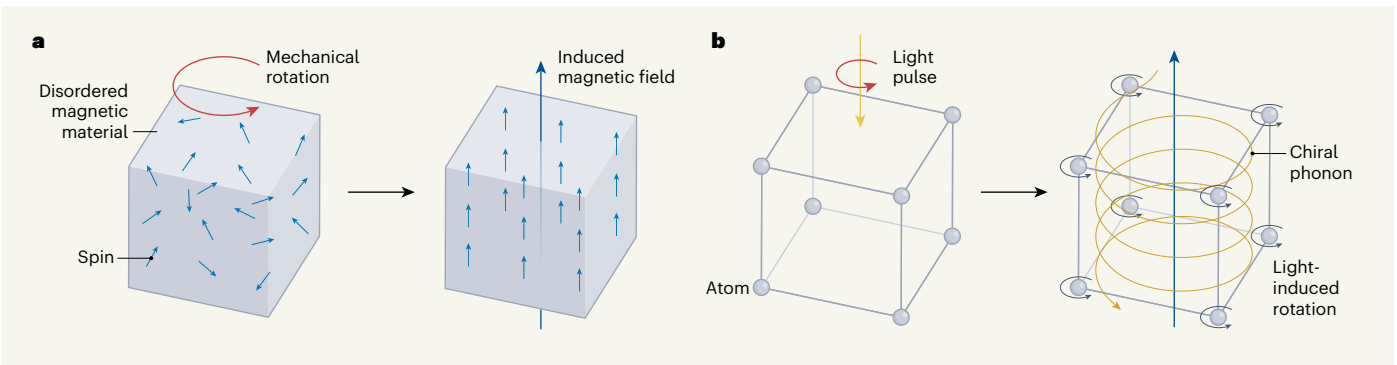

Figure 1 | Magnetic fields on atomic length scales. a, Rotating a disordered magnetic material can make the intrinsic angular momenta (spins) of its electrons align, resulting in a magnetization inside the material, which is known as the Barnett effect[8]. **b**, Basini *et al.*[1] and Davies *et al.*[2] showed that a similar effect can also occur on an atomic scale: light pulses that are circularly polarized (meaning their electromagnetic field rotates in a plane perpendicular to their direction of motion) can make the atoms in a non-magnetic material form collective circular vibrations called chiral phonons. These circular motions induce microscopic magnetic fields in a way that is reminiscent of the mechanism by which an electric current in a coil of wire generates a magnetic field. The resulting atomic-scale fields could be used to increase the rate at which spin states are flipped in electronic devices and computers.