LETTERS

Incorporating measurements from individual trees, such as those taken by this scientist in Ghana, can increase the accuracy of forest carbon estimates.

Edited by Jennifer Sills

Editorial Expression of Concern

In the 4 June 2010 issue, *Science* published the Report "FCHo proteins are nucleators of clathrin-mediated endocytosis" by W. M. Henne *et al.* (*1*). The editors and authors have been made aware of potential data integrity issues in several figures. We are alerting readers to this concern while we work with the institution and the authors to determine an appropriate course of action.

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Spatial resolution for forest carbon maps

Forests are central to climate solutions (*1*), and transparent and accurate data on forest carbon stocks and fluxes are critical for scientists and decision-makers. Satellite-based forest carbon maps have recently proliferated from public agencies such as NASA and the private sector. These maps have tended toward ever-higher spatial resolutions. However, higher spatial resolutions increase the uncertainties of carbon maps, rendering products at very high spatial resolution largely meaningless for forest carbon monitoring.

Many new satellites can resolve fine features on the landscape, and even some individual trees outside forests (*2*), but this resolution (0.3 to 5 m) is too high for mapping forest carbon. Forest carbon has a natural resolution constraint: the size of an individual tree. To create these maps, tree data from the ground are required because there is no direct measure of tree carbon nor any way to accurately divide trees into smaller components from space (*3*). Typically, a plot the size of some desired mapping resolution is created in a forest, within which trees are measured and converted to carbon estimates, summed, and combined with satellite data to develop statistical models used to map forest carbon. It is not possible to map (or validate) forest carbon with meaningful accuracy at resolutions higher than the area of the forest plot data used to create a map (*4*).

Because most carbon in a forest is stored in large trees (*5*–*7*), map resolutions should at minimum exceed the crown diameter of a typical large tree, which ranges from about 10 m for temperate forests to about 20 m for tropical forests (*8*). To minimize other sources of uncertainty that increase at high resolution (*9*, *10*), forest plots that include many trees should be at least 0.25 ha (50 m) and ideally 1 ha (100 m) in tropical forests (*11*) and at least 0.1 ha in boreal and temperate forests (*12*). Maps should not be downscaled to higher spatial resolutions given that a map's values and uncertainties are only meaningful at their original resolution.

By adhering to these resolution guidelines, map users can make informed decisions about the data used to monitor forests as nature-based climate solutions, and map producers can make useful maps. Any satellite-based product should undergo rigorous and transparent validation before it is used for operational monitoring, including the generation of forest-based carbon credits. Without aligning forest carbon map resolution with forest plot data, we cannot accurately quantify carbon in the forest or in the trees.

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Tanzania's effective trophy hunting laws

In their Letter "Stop elephant hunting in Tanzania borderlands" (19 July 2024, p. 265), J. Poole *et al.* object to recent killings of elephants by trophy hunters on the grounds that the targeted animals were important to population sustainability and were part of a long-term research study in Kenya. Although we agree that this elephant population is crucial to species conservation, we consider only collared elephants to be under study, not the entire subpopulation or all elephants monitored, and we do not agree that the handful of elephants killed by trophy hunters puts the population at risk. Poole *et al.* also suggest that Tanzania should make exceptions to the United Nations (UN) Principle of Permanent Sovereignty over Natural Resources, essentially ceding management of the elephant population to Kenya, but the UN principle has no exceptions and applies universally and equally, unless a bilateral agreement has been established and agreed upon by partner states.

Trophy hunting in Tanzania is well-regulated and complies with the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Tanzania's conservative annual quota of 50 elephants (*1*) for trophy hunting represents less than 0.1% of the country's elephant population (*2*). Between 2018 and 2023, only 38 elephant bulls were hunted in Tanzania (*3*), instead of the approved quota by CITES of 300 elephants for the 6 years. Trained wildlife officers, professional hunters, and village game scouts accompany trophy hunters and identify appropriate targets on the basis of age and sex (*4*). Hunters are permitted to kill only males with tusks that weigh at least 20 kg or measure at least 160 cm (*2*). Although killing animals wearing collars or otherwise marked for research is not formally prohibited, the accompanying professionals are trained to understand the importance of avoiding such animals as targets.

Poole *et al.* argue that the targeted "super tuskers" are important to population growth, but most mature bulls sire offspring starting at about 25 years old (*5*), and most super tuskers (elephants with tusks that weigh more than 45 kg each) are between 45 and 55 years old (*6*) and are nearing the end of their natural life cycle of about 70 years (*7*). Therefore, elephants approved as hunting targets have likely already been breeding for at least 20 years. If not hunted, such elephants are often killed in human-elephant conflicts (*8*). Given that males gain in dominance rank as they age (*9*), old bulls prevent young bulls from breeding effectively. Therefore, trophy hunting allows young bulls to breed earlier, contributing to increased genetic diversity (*5*).

Trophy hunting benefits conservation and community development (10, 11). Revenue from trophy hunting accounts for 55.5% of the money that the Tanzania Wildlife Management Authority invests in conservation (12), whereas photographic tourism accounts for only 21.1% (12), Special Wildlife Investment Concession Areas (SWICA) account for 12.9%, and other sources (such as sport fishing, resident hunting, and the Tourism Development Levy) account for 10.5% (12).

Elephants that are part of research studies provide important data for conservation and management, including information about reducing human-elephant conflicts. To help protect elephants under research, researchers in Kenya and Tanzania could alert one another when research elephants with GPS collars or known body markers (such as a broken or single tusk) move into another country. By sharing knowledge, countries can jointly monitor research elephants and save them from trophy hunters. Cross-border coordination framework laws have successfully improved cross-border biodiversity management in the Maasai Mara–Serengeti ecosystem (13).

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A path to US Tribal energy sovereignty

Native American Tribal lands are extraordinarily rich with energy and mineral resources. A rapidly changing energy system, increasing energy demand, and energy-related national security imperatives present Tribes with a generational economic opportunity. If the federal government respects Tribal sovereignty, resource extraction and related projects such as natural gas development, power plants, and data centers on Tribal lands can help create economic prosperity. Tribes could benefit from choosing to become better networked and integrated into domestic and global supply chains.

Despite making up only 2% of the US land base, Tribal lands contain 50% of US uranium reserves (*1*) and enough wind and solar energy generation potential to produce $75 billion in project investment (*2*). Nearly all US reserves of critical minerals needed to manufacture batteries, wind turbines, and electric motors are on or near Tribal reservations, including 97% of nickel, 89% of copper, and 79% of lithium (*3*).

Centuries of violence, colonialism, and systematic oppression by the federal government have deeply eroded Tribal sovereignty and trust (*4*). Laws such as the 1887 Dawes Act stripped land from Tribes, and the legacy of energy and mining on Tribal lands is rife with financial exploitation, human rights abuses, broken treaties, and dire environmental and health impacts (*5*, *6*). Although poverty and education levels have begun to improve in some cases, the pace and scale of these changes remain insufficient (*7*).

Tribes electing to engage in energy and mineral development on their lands face challenges with roots in these historical injustices. Bureaucracy and outdated federal regulations hinder Tribes' ability to invest efficiently and effectively and impede their access to wider markets. Because scientific and economic resource analyses of Tribal lands are sparse, Tribes are often unaware of the scale of their opportunities. Limited organizational and technical capacity constrain Tribes' ability to develop new projects and access government funds (*8*). Many Tribes lack the necessary administrative capabilities, institutions, and technically trained workforces to fully use the energy resources on their own lands (*8*).

A statue stands on Southern Ute Indian Tribal lands, home to sophisticated natural gas operations.

To improve relationships and support vibrant Tribal societies, US federal and state governments must center Tribal communities' desires, acknowledge historical injustices (*9*), and support Tribes as they address skill gaps and expand workforces and infrastructure. Tribes must have the right to lead development projects and ensure that jobs and economic opportunities remain within Tribal communities (*10–12*). In addition, Tribes must be empowered to apply their expertise, values, and traditional knowledge to resource development and infrastructure development.

Although challenges remain, collaborating to pursue mutually beneficial aspirations represents an important opportunity to improve relations between the US government and Tribal Nations. As an example, producing and refining critical minerals in Indian Country could support US energy and security goals as well as provide Tribal Nations and people with enhanced sovereignty and increased economic well-being. Development and incorporation into domestic and global supply chains (*13*) would give Tribes access to substantial revenue streams outside of gaming and tied to the modern economy. Tribes might then choose to invest their earnings and capital into a diverse portfolio and take advantage of wider economic opportunities.

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