Received: 29 February 2024 | Revised: 21 March 2025 | Accepted: 6 April 2025

DOI: 10.1111/cobi.70118

Conservation Biology

CONTRIBUTED PAPER

Community-based timber comanagement and the boundaries of people-centered conservation in Brazil

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Article impact statement: Thoughtful actor engagement yields positive organizational, operational, and socioeconomic timber comanagement outcomes in reserves.

Funding information
Rufford Foundation Small Grant; School of Forest, Fisheries, and Geomatics Sciences; UF Research Abroad for Doctoral Students Grant; International Tropical Timber Organization (ITTO) Fellowship Program; UF Center for Latin American Studies; IdeaWild; UF Tropical Conservation and Development Program

Abstract

Brazil's protected areas for sustainable use represent a massive shift in conservation policy that operationalizes the widespread global trend for governments to share resource management rights, responsibilities, and benefits with local communities via comanagement. ICMBio's Normative Instruction 16/2011 guides communities in comanagement of timber in the protected areas in which they live. We assessed this norm operationalization and governance in 7 timber comanagement projects in 3 Amazonian extractive reserves. We conducted 52 semistructured interviews with 39 community and 13 external actors who represented government, timber market operators, private forest service providers, and nongovernmental organizations. Interviews were complemented with archival research, participant observation over 15 months, and assessments of timber comanagement processes and outcomes in 5 community workshops. The state consistently fulfilled its administrative role to approve community forest management plans and subsequent annual timber operational plans. It approached its more ambiguous comanagement responsibilities on a case-by-case basis. When complementary and supportive external actors were part of timber comanagement decision-making, better organizational, operational, and socioeconomic outcomes ensued, particularly in cases with strong intracommunity organization. Where trusting partnerships were cultivated, community members and external actors reported more positive perceptions of timber comanagement processes and outcomes. We also found that different actors influenced active and horizontal community engagement in governance, management of conflicts, integration of local management know-how, and hybrid benefit-sharing that satisfied reserve residents. While our results illustrate timber comanagement complexities, insights extend well beyond operational timber technicalities, shedding light on comanagement pathways for other biodiversity products (e.g., fisheries, non-timber products) within sustainable use protected areas that epitomize people-centered conservation.

KEYWORDS

benefit-sharing, comanagement, community forestry, environmental governance, extractive reserves, protected areas, sustainable use, timber, tropical forestry

INTRODUCTION

Since the 1990s, legal reforms to decentralize forest governance and enhance forest tenure security in the tropics have transferred significant rights from government to Indigenous peoples and local communities (Larson et al., 2010). Globally, Afro-descendant (AD), Indigenous peoples and local communities (IPLCs) are estimated to have grounded territorial claims to over 50% of terrestrial lands, compared with 10% of terrestrial lands that governments have legally recognized AD and IPLC ownership rights (RRI, 2020). In Latin America and the Caribbean specifically, IPLCs govern nearly 380 million ha of forests (FAO, 2023); Brazil accounts for the majority (FAO, 2023; RRI, 2014). These locally held forest rights may be best understood as a diverse bundle of rights, extending from simple permission to pass through a forest (access), to those that enable extraction of specific resources (withdrawal), to those that involve decision-making into the future (management) (RRI, 2014). Regardless of the specific bundle of rights communities may hold, state devolution of control and power is typically

only partial (Cronkleton et al., 2012). Government usually maintains total or partial control over land use rights to ensure their ability to oversee, monitor, and evaluate how local people use forest resources, such that collaborative (or comanagement) systems have been established (Cronkleton et al., 2012; Gnych et al., 2020; Sikor, 2006). Comanagement refers to a process wherein multiple actors negotiate to define key management responsibilities, rights, and benefits over an area or set of natural resources (Borrini-Feyerabend et al., 2013; Carlsson & Berkes, 2005; Cronkleton et al., 2012). Negotiations vary widely across cases and result in a diversity of power-sharing arrangements. As the number of communities that have (partial) rights to manage forests has increased, so too has the number that engage with timber management (Gilmour, 2016; RRI, 2012).

Timber is the most financially lucrative of all tropical forest products, at least in the short term (Ezzine-de-Blas et al., 2009). Timber harvests can also help diversify livelihood options, enhancing household resilience in the face of fluctuating markets (Humphries et al., 2020; Miteva et al., 2025). Managing timber sustainably, however, is widely considered to be technically challenging. Compared with nontimber harvests, it presents much greater risks to forest structure, composition, and function (Piponiot et al., 2019), particularly in the tropics where tree species richness is extremely high and conspecific densities are exceedingly low (Putz et al., 2001). This means that of all forest uses, logging typically results in the most severe impacts on ecosystem services (e.g., carbon stocks and water) (Roopsind et al., 2017). Notoriously, conventional logging, particularly in tropical forest frontiers, has been widely documented to open roads that promote deforestation (Fearnside, 2005; Holmes et al., 2002). However, when community-based logging has been well-planned and executed in communities where land tenure is well-defined and in-migration is low, logging infrastructure can improve information and product flows with minimal forest cover loss (Chomitz, 2007; Porter-Bolland et al., 2012). In Brazil, with government and communities as central actors, timber comanagement has been operationalized, even in Amazonian reserves designated for sustainable use (i.e., some protected areas are logged).

Long considered the cornerstone of biodiversity conservation, protected areas traditionally prioritized the separation of people and conservation targets, sometimes leading to physical and symbolic erasure of former residents (West et al., 2006). Critics of this type of fortress conservation argue that excluding local communities is misguided (Neumann, 2015). It often led to violent conflict, changed how local people related to their surroundings, and constrained valuable traditional knowledge and practices (West et al., 2006)—assets to sustainable resource management and biodiversity conservation. In contrast, of the 1.23 million km^2 of protected areas in Brazil, half are designated for direct use, whereby sustainable extraction of renewable natural resources is allowed and supported (Josse et al., 2021). These extractive reserves, sustainable use reserves, and national forests integrate Indigenous peoples as partners in conservation and exist "explicitly because of people, and not despite them" (Eringhaus 2005, p. i).

These people-centered protected areas represent a massive shift in conservation in which the government shares resource management rights, responsibilities, and benefits with local communities. Comanagement of timber, with its sizeable and tightly coupled rewards and risks, uniquely stretches conservation boundaries. Boldly, timber comanagement in Brazil's sustainable use protected areas has been operationalized, offering an exceptional opportunity to examine the extent to which collaborative management has lived up to its conceptual promise, even when centered on a challenging resource, such as timber. Conducting a comparative analysis across 7 timber comanagement projects in 3 Amazonian extractive reserves, we explored the extent to which different comanagement actors shaped and were satisfied with comanagement rights, operational responsibilities, and benefit accrual. We asked what variations in timber comanagement have emerged and why; how did local communities and external partners perceive collaborative timber management arrangements distinct to each case; and what was their level of satisfaction with the execution of logging activities and outcomes of timber management? Few studies provide detailed and comparative analyses of the operationalization of comanaged systems, particularly as it relates to timber resources. Further, such analyses are rarely linked to rigorous assessment by the diverse comanagers who have to live with the results of resource comanagement decisions.

METHODS

Research design

We adopted an embedded multiple-case study design (Yin, 2009) to combine a variety of in-depth studies on timber comanagement and identify underlying patterns that were contextually not dependent (Ezzine-de-Blas et al., 2009, 2011). Our comparative analyses were guided by Normative Instruction No 16/2011 (hereafter Norm 16/2011), which outlines specific rules for the comanagement of timber resources in select units of Brazil's 24,255,600 ha of sustainable use protected areas in the Amazon (Miranda et al., 2020; Santos, 2017). This norm was established in 2011 by the Chico Mendes Institute for Biodiversity Conservation (ICMBio), the government agency that oversees federal protected areas management, and includes the resources in the sustainable use areas, such as timber. The ICMBio can make cooperative technical and financial agreements with both governmental and nongovernmental organizations (NGOs) at its various levels of organization.

At the national level, ICMBio's office accommodates diverse divisions and technical coordination roles. At the extractive reserve level, ICMBio maintains local offices with at least 1 managing director of the given protected area and environmental analysts, the latter vary in number depending on ICMBio's budget. It is this local office that also organizes and presides over Deliberative Councils for each sustainable use reserve. Councils include government actors at diverse levels, researchers, private sector actors, and community leaders. Norm 16/2011

was established to improve responses to contextual conditions of forest communities by distinguishing community-based timber projects from industrial logging (Kluvánková et al., 2018; Schmink, 2004) based on 3 main concerns: organizational (e.g., social organization and community participation), operational (e.g., logging intensity and practices adopted to harvest trees), and socioeconomic (e.g., financial viability and benefit-sharing) (ICMBio No 16, 2011).

Under Norm 16/2011, ICMBio assumes overall responsibility to analyze, approve, and oversee community-based timber comanagement projects. Decision-making and timber harvesting activities are to be conducted by resident communities, although with ICMBio approval, they can also contract service providers to implement some activities that required heavy machinery, such as skidding, loading, and transporting logs (Santos, 2017). As required by all state agencies, Norm 16/2011 requires implementation of reduced-impact logging (RIL) techniques designed to plan timber harvesting operations and minimize environmental impacts on standing forests and forest soils (ITTO, 2004). These include preharvest inventories, defined harvest intensity, cutting cycles, skid trail planning, and liana cutting. Norm 16/2011 also requires a financial viability assessment to be approved by ICMBio and a collective benefit-sharing proposal for the whole community, whether they are collectively involved in logging activities or not (Santos, 2017).

Finally, Norm 16/2011 dictates that community-based associations are to be legally responsible for the timber project. Overall, the new norm reinforces government recognition of local forest management rights by resident populations and simplified timber management regulations in sustainable use reserves and provides new government investment in timber comanagement and formalization of community logging enterprises (Miranda et al., 2020).

We used 3 criteria to select community-based timber comanagement projects (hereafter timber projects) for inclusion in our study: located in a sustainable use protected area, approved under Norm 16/2011, and completed at least 1 timber harvesting season. Seven communities met these criteria (Appendix S1) in 3 distinct Brazilian Amazonian extractive reserves: Chico Mendes (CMER), Ituxi (IER), and Verde para Sempre (VSER). These communities are located in the states of Acre, Amazonas, and Pará, respectively (Appendix S2). Although all projects operated under Norm 16/2011 with ICMBio oversight, each reserve varied by predominant forest types, main resources commercialized, and the number and year of timber projects approved (Appendix S3).

Data collection

Data were collected from May 2018 to September 2019 following professional interactions in these regions and sometimes with these specific communities since 2011. Group activities in communities and semistructured individual interviews with community members and external partners were supplemented with local archival research and participant observation to triangulate data and provide greater contextual depth (Baxter and Jack, 2008; Yin, 2009). Given the centrality of communities in timber comanagement, A.L.V.E. spent significant portions of these 15 months of dedicated fieldwork building trust with community-level (or internal) actors (i.e., extractive reserve residents). These residents varied by subgroup (community leaders, local association representatives, active forest workers, gender, age), degree of participation in their respective community timber project, and by their individual interests (Agrawal & Gibson, 1999). This lengthy time frame also allowed for clear identification of external actors (used interchangeably with external partners) who were most intimately engaged with timber comanagement in each of the 3 reserves. These included government actors, who played a core role, and other outsiders (local representatives from NGOs, research institutes, and timber markets) who intensively supported timber comanagement efforts, bringing additional technical support, capacity building, and funding (Barsimantov, 2010).

Although our research methods were consistent and complementary across sites, we acknowledge some data collection limitations. For instance, both semistructured and group interviews provided data based on research participants' perceptions that did not perfectly match the 3 topical categories that reflected Norm 16/2011 concerns: organizational, operational, and socioeconomic. We complemented our data analyses with secondary data sourced with permission from community archives, ICMBio reports, and participant observation. Within these acknowledged research limitations, we sought to showcase context-specific natural resources governance for the Amazon region and the Brazilian institutions, but other countries and tropical regions in the world could learn from our comparative study. Appendix S4 contains a list of actor classifications, definitions, and examples.

Community-level group activities

Group activities were carried out during 5 events: 1 each in CMER and IER, and 3 in VSER. For each of the 5 events and with community consent, we used volunteer sampling (Brick, 2011) to recruit adult participants above 18 years old and advertised through communications with community leaders, community associations, local schools, and religious groups. A total of 135 participants attended (CMER, 29 attendees; IER, 23; VSER, 83), with an average of 27 people per event. Participants were fairly evenly divided between men and women. We used a participatory approach (Chambers, 2002) with group discussions to encourage joint analyses (Morgan, 1996) (Figure 1) and critical reflection among community participants (Arnold & Bartels, 2014; Slocum et al., 1995). Group events took an average of 8 h to complete; the longest lasted 15 h, and the shortest 6 h.

After opening with a community timeline activity, we used a spider web configuration tool (Laverack, 2006) to assess timber comanagement arrangements, logging activities, and perceived outcomes. This tool provides a visual representation of measurable perceptions in a concise format that can be complemented with interviews to better understand the logic behind measured

FIGURE 1 Application of the spider web configuration tool at the individual level with an (a) external actor and at the (b, c) community level to gather perceptions on timber comanagement arrangements and logging activities and outcomes regarding community timber comanagement in the studied extractive reserves (Photo by A.L.V.E.).

TABLE 1 Indicators used to gather perceptions of timber comanagement arrangements and logging activities in 3 Brazilian Amazonian extractive reserves.

Topic and indicator	Description of indicator
Timber comanagement arrangements	
collaborative organization for decision-making	degree of satisfaction with the way internal and external actors structured themselves to make decisions.
collaborative organization for logging activities	degree of satisfaction with the way internal and external actors structured themselves to execute logging activities.
community participation in decision-making	level of participation of internal actors in decision-making.
community leadership	extent to which community leaders represented interests of reserve residents.
integration of local timber harvesting methods	extent to which local timber harvesting methods were integrated in the timber project.
participative assessment of timber harvesting	extent to which internal and external actors collaboratively assessed last harvest to improve the next one.
internal-external conflicts	degree to which conflicts arose between internal and external actors of the timber project.
logging activities and outcomes	
logging area	size and location of the area designated for the logging activities was appropriate.
logging operations	operations and equipment used (skidder, other) for logging activities was appropriate.
community participation in logging operations	level of internal actor participation in logging activities.
environmental impacts	extent to which area designated for logging was impacted.
income	degree to which income generation from timber sales for internal actors was satisfactory.
collective benefits	degree to which benefits from logging accrued to the entire community.
internal conflicts	degree to which conflicts arose between internal actors of the timber project.

rankings (Laverack, 2006). It also foments a comparative assessment of all measured variables, of what is similar and different, and provides an overall visual assessment of the entire suite of variables. Following previous studies that applied this tool (Gibbon et al., 2002), we first identified a set of 7 indicators for each of 2 topical foci: timber comanagement arrangements and logging activities and perceived outcomes (Table 1). Indicators were based on preliminary data collected from May to July in 2017 during exploratory research and a review of relevant literature with particular reference to natural resources comanagement (Borrini-Feyerabend et al., 2013). Indicators were finalized during the first months of the 2018 field season. With 7 key indicators for each topical foci identified, each indicator was plotted in a spider web configuration and assigned even values ranging from low (0) to high (10), effectively resulting in a 5-point Likert value. We used even values to make it easier for research participants to assimilate the activity given their mental models. For instance, the number *dez* (or 10) in Portuguese is a symbolic value for something exceptionally good or positive. On the opposite end of the range, *zero* (or 0) has a symbolically strong meaning of absolute negativity.

In each of the 5 group events, community participants were first paired to rank the respective 7 indicators of each of the 2 focal topics (Table 1). Each pair then joined another to generate a configuration that represented their 4-person group. They then joined another small group, until ultimately, 1 large group was formed with all community event participants. At this last stage, 2 large banners with 2 blank spider web configurations were displayed so that all could assess the indicators together. Two community members were invited to moderate this final group assessment. We observed the assessment without intervening. These final ratings, derived from all meeting participants at the last stage, were used to represent insider values. For VSER, we averaged the ratings of the 3 big group community assessments to represent VSER insider values. Toward the end of each of the 5 events, we applied a follow-up questionnaire to

determine the reasons for the assigned scores of each indicator, recording group responses.

Individual interviews

In-depth semistructured individual interviews were conducted with 39 internal (22 men, 17 women) and 13 external actors. In extractive reserves, we used snowball sampling (Heckathorn, 2011) to first identify and interview community leaders (first tier) (Penrod et al., 2003), who then indicated names of key reserve residents (second tier). Second-tier interviewees sometimes recommended additional participants for interviews. We followed this procedure until reaching a saturation point (Malterud et al., 2016). Respondents were asked to recommend interviewees based on the following criteria: reserve residents who were participating in the timber projects, reserve residents not participating in the projects but who were immediate neighbors of those who did, and reserve residents interested in participating but had not yet done so. A guided questionnaire was developed based on an exhaustive literature search of dimensions, factors, and conditions which define community timber management and ultimately covered 4 topics: demographic and socioeconomic information at 3 levels (household, community, and extractive reserve); general information about community timber management, including previous resident experience with commercial logging and resident participation in decision-making and timber management activities; external support (financial, technical) of the timber projects; and financial viability of the projects and benefit-sharing agreements.

The 13 external actors who were individually interviewed were all men and included representatives from government (7), private forest service providers (2), NGOs (3), and timber markets (1). They were chosen based on their detailed understanding of and involvement with the studied timber projects. We used the same guided questionnaire and followed the same procedures as with community members (internal actors), with 1 exception. When interviewing each external actor, we also individually applied the spider web configuration tool to gather external perspectives on each of the 2 topical foci: timber comanagement arrangements and logging activities and perceived outcomes (Table 1 & Figure 1). For these external actors, we averaged the individual values related to each reserve and for each indicator of the 2 focal topics to ultimately represent outsider values for each of the 3 reserves. Individual interviews were recorded with permission from internal and external participants and took an average of 90 min to complete; the longest lasted 4 h, and the shortest 30 min.

Archival research and participant observation

To cross-check and complement data collection, we conducted archival research of documents in possession of the community association board related to each of the 7 timber projects. These documents included the sustainable community forest management plan, annual timber operational plans, economic feasibility studies, and postexploratory timber reports. We used these documents to gather information on timber production volume, tree species logged, surface area logged, timber production costs, and timber markets. We also reviewed community meeting minutes and the constitutions of community associations to cross-check information and better understand reserve residents' participation in timber decision-making and management activities. Finally, participant observation of community activities over a 15-month span, including logging and community meetings, was applied during overnight stays in all study communities in each of the 3 reserves. Observations also occurred during 1 Deliberative Council meeting. All field data collection methods complied with research ethics overseen by the University of Florida's International Review Board (approval IRB201800341) and by the Brazilian Ministry of Environment (SISBio 62191-1).

Data analyses

We applied thematic analysis (Flick, 2009) in 4 steps to investigate variations between timber projects. We first created open codes to broadly describe the timber projects with MAXQDA 2020 (VERBI Software, 2019) from transcribed individual interviews and community timeline activities in each reserve. Second, to focus on timber comanagement variations, we grouped codes into relevant themes. Third, these themes, which emerged directly from the interviews, were cross-checked with literature that defined community timber management. This resulted in a short list of key variables that highlighted variation in timber comanagement among the extractive reserves and the 7 community timber projects. Finally, these key variables were organized into 3 topical categories that reflect Norm 16/2011 concerns: organizational, operational, and socioeconomic (Appendix S2 contains a short list of key variables and references).

From ICMBio archival data, we identified progress toward measured environmental outcomes of the timber projects over the years. We analyzed ICMBio's field-based evaluation of post-timber harvesting reports that are mandatory for ICMBio's approval of the annual timber operational plan. Based on a technical normative established by the Brazilian Institute of the Environment and Renewable Natural Resources (IBAMA, Federal Normative No. 3, 2001), these field data collected annually by ICMBio staff reflect environmental requirements, which, if met, ICMBio authorizes the project for the subsequent annual timber harvesting season. Through scrutiny and analyses of the mostly quantitative data contained in these annual reports, we felt confident of their rigor and used this secondary data to reflect environmental outcomes of the timber projects.

To determine the degree to which internal and external actors represented statistically different perceptions of timber comanagement arrangements and activities and outcomes, we first calculated the standard error of the mean by reserve with the spider web configuration rating scores obtained from the 2 comparison groups by reserve. To supplement quantitative findings and better understand the rationale behind the rating

scores, we transcribed the recorded follow-up individual interviews with external actors and internal actor group meetings into Microsoft Word documents. Thematic coding procedures (Flick, 2009) were used for interpretive analyses of recorded transcripts. We looked for statements that explained the reasons for the actors' scores for each indicator.

RESULTS

Variations in timber comanagement

Guided by the concerns that Norm 16/2011 was designed to address, we identified a suite of organizational, operational, and socioeconomic variables that differed between the 7 community-based timber comanagement projects (Table 2). See Appendix S5 and the accompanying text explanation (Appendix S6) for comprehensive details.

Comparative internal and external actor perceptions

Generally, based on average values, internal actors from VSER perceived timber comanagement arrangements more positively than IER and CMER: VSER = 8.0, IER = 6.9, and CMER = 6.0 (Figure 2a). The highest internal actor indicator values from CMER and VSER were internal-external conflicts, with 8.0 and 9.3, respectively, suggesting low conflict levels (10, least conflict). In IER, the most highly ranked value was integration of local timber harvesting methods (10.0), the highest value for any indicator across all topics and cases. The lowest indicator value shared by internal actors from CMER and IER was 4.0 for assessment of annual timber harvesting and participation in decision-making, respectively. In VSER, the lowest ratings were well above the midpoint rating at 7.3 each for participation in decision-making, leadership, and assessment of annual timber harvesting (all rating scores in Appendix S7).

Average VSER external actor values (8.5) suggested that they perceived timber comanagement arrangements more positively than CMER (7.0) and IER (6.8) external actors (see Figure 2b). The CMER external actors ranked leadership highest, with 8.0. In IER, 3 indicators received the highest values of 7.3 each: organization for decision-making, participation in decision-making, and integration of local timber harvesting methods. In VSER, 3 indicators also ranked equally highest at 9.0 each: organization for decision-making, organization for logging activities, and integration of local timber harvesting methods. The lowest outsider indicator in both CMER and VSER were conflicts, with 6.0 and 7.5, respectively, suggesting that external actors perceived more internal-external conflicts than internal actors from these 2 cases. In IER, external actors also scored conflicts with the lowest value of 6.0, the same as their rating of the assessment of annual timber harvesting.

Just as with timber comanagement arrangements, internal actors from VSER perceived logging activities and outcomes more positively than internal actors from CMER and IER (Figure 3a) based on average values of all indicators: VSER = 7.3, CMER = 5.7, and IER = 5.7. The highest indicators valued by CMER internal actors were collective benefits and internal conflicts (again, suggesting low conflict levels), with 8.0 each. In IER, it was environmental impacts and collective benefits, each with 8.0. In VSER, it was logging area, logging operations, and environmental impacts. The lowest indicator (2.0) by both CMER and IER internal actors was income. In VSER, 2 indicators received the lowest internal ratings of 5.3 each: income and collective benefits (7 all rating scores in Appendix S7).

External actors from VSER also perceived logging activities more positively than CMER and IER external actors (Figure 3b) based on average values for all indicators: VSER = 7.1, CMER = 6.2, and IER = 6.1. Both CMER and IER external actors ranked environmental impacts highest at 8.7, whereas in VSER, it was logging operations (9.0). The lowest CMER external actor indicators were logging area and participation in logging operations, at 4.7 each, whereas in IER and VSER, it was income, at 3.3 and 5.0, respectively.

Secondary data from ICMBio's field-based evaluation on the posttimber harvesting reports showed that all timber projects met the Brazilian federal technical requirements regarding environmental impacts on forests. This signals that the timber projects applied RIL techniques satisfactorily and used planned and controlled implementation of timber harvesting operations to minimize environmental impact on standing forests and forest soils. The adoption of RIL components included preharvest inventories, defined harvest intensity, cutting cycles, skid trail planning, and liana cutting.

Standard errors (SE) of the mean rating scores by case studied indicated that for timber comanagement (Table 3), CMER and IER internal and external actors had more divergent ratings (SE values differed more between their respective comparison groups) than VSER internal versus external actors. For logging activities and perceived outcomes, SEs of internal and external rating scores also indicated that CMER and IER internal and external actors had more divergent ratings than VSER.

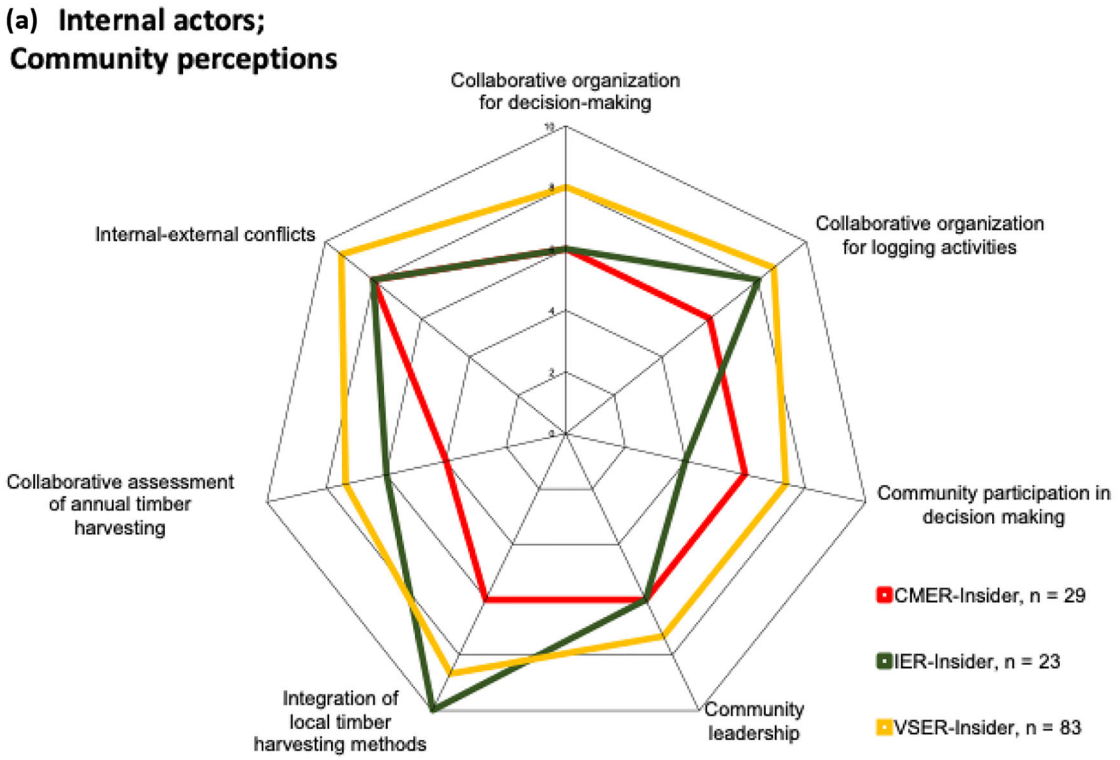
DISCUSSION

Our comparative analyses of collaborative management in 3 Amazonian extractive reserves demonstrated that even when operationalizing the harvest of a challenging forest resource, such as timber, comanagement can yield positive perceived outcomes. Our findings affirmed the complexity of managing timber resources in protected community forests and offered insights into the various ways comanagers tackled that complexity. Underscoring the extent to which community-level and external actors were satisfied with timber comanagement arrangements and logging activities and outcomes, our insights extend well beyond operational technicalities to shed light on broader possible comanagement pathways. Although we highlight the roles of central actors (government and communities), we also stress that when the state and communities integrated and cultivated trusted partners with complementary and supportive skills, both community members and

TABLE 2 Comparative results of organizational, operational, and socioeconomic variables used to assess differences in timber comanagement among the 7 community timber projects in 3 Brazilian Amazonian extractive reserves.[a]

Variables	Extractive reserve		
	Chico Mendes	**Ituxi**	**Verde para Sempre**
Organizational			
intracommunity organization timber project units	9 rubber estates, 97 total family landholdings; 7 associations	5 sectors; 15 households or less with kinship ties per sector; 1 association	5 communities of 15–50 households with kinship and/or religious ties; 5 associations
in situ decision-making forums	monthly meetings in 2 estates only	sector coordinator represented interests in 5-sector joint monthly meetings	association representatives in monthly meetings
engagement with external actors[b]	high with the state-level agencies medium with private forest service providers low with ICMBio and NGOs	high with ICMBio and nongovernmental organization (considers Timber Working Group) medium with state-level agencies low with private forest service providers	high with nongovernmental organization and private forest service providers medium with ICMBio (but did participate in Forest Management Group meetings) low with state-level agencies
Operational			
government approval of timber management documents	delayed approval of technical documents for CMER	timely approval of technical documents	timely approval of technical documents
timber management arrangement	community association and its members sold timber as standing trees to an external actor and had minimal participation in timber sales	community association executed all logging activities, retained control over timber sales, and processed sawn timber	community association hired external actor for some logging activities (e.g., skidding) and retained control over timber sales
operational coordination and decision-making	1 local timber project coordinator	sole association president usually also general timber project coordinator	association presidents usually also general timber project coordinators
resident participation	5 timber workers employed from CMER; other timber workers were outsiders	19 timber workers, all from IER	127 timber workers, all from VSER
women's participation	none	32% (6 of 19 timber workers)	26% (33 of 127 timber workers)
previous timber skills	no	yes	yes
hours of reduced impact logging training received	32	96	127 (for each project)
logging area distribution	discontinuous	continuous	continuous
logging area size (ha)	24,589	1400	40,600 (total) Por-Ti-Meu-Deus: 2421 Espírito-Santo: 4187 Ynumbí: 5814 Paraíso: 6921 Itapéua: 21,259
Socioeconomic			
economic efficiency of timber harvesting[c]	low	low	high
average timber income per timber worker per year (US$)	338	100	515
benefit-sharing agreement	individual	hybrid	hybrid

[a]Abbreviations: CMER, Chico Mendes Extractive Reserve; ICMBio, Chico Mendes Institute for Biodiversity Conservation; IER, Ituxí Extractive Reserve; VSER, Verde para Sempre Extractive Reserve.
[b]Level of external partners engagement to technically support the timber projects, from higher (i.e., participating in community meetings decision-making processes) to lower (i.e., providing minimal guidance by distance).
[c]Economic efficiency of timber harvesting meaning the percentage ratio of timber volume harvested versus authorized to harvest by the government.



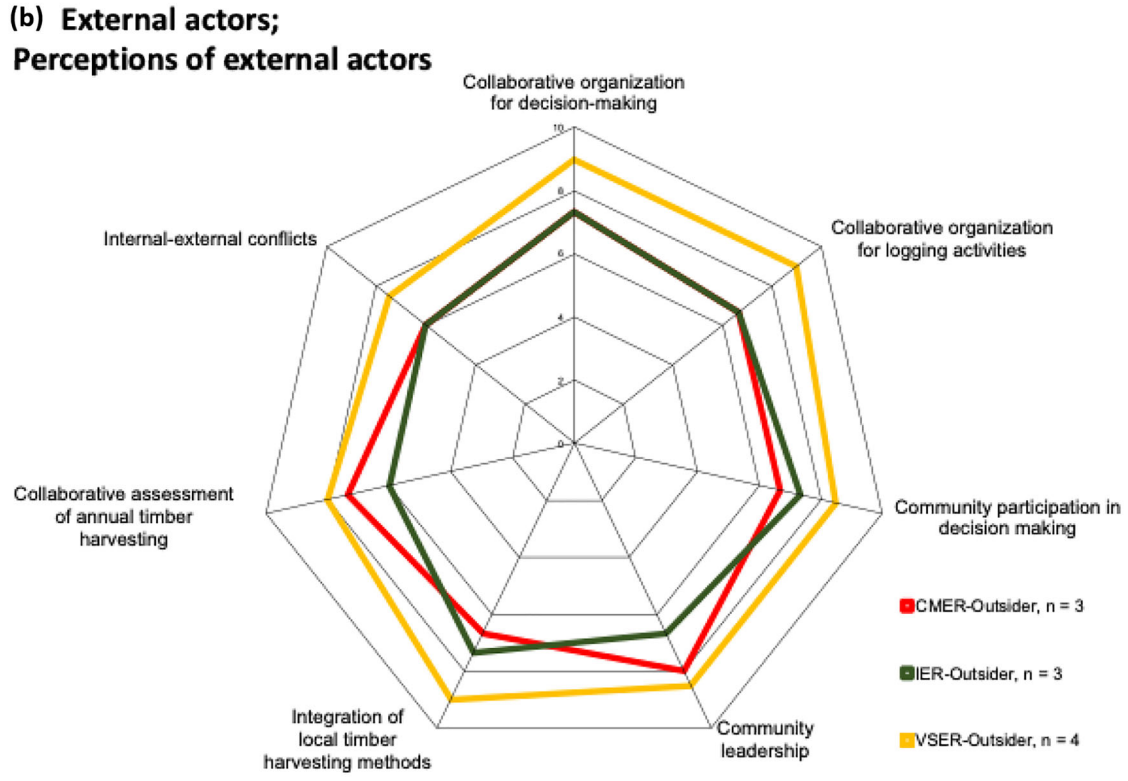


FIGURE 2 Visual representation of perceptions of timber comanagement arrangements between (a) internal actors and (b) external actors from each of 3 extractive reserves (0, comanagement is terrible or unsatisfactory; 10, comanagement is very good or satisfactory; CMER, Chico Mendes Extractive Reserve; IER, Ituxí Extractive Reserve; VSER, Verde para Sempre Extractive Reserve).

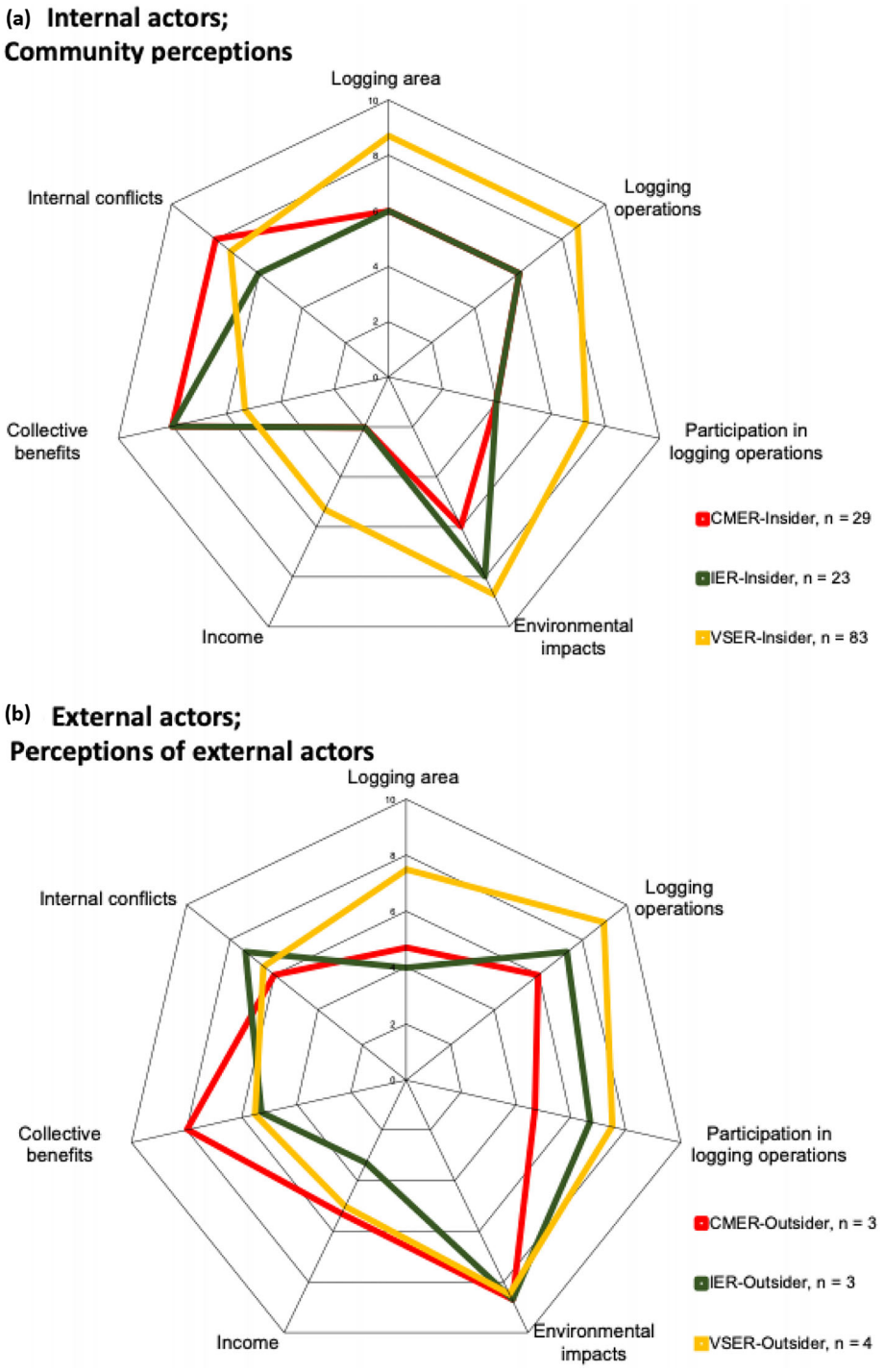


FIGURE 3 Visual representation of perceptions of logging activities and outcomes between (a) internal actors and (b) external actors from each of 3 extractive reserves (CMER, Chico Mendes Extractive Reserve; IER, Ituxí Extractive Reserve; VSER, Verde para Sempre Extractive Reserve).

external actors reported more positive perceptions of timber comanagement processes and outcomes (VSER findings). Our comparative analyses also highlighted how different actors could influence active and horizontal community engagement in governance, avenues to manage inevitable conflicts, integration of local management know-how, and hybrid benefit-sharing that satisfied reserve residents.

Role of government

The ICMBio had a clear legal role to manage Brazil's national-level protected areas, including the 15,126,400 hectares of Amazonian sustainable use reserves (Miranda et al., 2020; Santos, 2017). Charged with expanding reserve resource management to include timber, ICMBio solicited community and

TABLE 3 Standard errors of the mean of internal and external actor rating scores from the timber comanagement perceptions and logging activities and perceived outcomes.

Indicator	CMER, Acre	IER, Amazonas	VSER, Pará
Timber comanagement			
collaborative organization for decision-making	0.9[a]	0.9[a]	0.7[a]
collaborative organization for logging activities	0.5	0.9[a]	0.2
community participation in decision-making	0.5	2.3[c]	0.8[a]
community leadership	1.4[b]	0.5	0.8[a]
integration of local timber harvesting methods	0.5	1.9[b]	0.2
collaborative assessment of annual timber harvesting	2.3[c]	0.0	0.5
internal-external conflicts	1.4[b]	1.4[b]	1.3
Logging activities and perceived outcomes			
logging area	0.9[a]	1.4[b]	0.8[a]
logging operations	0.0	0.9[a]	0.2
community participation in logging operations	0.5	1.9[b]	0.1
environmental impacts	1.9[a]	0.5	0.1
income	2.3[c]	0.9[a]	0.2
collective benefits	0.0	1.9[b]	0.1
internal conflicts	1.4 [b]	0.9	0.6[a]

[a]Values of standard error of the mean of the internal and external actors differed among case studies from 0.5 to 1.
[b]Values of standard error of the mean of the internal and external actors differed among case studies from 1 to 2.
[c]Values of standard error of the mean of the internal and external actors differed among case studies by 2 or more.

NGO input to develop Norm 16/2011, fulfilling its role to establish timber comanagement guidelines that it considered to be elaborated from the ground up. In all 3 cases, ICMBio also fulfilled its very clear administrative role to approve timber management and annual logging operational plans under Norm 16/2011. Although this norm represented a step forward to build technical capacity and accountability skills in forest communities, in line with recommendations from a decade of scholarly and practitioner debates (Gilmour, 2016; Sabogal et al., 2008), the definition and completion of other state responsibilities were more ambiguous. Because ICMBio is understaffed (Boakye, 2020), has undergone budget and personnel cuts over time (Vale et al., 2021; Veríssimo et al., 2011), and does not hold specific technical and socioeconomic expertise crucial to collaboratively make decisions with community partners to comanage timber resources (Holmes et al., 2002), it has had to find approaches to address community needs for both financial and technical assistance, particularly in the first critical years of timber management (Ezzine-de-Blas et al., 2009; Humphries et al., 2020).

In both IER and VSER, ICMBio, particularly at the local office level and in partnership with the community associations, integrated external comanagement actors, such as NGOs, with specialized skills in RIL, commercial timber management, and community engagement. In 2 reserves, we uncovered evidence that ICMBio and the community associations acknowledged their limitations and cemented the formation of 2 interorganizational working groups—a timber working group in IER and a forest management group in VSER. Additionally, in the cases of IER and VSER, the local ICMBio office was located in close physical proximity to participating logging communities (Espada & Sobrinho, 2019) and shared its offices with the respective local community associations. This eased practical interorganizational support and may have enabled ICMBio to better understand association and timber comanagement challenges and opportunities (Espada & Kainer, 2024), making a clear difference in efficiencies and outcomes.

In contrast, CMER's community association was not even located in the same municipality as the local ICMBio office, which had a very small office staff to administer this ~1 million ha protected area. As ICMBio was unable to engage effectively, the state government of Acre gained space, providing massive financial support to CMER's timber project, which was accompanied by power over timber decision-making (Espada & Kainer, 2024). The state government of Acre had a long history of forest development policies targeting sustainable management (Kainer et al., 2003), making significant investments to produce commercial timber from community areas (Castelo, 2020, 2016). During the time frame of our study, however, recommended progressive capacity building (Barsimantov, 2010) and other measures for community members to take ownership of timber comanagement activities were not forthcoming. Instead, the state government of Acre hired an external private forest service provider to execute the CMER's timber project.

Although overly dominant government comanagement actors can negatively affect community efforts to sustainably manage forests in the long-term (Agrawal & Chhatre, 2007; Boakye, 2020), we argue that subsidies by government and other actors were essential, particularly in the first critical years of a formal community forest enterprise (Humphries et al., 2020). Norm 16/2011 induced a shift from informal to formal (legal) logging and precipitated integration of new formal institutions (or rules) with informal traditional norms—a critical blending of institutions that evolved over time and interacted in diverse and complex ways (López-Vargas et al., 2023). In our cases, administrative and possibly even financial government subsidies were needed, as was specialized expertise to improve community members' technical timber management skills and to support them in addressing larger managerial issues. These included navigation of both formal and hierarchical processes under comanagement systems (Agrawal & Chhatre, 2007), increasing the likelihood of acceptable outcomes for communities and government alike. Similar appropriate levels of external support were crucial for key innovations in community-based forest concessions of the Maya Biosphere Reserve in Guatemala (Taylor, 2012) and in natural resource comanagement in the Cardoso Island State Park, Brazil (Sattler et al., 2015).

Rights, responsibilities, and effective integration of community-level actors

Previous logging and timber management experience go a long way to developing skilled community participation in timber comanagement. Community timber workers can bring local practices and contextual forest conditions into timber comanagement (Klooster, 2002) and can use their timber knowledge assets to collaboratively problem solve in complex timber comanagement settings (Carlsson & Berkes, 2005). Like other Amazonian forest-based communities, residents in 2 of our studied reserves had been logging informally for local use for generations, and this knowledge base was integrated. Both IER and VSER internal and external actors indicated that local timber harvesting methods had been integrated into timber comanagement arrangements (Table 2 & Appendix S7). Additionally, both IER and VSER community associations partnered with the local ICMBio office to bring in NGO technical support, filling a community-level knowledge gap on reduced impact logging and managing forests for commercial timber markets. In contrast, internal and external actors in CMER agreed that local know-how had limited integration (Table 2 & Appendix S7), likely due to a lack of previous logging history and because community members were not engaged in day-to-day timber comanagement operations.

Although participation of community members in technical decisions is a good thing, preeminence of community leaders can inhibit acquisition of technical experience and administrative decision-making by other community members. Similarly, external organizations can also overvalue community leaders. Caveats of focusing on community leaders in decentralized forest governance systems were also observed by Persha and Andersson (2014), wherein elite capture of forest harvest benefits was more likely to occur in forests that had been decentralized for more than 6 years. However, these authors also reported that the presence of external actors can potentially reduce the likelihood of elite capture by revealing the need to create, for instance, diverse coordinator positions to split tasks among community members and other mechanisms to decentralize leadership (Ezzine-de-Blas et al., 2011). Furthermore, involvement of a larger suite of timber workers in logging decisions can benefit the comanagement arrangement because community members are not homogenous in their interests, knowledge, and motivations (Agrawal & Gibson, 1999). Greater and varied involvement of local timber workers in 2 of our reserve cases was associated with higher ratings for logging activities and perceived outcomes, especially by insiders (Figure 2).

Collaborative management of extractive reserves, including comanagement of timber resources under Norm 16/2011, does not differentiate use rights by gender, opening the possibility of women's participation in timber comanagement. In 2 of our reserve cases, women were gradually allowed to participate in local timber worker trainings that, with strategic allocation of resources and the support of transformative processes, moved some of them from cooking to strategic decision-making (Espada & Kainer, 2023). Evidence shows that enhanced conservation education and training can benefit forest user groups typically excluded or marginalized in community forestry, such as women (Westermann et al., 2005).

Community access and organization of decision-making meetings can also increase the representativeness of local resource users, particularly if they are geographically dispersed. In CMER, decision-making meetings were not accessible to all timber comanagement participants. This seemed to have weakened internal relations between rubber estates and excluded community members from estates who were less socially organized from participating fully in decision-making. In contrast, IER and VSER community associations methodically organized accessible decision-making meetings, promoting deeper and broader levels of community participation and better capture of responsibility and control over the timber projects (Espada & Kainer, 2024). Based on a 51-country analysis of 643 cases, Hajjar et al. (2020) reported that such a positive increase in rights following government formalization of community forest management is less common than positive income- and environmental-related outcomes. Benzeev et al. (2023) demonstrated that land managed under Indigenous forest use regimes has the potential to conserve forest resources and that those Indigenous lands with secure tenure improved forest outcomes and local livelihoods. Yet, communities that achieve their rights and assert them can leverage their initial assets (or capitals) over the years to obtain even further investments from partners and projects (Humphries et al., 2022). Finally, forest communities that create local and accountable institutions with fair representation of all community members are much more likely to succeed in community forestry in general (Charnley and Poe, 2007), particularly in comanagement systems

wherein interests of external actors can dominate the comanagement regime (Cinner & Huchery, 2014; Cronkleton et al., 2012).

Solid and positive collaborative partnerships

When the 2 central comanagement actors of government and local communities lack financial, technical, or other types of expertise, they can effectively engage other comanagement actors to fill those gaps. Both IER and VSER community associations partnered effectively with external actors to create linkages with research institutes, local timber buyers, and NGOs, even solidifying a Timber Working Group and Forest Management Group, respectively. Such thoughtful linkages can improve community technical skills (Humphries et al., 2015, 2020) and community participation in all stages of timber management activities (Ezzine-de-Blas et al., 2009). In our study, the VSER partnerships stood out because both internal and external actors in this case expressed remarkable symmetry in their perceptions of timber comanagement arrangements and logging activities (Table 3 & Appendix S7). These results can be related to an interorganizational working group led by the local grassroots organization and the 5 community association presidents. In VSER, the Forest Management Group (for details, see Miranda et al. [2019] and Miranda et al. [2022]) was formed to strengthen community timber comanagement initiatives in this protected area. This interorganizational arrangement also reflected a resourceful organization involving all 5 timber projects to execute logging operations, thereby splitting costs and reinforcing the community associations' negotiation power with regional timber industry buyers. For VSER research respondents, the timber comanagement arrangement between the community association leaders, local grassroots organization, and the external organizations, including ICMBio, was considered essential to address the complexity of uniting the 5 community timber comanagement projects.

Humphries et al. (2015, 2020) also found that close community partnerships with government agencies and NGOs were critical factors in the financial and local livelihood successes of a community-based timber cooperative and an innovative collective benefit-sharing agreement established with external actor support. Appropriate NGO participation in the Indian Joint Forest Management program also resulted in greater collaboration between the government staff and local people, including forest-based women (Elias et al., 2020). Similarly, Mello and Schmink (2017) found that NGOs were crucial for women to succeed in forest-based economic activities in the Brazilian Amazon. In our cases, we also found that some spaces for women were created by NGOs and their donors, but these partners also had to overcome gender-biased social norms to provide opportunities for transformative agency (Espada & Kainer, 2023).

We observed several key principles for building solid and long-term community relationships (Mishra et al., 2017) in our IER and VSER cases: a community of practice (Arts & de Koning, 2017) established over 10 years based on solid social interaction among actors (Barsimantov, 2010); sustained field presence through joint activities, such as logging operations; and mutual respect (Stern & Baird, 2015; Stern & Coleman, 2015). Nonetheless, comanagement partnerships involving government and local communities can come with caveats (Persha & Andersson, 2014). For instance, as evidenced in CMER, a sole focus on community members directly involved in an initiative can neglect building presence and transparency with the entire community (Mishra et al., 2017). Finally, as we observed, when the government lacks financial or specific technical expertise, it can effectively engage other comanagement actors to fill these gaps in close coordination with community managers.

Timber income and benefit-sharing

One of the main questions in scholarly debate about community forestry is whether community timber projects can be financially viable based on timber sales income (Humphries et al., 2020; Pokorny & Pacheco, 2014). The primacy of logging income was evident in our CMER community residents when they were deciding whether, as in Cooper and Kainer (2018), "to log or not to log." Although these reserve residents anticipated the logging projects' first harvests, community supporters of logging most frequently listed income (79%) as a positive aspect of the anticipated timber project, whereas nonsupporters most frequently listed the offered stem prices as the most negative aspect. Income generation from timber comanagement continued to be an essential point of interest to both internal and external actors we interviewed. Actors from all of our cases perceived the community member's income from timber sales as low. In CMER, however, external and internal actor groups diverged significantly in their ratings (SE differences of 2.3) obtained from the spider web configuration tool. The CMER's internal actors were incredibly unsatisfied with income generation, whereas CMER external actors were less so. Perhaps external actor perceptions reflected their direct understanding of timber production costs (higher costs, less net revenues) as well as their technical knowledge about the biophysical and operational constraints to achieving estimated timber volume production. The CMER internal actors, in contrast, did not have that knowledge because they were not engaged in day-to-day timber operations. In contrast, in both VSER and IER, both internal and external actors understood the cost of logging operations and were more likely to have similar perceptions of income generation, whether positive or negative, respectively. In these 2 cases, both external and internal actors had intimate knowledge of timber comanagement and had coconstructed a process of participatory budgeting for project accountability (Berkes, 2010; Sikor, 2006).

Although Humphries et al. (2020) highlighted that the most direct benefit of community timber management is wage income to individual timber workers, we argue, and our findings suggest, that combining individual (cash wages) with collective benefits (system of funds for community development) can result in better long-term performance of timber comanagement to improve livelihoods and regulate forest use. We

also found that this hybrid benefit-sharing agreement (both individual and collective benefits) observed in our IER and VSER cases also generated greater approval of comanagement systems. Klooster (2000) reported similar patterns among 7 successful community logging initiatives in Mexico that reinvested logging benefits into local collective facilities, collective goods, and the logging business. Among our cases, differences in benefit-sharing agreements were linked to the degree to which community members participated in decision-making and took ownership of timber comanagement activities. Communities where proportionally more members participated in the timber projects were also more likely to incorporate indirect collective benefits for the wider community, for example, improvement of local facilities and education. This finding is supported by Humphries et al. (2020), wherein a timber cooperative under strong community control invested profits in infrastructure and agroforest production to provide benefits to as many people as possible in the studied protected area.

Unsurprisingly, positive perceptions of comanagement systems have been related to the provision of local economic incentives and benefits (Soliku & Schraml, 2020). Furthermore, the existence of interorganization working groups, as created in IER and VSER, can be linked with accountability-building mechanisms (Persha & Andersson, 2014) that ultimately result in choosing to share benefits collectively (Espada & Sobrinho, 2019; Humphries et al., 2020). On the other hand, inequitable distribution of benefits, or poorly established benefit-sharing agreements—such as CMER's individual level agreement—can increase risks of elite capture and distrust among community members (Antinori and Bray, 2005). Still, Chakraborty (2001) found that inequitable distribution of benefits did not seem to interfere with Nepalese community forestry user groups since forest size and biophysical conditions (i.e., well-stocked forests) could satisfy subsistence needs of all users, including those most marginalized. Ultimately, understanding perceptions of community-level actors about fair benefit-sharing and their distribution at individual and collective levels could shed light on the endurance of timber comanagement arrangements, and community members' engagement with good practices in timber, or other natural resources use.

Timber comanagement in support of protected area goals

Brazil's widespread adoption of sustainable use protected areas that integrate traditional peoples as partners bucked the historical norms of strict protected areas. That timber has been added to the menu of renewable natural resources for harvest and collaborative management in these territorial spaces is noteworthy. Despite the risks and complexity of managing timber sustainably, our research demonstrated that thoughtful actor engagement can yield solid organizational, operational, and socioeconomic comanagement outcomes, even in protected areas (Miteva et al., 2025). But as our findings reveal, no matter how well-intentioned, government alone is unlikely to have the capacity, technical forest management knowledge, and market linkages necessary to successfully devolve and implement timber comanagement with communities. But as Mulder and Coppolillo (2005, p. 177) observed, "Clearly, comanagement succeeds not by valorizing local devolution, but by addressing and working through the inevitable historical de facto interdependencies between local users and state-level authorities." We sought to provide details and analyses of how such interdependencies were worked through to sustainably comanage timber in 3 Brazilian sustainable use reserves. In our cases, the complementary addition of reflective and skilled civil society and private sector actors proved to be a key difference between solid or satisfactory, or weaker comanagement processes and outcomes, as perceived by involved actors. Larger collaborations with those experienced in the technicalities of timber management and community-level work were critical, particularly in the precarious early years of timber comanagement.

We also found that comanagement arrangements with greater participation of local timber workers in decision-making and timber management activities were essential, providing better opportunities to integrate and adapt locally tested timber harvesting methods. Providing space for multiple and diverse reserve residents to assume technical and decision-making positions can also reduce overload on community leaders and lead to fewer conflicts and more acceptable benefit-sharing among community members. Our results showed the importance of investing in at least 3 main provisions. First, strengthen intracommunity organization for collective management and use of timber resources because sustained timber production in tropical forests requires larger areas beyond individual family parcels. Second, secure medium-term commitments from comanagement partners who are trusted by the community to engage in continuous support of timber comanagement decision-making. This support and capacity building is particularly critical in the beginning stages when communities are defining multiple processes and procedures, such as reduced-impact logging, financial management, market negotiations, benefit distribution norms, and intracommunity organization. Third, involve different levels of government (i.e., local, regional, and national) to participate in comanagement arrangements, wherein these key comanagement actors can share institutional knowledge with local communities and create avenues for inclusion of other comanagement partners, particularly those with specialized expertise in community-based timber comanagement. Finally, we hope our findings shed light on ways forward from simplified notions of relations between parks and people (West et al., 2006) to ones that address the nuanced tensions and emblematic complexities of conserving nature (Neumann, 2015) and respecting local rights. We are heartened that the conservation community increasingly calls for greater collaboration with communities and Indigenous groups and increased recognition of spaces outside the traditional protected-area estate (Maxwell et al., 2020). As collaborative approaches for effective conservation become increasingly normalized globally, our results comparing timber comanagement arrangements and perceived outcomes by those intimately and actively engaged in day-to-day management may help inform and adapt protected area comanagement in Brazil and elsewhere.

ACKNOWLEDGMENTS

This study was supported by the School of Forest, Fisheries, and Geomatics Sciences at the University of Florida (UF), the Tropical Conservation and Development Program at the UF Center for Latin American Studies, the Rufford Foundation Small Grant, IdeaWild, the UF Research Abroad for Doctoral Students Grant, and the International Tropical Timber Organization Fellowship Program. We are grateful to all the research participants and the following organizations: the Brazilian Chico Mendes Institute of Biodiversity Conservation, the Tropical Forest Institute through the Amazon Fund/BNDES, the Institute of Conservation and Sustainable Development of the Amazon through the Amazon Fund/BNDES, and the Observatory of the Dynamics of Interactions Between Societies and Environment in the Amazon.

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How to cite this article: Espada, A. L. V., Kainer, K. A., & Ezzine-de-Blas, D. (2025). Community-based timber comanagement and the boundaries of people-centered conservation in Brazil. *Conservation Biology*, e70118. https://doi.org/10.1111/cobi.70118