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Ecotourism, wildlife conservation, and agriculture in Costa Rica through a social-ecological systems lens

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Parks and protected areas have long been promoted for their environmental conservation benefits, opportunities for outdoor recreation and nature-based tourism, and associated economic opportunities. However, conservation biologists and ecologists are increasingly embracing the idea that achieving their conservation goals requires working outside these protected areas and within more developed agricultural lands occupied and used by people. This shift toward a systems perspective for conservation involves working within integrated social and ecological systems. Outdoor recreation and nature-based tourism operate within these same linked systems across a range of scales. Ecotourism in particular is a complex social-ecological system (SES) that relies on environmental resources such as protected areas, tourism industry elements such as lodging and transportation, and locals who obtain their livelihoods in the surrounding regions. To understand this complex system, we apply a framework for situating disciplines within an SES across scales. This framework includes two-way interactions between nested hierarchical levels of social and ecological systems. Interactions range from positive to negative, forming a four-quadrant framework. We argue that this framework is more representative of this highly complex system of ecotourism than traditional human-impact research and provides a more holistic understanding of the nature-based recreation ecosystem. We apply this SES to a case study in Costa Rica, where ecotourism has become an important source of income for residents and thus generates conservation success. Our study area comprised the upper Guacimal watershed, a regional tourism hub in northwestern Costa Rica. We apply this SES framework to interview data regarding missions, goals, and management practices from representatives of 20 government and non-government organizations active in conservation, and thus engaged in ecotourism, in the area. Applying our SES framework to the Costa Rican case study revealed the dimension of varied challenges and benefits of ecotourism for and by local conservation organizations as compared with ecotourist visitors. The framework reveals opportunities for identifying trade-offs and maximizing benefits to social and ecological systems while minimizing negative impacts. Through this framework, we also discuss how ecotourism can contribute toward conservation of unregulated lands. Considering ecotourism as an SES can enable more comprehensive decision-making around an ecotourism system.

KEYWORDS

outdoor recreation, bird watching, nature-based tourism, corridor, landscape scale, recreation ecology

1. Introduction

Protected areas are a critical mechanism for achieving ecosystem and biodiversity conservation goals (Cumming and Allen, 2017). They are also a primary destination for outdoor recreation and nature-based tourism. Nature-based tourism is any form of travel for the use and enjoyment of conserved natural settings and wildlife (Stronza et al., 2019; Fennell, 2020). Outdoor recreation refers to the types of activities and experiences that occur in natural settings and describes what we do, why we do it, and what we gain from our nature tourism experiences (Moore and Driver, 2005).

The global expansion of protected areas in the 20th century (Brandon and Wells, 1992) led to a corresponding proliferation of unique protected area categories with accompanying varied definitions of appropriate uses and conservation goals (Leung et al., 2018). The IUCN has developed a list of six categories of protected areas that range from conservation areas where natural systems are strictly protected with very limited human visitation to occupied landscapes where traditional natural resource management and cultural values are paramount. Thus, these categories recognize the larger social-ecological system (SES) through which people and protected areas interact and are managed.

Conservation management of protected areas is correspondingly evolving away from protected areas as islands of pristine nature to protected areas as integrated social-ecological systems (Berkes et al., 2003; Cumming et al., 2015; Cumming and Allen, 2017). Additionally, fundamental shifts in conservation biology and applied ecology have led to broadening from a focus on single species to recognizing the variety of disciplines and the intertwined nature of ecosystems and social systems in conservation problems (Cumming and Allen, 2017). Protected areas must provide benefits to, and be supported by, society (Maciejewski et al., 2015). With this shifting paradigm, numerous SES concepts and frameworks have been proposed, described, and applied in the field of natural resource management and for protected area systems specifically (e.g., Berkes and Folke, 1998; Ostrom, 2009; Cumming et al., 2015; Colding and Barthel, 2019; Morse, 2020).

Key considerations for protected area management and conservation are derived from the recognition that protected areas exist within larger social-ecological landscapes and that interactions and impacts to and from protected areas occur across multiple scales (Cumming et al., 2015; Mathevet et al., 2016). Biological corridors, used for targeting conservation in areas connecting protected areas across mixed-use landscapes, are a recognition of the importance of the larger social-ecological landscape. These SES frameworks include analysis at hierarchical levels that interact through feedbacks between different systems and across both spatial and temporal scales (Maciejewski et al., 2015). Resilience is an important component of SES frameworks as well, highlighting the importance of redundancy in a system to act as a buffer for inevitable change (Cumming et al., 2015; Cumming and Allen, 2017). Research has demonstrated the contributions that unregulated lands that are left undeveloped can make to the mosaic of a protected landscape, adding to the resilience of a landscape by providing additional wildlife habitat or movement corridors (e.g., Cumming et al., 2015; Aslan et al., 2022). However, less is known about how conserving lands for human activities such as nature-based tourism can contribute toward the conservation of nearby unregulated lands.

Large-scale tourism was initially promoted in developing countries as a tool for progress and growth or modernization–a way to generate foreign exchange and integrate with the world economy (Machlis and Tichnell, 1985; Stronza and Hunt, 2012). In developed countries, the "worthless lands" hypothesis suggests the creation of national parks were a way to give value through tourism to lands considered worthless for exploitative endeavors such as logging or mining (Hall and Frost, 2012). Thus, many early parks were located in marginal areas that were difficult to access (Powell et al., 2000). More critical evaluation of the social and environmental impacts of mass tourism and the advent of sustainable development in the 1980s led to a push toward more sustainable forms of tourism designed to benefit and empower local communities and the environment (Stronza and Hunt, 2012; Stronza et al., 2019). Alternative forms of nature tourism have been conceptualized, including sustainable tourism, responsible tourism, and ecotourism (Stronza et al., 2019). Ecotourism in particular is a form of nature tourism that is heavily connected to protected areas and national parks (Stronza et al., 2019; Fennell, 2020). Core principles of ecotourism include that it is nature-based, low-impact and contributes to conservation, involves learning, is culturally appropriate, benefits and empowers local people, is sustainable and equitable (Honey, 2008; Stronza et al., 2019; Fennell, 2020). More formally defined, ecotourism is "Travel with a primary interest in the natural history of a destination. It is a non-invasive and participatory form of nature-based tourism that is built around learning, sustainability (conservation and local participation/benefits), and ethical planning, development and management" (Fennell, 2020, p. 20). The tenets of ecotourism and sustainable tourism include a focus on the diverse landscapes, people, livelihoods, and social and ecological systems surrounding national parks and protected areas (Brandon and Wells, 1992; Bosak, 2019; Fennell, 2020).

The framing of protected areas and ecotourism, for research, development, and study, have coalesced on the necessity of SES approaches that include not just tourists visiting a region, but also locals and non-tourism landscape uses of that region. Furthermore, they have begun to conceptualize the nested hierarchy of these SESs and interactions of these systems across regional, national, and global scales (Cumming et al., 2015). Our contribution to these studies is the further development of a hierarchically-nested social-ecological systems model of recreation ecology, adding elements to develop a social-ecological system for ecotourism.

The purpose of this article is thus to present an SES framework that was originally developed to connect ecological research with social science research in the field of outdoor recreation, forming a social-ecological system for outdoor recreation (Miller et al., 2022). We apply our SES framework to analyze an existing case study to (1) demonstrate the application of the SES framework for ecotourism, (2) further develop the SES framework to become more relevant to the ecotourism context, and (3) explore the role of ecotourism in the conservation of unregulated lands in our case study area. A

thorough analysis of this case study has been published elsewhere (Cox, 2022).

1.1. A social-ecological systems framework for ecotourism

Recreation ecology is a field that has traditionally investigated the negative impacts that outdoor recreation has on the ecosystems in which it occurs (Bayfield and Barrow, 1985; Cole, 1987, 2021; Liddle, 1997). Research in this field has improved our understanding of how different soils, plants, and wildlife species respond to outdoor recreation activities and infrastructure (Monz et al., 2013). Results of recreation ecology research have informed management decisions aiming to reduce negative impacts of recreation on various ecosystem components (Marion, 2016). While this body of research is important toward this aim, it is critical to recognize that outdoor recreation exists within a social-ecological system that involves two-way interactions between recreationists and the environments where they recreate. While outdoor recreation has negative impacts on ecosystems, it also benefits broader conservation goals. Ecosystems that host recreation provide a plethora of benefits to recreationists and can also negatively affect recreationists. Miller et al. (2022) developed a SES framework for wildlife-recreation interactions. This consists of a four-quadrant system (Figure 1), considering the spectrum of positive to negative effects (y axis) of recreationists on ecosystems and vice versa (x axis). In this four-quadrant system, quadrant 1 (Q1) contains positive outcomes for social systems, quadrant 2 (Q2) contains positive outcomes for ecosystems, quadrant 3 (Q3) contains negative outcomes for ecosystems, and quadrant 4 (Q4) contains negative outcomes for social systems, resulting from interactions between social and ecological systems. Further description and review of research topics that fall within each of these quadrants is discussed in detail by Miller et al. (2022). Positive and negative outcomes can also be considered "benefits" and "challenges", respectively. Furthermore, these interactions occur at different levels, ranging from individual recreationists and wildlife, through societies and ecosystems. This system builds on a conceptual framework developed by Lischka et al. (2018), adding the y-axis that recognizes the directionality of interactions.

Categorizing outcomes of interactions for social and ecological systems through this SES framework provides an opportunity to systematically consider the potential tradeoffs of outdoor recreation. For example, disturbing individual birds through bird watching in a designated area may benefit the people who observe those individuals, while also benefiting bird populations, wildlife communities, and ecosystems through greater habitat conservation. While we do not suggest that identified outcomes should balance in quantity among quadrants, this framework can prove useful to conceptualize elements of the SES and to facilitate discussions between a diverse set of stakeholders.

While the concept of an integrated SES for outdoor recreation has been discussed and applied by several researchers (e.g., Blahna et al., 2020; Morse, 2020; Solomon et al., 2020; Ferguson et al., 2022; Miller et al., 2022; Morse et al., 2022), it has rarely extended beyond outdoor recreation-related tourism to include local residents and related land uses (e.g., Almeyda Zambrano et al., 2010; Lamborn et al., 2023), particularly on nearby unprotected natural areas. However, local residents and visitors interact in many ways, and can be affected by many of the same factors. Local residents may both benefit from and experience negative effects of ecotourism in their area. Their use of unprotected lands can be influenced by the existence of nearby protected areas as well as the organizations involved in conservation and ecotourism, and other parts of this social-ecological system.

In this article, we take the SES concept for recreation ecology a step further to include non-local ecotourism alongside local resident land use and livelihoods, conservation organizations and agencies, considering unprotected natural areas in the study site. Starting with the SES for outdoor recreation described by Miller et al. (2022), we expand the scope of this framework from outdoor recreation to ecotourism, including both people who visit and those who live in the landscape, and organizations and agencies that work to conserve the landscape, within and outside of protected area boundaries. Expanding the framework in this way, we aim to explore how the SES concept can better represent the definition of ecotourism, which calls for benefiting and empowering local people (Honey, 2008; Stronza et al., 2019; Fennell, 2020). We focus on the SES for wildlife-based ecotourism, specifically investigating the role of ecotourism in the protection of unregulated natural areas, through a case study in Costa Rica.

1.2. Case study: wildlife corridors and ecotourism in Costa Rica

The nation of Costa Rica is located within the Neotropical region, which is the most biodiversity-rich ecoregion across nearly all terrestrial taxa (Raven et al., 2020). However, Neotropical forests, which support the vast majority of regional wildlife, have been increasingly subject to human disturbance, particularly the expansion and intensification of agriculture, over the past half century (Graesser et al., 2015; Dang et al., 2019), resulting in the loss of 3.91 million hectares of forest annually between 2000 and 2010 (Achard et al., 2014). As part of this trend, approximately two-thirds of the tropical forest cover of the Central American nation of Costa Rica were cleared between 1950 and 1988 (Sánchez-Azofeifa et al., 2001) due to a nation-wide economic reliance on agricultural exports, primarily beef, pineapple, coffee, and bananas (Booth et al., 2010; Evans, 2010). Uniquely, Costa Rica has reversed this trend and experienced significant forest regeneration since the 1990s (Calvo-Alvarado et al., 2009; Moran et al., 2019). Reversals in deforestation rates in Costa Rica arose through a combination of fluctuations in the global market for agricultural exports, national default on international loans that resulted in pressure to remove agricultural subsidies and promote nature-based tourism (Edelman, 1999; Calvo-Alvarado et al., 2009; Allen and Padgett Vasquez, 2017), and the introduction of conservation legislation that prohibited deforestation and provided incentives for reforestation on private land (Brockett and Gottfried, 2002). Through additional conservation-oriented legislation, 28% of Costa Rica's landmass has been designated as protected areas, including national parks that encompass 12% of the nation's land

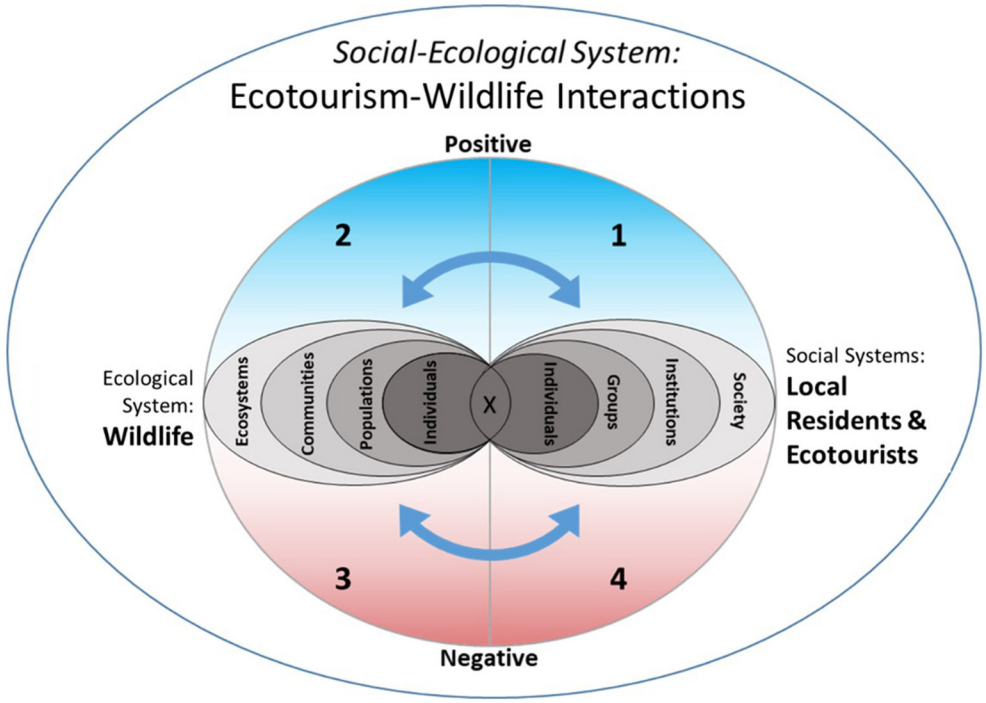

FIGURE 1
A social-ecological systems framework for ecotourism-wildlife interactions. This framework is based on the SES concept described by Lischka et al. (2018) and further applied to the outdoor recreation system by Miller et al. (2022). In this application, the focal ecological system is wildlife, with nested hierarchical levels including individual animals, wildlife populations, wildlife communities, and ecosystems. Two social systems critical to this application include local residents and the ecotourism system; levels range from individuals to groups, institutions, and society. Various levels of these social systems and ecosystems interact through feedbacks, represented by arrows. Interactions range from negative to positive (represented on the y axis). This system contains four quadrants, represented by numerals.

area (Figure 2) (Powell et al., 2000; Sánchez-Azofeifa et al., 2003; Evans, 2010). Along these lines, the forest transition model suggests that reforestation begins to outpace deforestation as society advances to later stages of demographic and economic transitions (Timms et al., 2013). Studies have found forest transitions to occur in circumstances in which economic development has led to regeneration of forest in previously farmed areas (Rudel et al., 2005), similar to our case study area. To increase forest connectivity between and outside of reserves, Costa Rica began introducing a network of biological corridors, which are composed of diversely managed privately-owned land, including protected areas, fragmented unprotected forest, agricultural lands, and towns (Fagan et al., 2013), in the 1990s (Sánchez-Azofeifa et al., 2003). This network has now been expanded to include 44 individual corridors (Figure 2) (SINAC, 2009). Many of these corridors grew out of grassroots initiatives led by non-governmental organizations (NGOs), which were able to take advantage of new conservation opportunities springing from the rapid expansion of the nature-based tourism industry (Newcomer et al., 2022). Biological corridors in Costa Rica are managed by individual councils that help facilitate cooperation between myriad partner organizations operating within the corridor, including both government agencies and NGOs (DeClerck et al., 2010). As a result, Costa Rica has emerged as a leader in conservation in the Neotropical region and has become a premier destination for nature-based tourism (Evans, 2010).

Our case study focused on the 129 km^2 upper Guacimal watershed, located within the *Corredor Biológico Pájaro Campana* (CBPC) on the Pacific slope of northwestern Costa Rica (Figure 2). The CBPC was established in 2007 to enhance forest connectivity along an elevational gradient from highland cloud forests to coastal mangroves (SINAC, 2009; Newcomer et al., 2022). The flagship species of the CBPC is the Three-wattled Bellbird (*Procnias tricarunculatus*), a vulnerable intra-tropical migratory bird that moves seasonally along the elevation gradient encompassed by the CBPC as it tracks ripening wild avocado fruits (family *Lauraceae*) (Newcomer et al., 2022). Within the CBPC, we selected the upper Guacimal watershed for this case study because it includes a national nature-based tourism hub anchored by the Monteverde Cloud Forest Reserve, which receives more than 100,000 visitors annually (Newcomer et al., 2022), and is also at the forefront of many conservation initiatives and hosts a plethora of locally operating conservation organizations (Burlingame, 2000). We focused on the upper portion of the Guacimal watershed because tourism impacts, climate, species, scale of agricultural production, and conservation priorities are significantly different at lower elevations. The upper Guacimal watershed includes a gradient spanning from well-protected highland cloud forests to fragmented middle elevation seasonally dry forests. The study area has approximately 5,000 inhabitants, with approximately 80% of the population concentrated in the town of Santa Elena, located at the upper extreme of the study area, which is a local nature-based

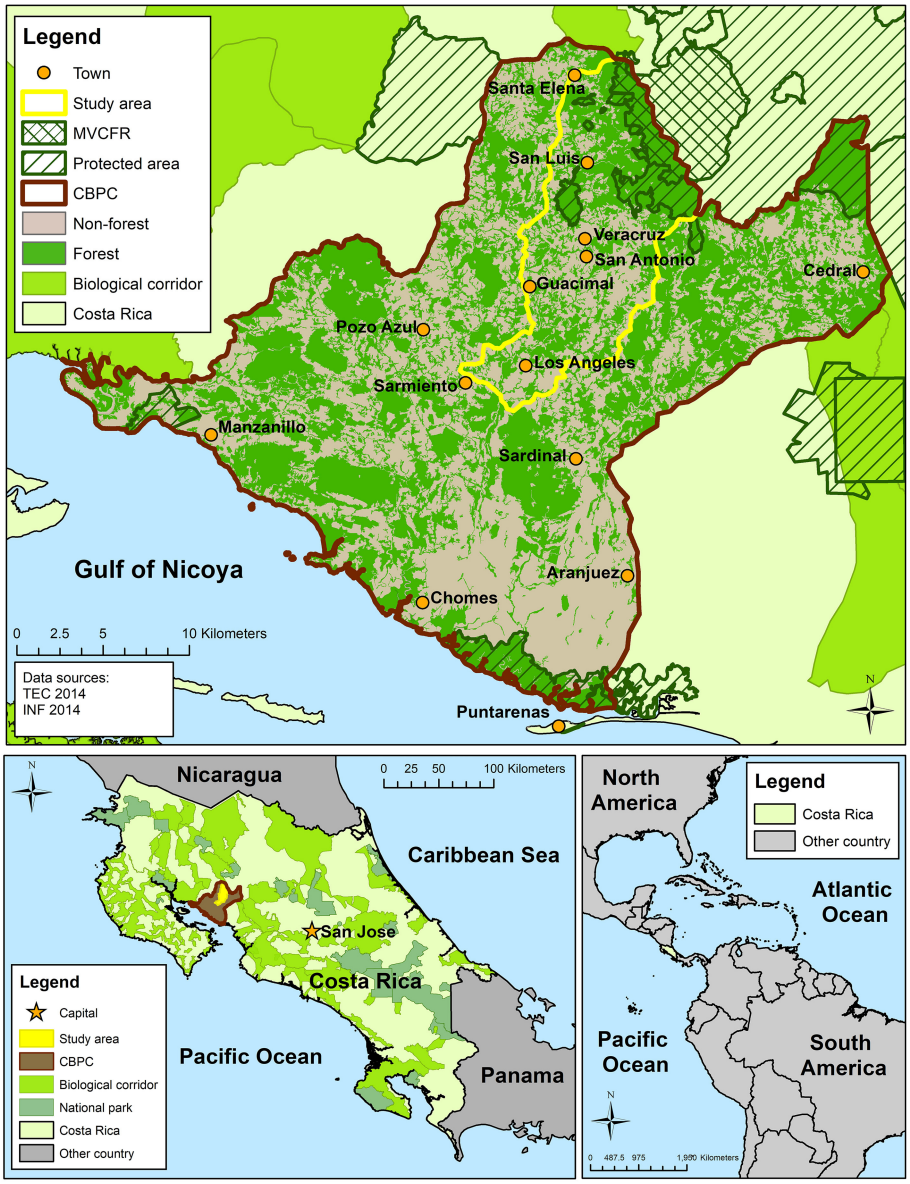

FIGURE 2
Map of the upper Guacimal watershed study area, highlighting location within the *Corredor Biológico Pájaro Campana* (CBPC) and Costa Rica. The map of Costa Rica also illustrates the nation's extensive network of biological corridors and national parks.

tourism hub [INEC (Instituto Nacional de Estadística y Censos), 2011]. The remainder of the study area is sparsely inhabited, consisting of forest reserves and small-scale agriculture (Griffith et al., 2000). Historically, the primary source of income for residents of the study area was agricultural production, primarily dairy cattle and coffee, but tourism has emerged as the leading industry in the vicinity of Santa Elena (Burlingame, 2014).

TABLE 1 Number of organizations that participated in interviews by type.

Organization type	Number of participating organizations
Federal government agency	6
Local government agency	3
Non-government organization	11

2. Methods

2.1. Interview methods

As part of a broader study on the effects of regional conservation priorities on wildlife populations (Cox, 2022), we conducted interviews with key informants from 20 organizations involved with developing land use priorities in the study area between November 2017 and July 2018 (Table 1). We restricted sampling to a single key informant from each organization

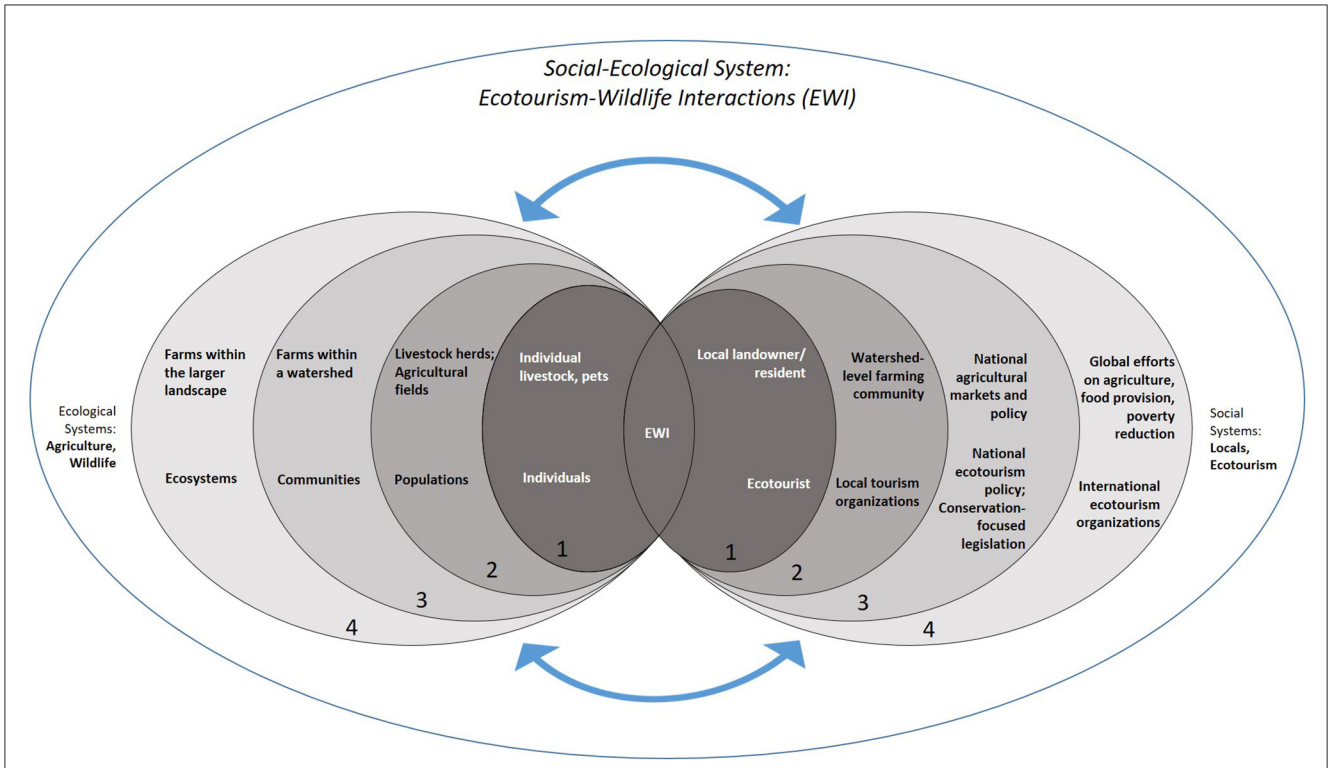

FIGURE 3
A social-ecological system for wildlife-based ecotourism alongside local residents. This diagram details examples of hierarchical levels contributing to the social (right side) and ecological (left side) components of the ecotourism system. Numbers indicate a reference system for the hierarchical levels, which are referred to in Figure 4.

or agency and limited the candidate pool to organizations operating within the study area that included elements of land use planning in their mission statements. We did not include businesses in our analysis, even though many nature-based tourism businesses in the region might also influence land use decisions. Participating organizations included a range of local and national government agencies and non-government organizations, with priorities including ecological conservation, tourism, and agriculture. We developed an initial list of interview candidates based on contacts developed by the authors through previous research in the area and augmented the list using the snowball sampling technique (Newing et al., 2011), whereby participants were asked to list other relevant organizations during their interviews until we reached a point of saturation where no new organizations were identified by participants. Once identified, we invited candidates to participate in the study using a modified version of the Dillman et al. (2008) contact approach. We began by sending candidates a pre-notice email which described the study and invited participation and followed up with two reminder messages to candidates who had not responded after two and four weeks, respectively. To gather information, we conducted semi-structured interviews (Chambers, 1998; Creswell and Poth, 2017) with participants on a range of topics centered on conservation and land management in the study area, including the organization's mission, current conservation initiatives, perceived conservation challenges, and identification of conservation priorities on a map of the study area (for a complete list of interview questions see Appendix B of Cox, 2022). Participants were asked to respond from the perspective of their organization rather than provide personal opinions. Interviews were conducted in either English or Spanish, depending on participant preference, in a one-on-one format. Spanish language interviews were augmented with a translator to improve clarity. Informed consent was obtained from participants prior to the start of interviews. Interviews generally lasted ~30–45 min. Further details on methods are described by Cox (2022).

2.2. Data analysis

We transcribed and translated audio recordings of the interviews and subsequently coded transcript text using a hierarchical coding scheme in MaxQDA 18 (VERBI, 2017). We used both a priori and emergent categories to construct our code list, which focused on conservation and land management topics, and subsequently grouped codes into broader themes for analysis (Hutchison et al., 2010; for a complete list of themes see Cox, 2022). While interview questions did not directly focus on tourism, it emerged as an important theme in interviews, appearing in 43 coded sections in 16 interviews. We then analyzed themes to identify participant perspectives on a range of topics related to human-wildlife interactions involving both tourists and residents in the study area. Examples were used to provide support in each of the four quadrants of our model of human-wildlife interactions.

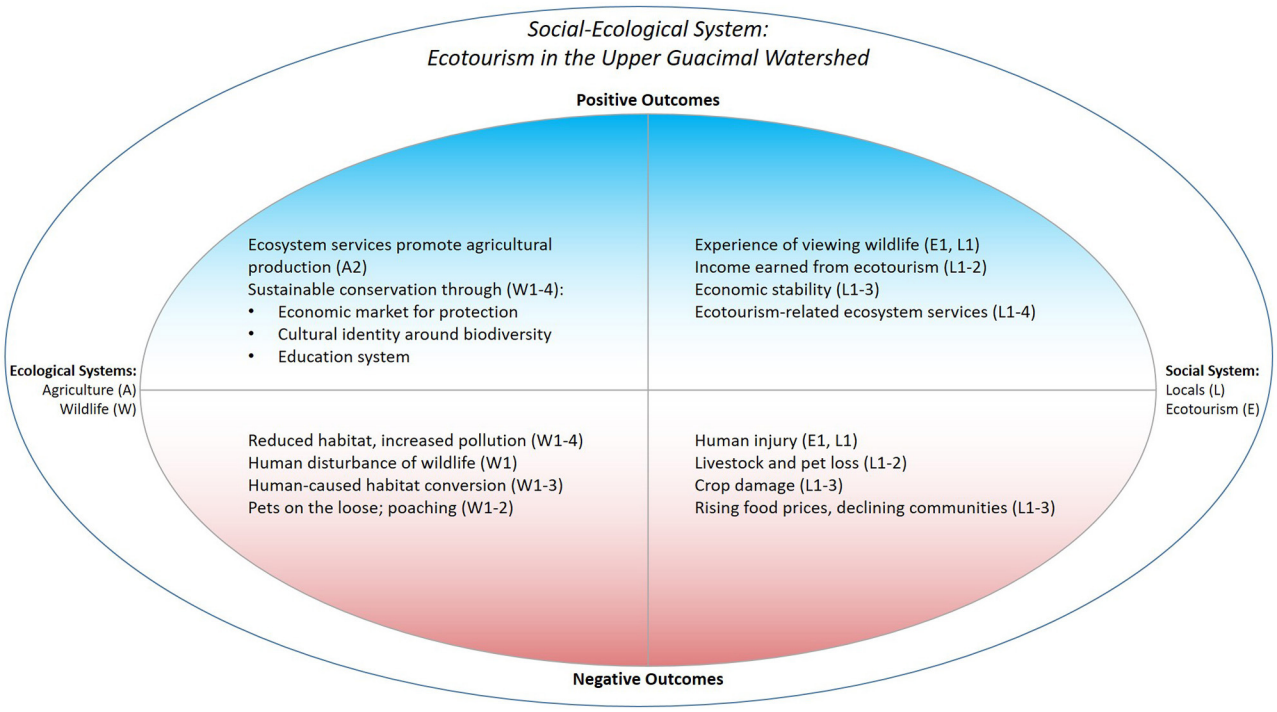

FIGURE 4
Examples of outcomes from our case study which fall within four quadrants of our social-ecological system for ecotourism. Outcomes are denoted with the portion of the system which they generally effect (local residents = L, ecotourism=E, agriculture = A, wildlife = W), and hierarchical nested levels they generally affect, as indicated in Figure 3 (individual = 1, groups/populations = 2, institutions/communities = 3, society/ecosystems = 4). This diagram is intended to be representative rather than exhaustive, providing a visual example of the application of this case study according to this framework. Thus, the number of items in various quadrants is not indicative of the balance of the system overall.

To meet our objectives of testing and expanding the SES framework proposed by Miller et al. (2022), we applied the results of interviews to this framework. The three authors discussed the relevance of this framework to the case study, considering how results from the original data correspond to elements of the SES framework. Authors also discussed how the ecotourism system in Costa Rica differs from the U.S. outdoor recreation system that the framework was developed within, specifically the addition of residents, landowners, organizations involved with setting land use priorities, and nearby unprotected natural areas. The author who collected the original data (C. Cox) then returned to interview transcripts to identify quotes and concepts discussed in interviews that represent elements of the SES framework, including the expanded ecotourism elements. All three authors discussed specific quotes to ensure the best match for the different quadrants. These are presented in the following section.

3. Results

With the SES framework for outdoor recreation having been developed separately from the Costa Rican case study, applying results from the case study to this framework helps demonstrate its utility while further developing the framework. Here we present results from stakeholder interviews that fall within each quadrant of our framework. As our data do not support a quantitative analysis, for example of the relative importance of specific benefits or challenges, we present a qualitative analysis through providing quotes that support our findings. We highlight links between quadrants, representing interactions between various hierarchical levels of the social and ecological systems. This SES is illustrated in Figure 3, with examples of hierarchical nested levels for both local resident and ecotourism social systems alongside agriculture and wildlife ecological systems. Figure 4 summarizes results across the four quadrants.

3.1. Quadrant 1: positive outcomes for ecotourists and local residents

Wildlife-based recreation is an important draw for tourists in our study area. As mentioned earlier, the Monteverde Cloud Forest Reserve within the study area receives over 100,000 visitors per year and is supported by numerous conservation initiatives, with a primary focus on wildlife. Interviewees in Costa Rica's upper Guacimal watershed discussed benefits such as locals earning income from ecotourism pursuits and benefiting from ecotourism-related ecosystem services. They also mentioned the benefit for both locals and visitors of the opportunity to view and learn about wildlife.

Income from ecotourism is believed to be a good opportunity for economic stability in the upper Guacimal region. Several interviewees discussed receiving income from ecotourism, and

especially from wildlife-based ecotourism. Tourists attracted to the area by the promise of viewing birds bring money for lodging, food, tour guides, equipment, and other components of the tourism system that allow them to experience and connect with bird habitat. The contributions of wildlife-based ecotourism seem to be increasingly supplementing other sources of income, as ecotourism becomes more popular in the region. For example, one interviewee stated,

> "Every year bird watching grows more, it draws much attention to the tourism sector. Many people think of this as an alternative strategy to improve their income."

Some farmers supplement their incomes through ecotourism efforts by providing birdwatching opportunities on their land. As one participant shared,

> "Not only do they have their production farms, but if there is a small forest, they can think of a tourism activity, having a trail to go and watch birds and attract the attention of people who come and can pay to go and watch birds."

Wildlife populations provide additional ecosystem services to residents, such as pollination, seed dispersal, and pest control. Having wildlife habitat on the land can also make it more attractive for ecotourism and educational opportunities, an example of a feedback between quadrants 1 and 2. Importantly, habitat restoration improves erosion control, water and soil quality, which in turn enhance agricultural productivity. One interviewee shared,

> "We want trees, but besides wanting trees to provide habitat for the birds, we want them for shade and to keep the nitrogen levels fixed."

Both visitors and locals benefit from the opportunity to view wildlife, experience and connect with natural ecosystems, and learn about the species that inhabit these ecosystems. Visitors travel thousands of miles to observe wildlife in the upper Guacimal:

> "This guy flew for five hours, whatever, went through hell in the airports and came all the way on that beautiful [sarcasm] road that we have to see a sloth and was so excited."

3.2. Quadrant 2: positive outcomes for wildlife and ecosystems

When ecotourism supports conservation of wildlife and protected areas (Stronza et al., 2019), it effectively creates a positive ecological footprint of tourism. Protecting lands as parks, private reserves, or wildlife corridors can create financial incentives for conservation, and ecotourism creates a market for the creation and expansion of protected areas. When conserving land is more profitable than developing it, this can be a win for wildlife. In our case study, the idea of shifting from mainstream tourism to ecotourism was considered an opportunity that can support conservation goals and connect tourists with nature:

> "The other strategy… is that you say, well, maybe we can create a different kind of tourism that, in a sense, takes the phenomenon of clustering that tends to isolate and make it more difficult to get outside and use that by pulling people out through this new recreational opportunity of a hiking trail."

This is an example of an interaction between quadrants 1 and 2, creating a positive feedback cycle of ecotourism-supporting conservation actions benefitting locals and in turn supporting conservation of wildlife habitat. For example, interviewees explained,

> "Farmers can get income from leaving forest because people pay to come watch the birds."

> "The conservation of symbolic birds attracts tourists who visit Monteverde to see the birds, which benefits the community economically."

Pro-ecotourism efforts and policies can lead to long-term support for conservation at a societal level when environmental values are bolstered. Interviewees described ways in which environmental values have become engrained in society, from environmental education initiatives highlighting the human benefits of conservation to a cultural identity and pride centered on conservation:

> "We started by working on environmental education and those types of things to teach farmers about the benefits of reforestation... and we find that it is easier to convince them of the worthiness of reforestation when they are better informed about its benefits to them."

> "We have a sense of pride in our [Costa Rica's] history as a global leader and proactive country in terms of conservation initiatives."

In our study area, ecotourism has led to the expansion of the Monteverde Cloud Forest Reserve and has contributed toward private conservation of unregulated areas. Financial incentives such as those discussed by interviewees support the idea that ecotourism can contribute toward the conservation of areas that are not protected through state policy. Emphasis on environmental values over decades can contribute toward the longer-term sustainability of conservation efforts.

3.3. Quadrant 3: negative outcomes for wildlife and ecosystems

In our case study, interviewees discussed several topics that fall into quadrant 3. For example, interviewees discussed the disturbance factors that human presence can have on sensitive wildlife species. Tourism guides and visitors sometimes use playback (recorded bird calls) to attract birds and enhance viewing opportunities, which is believed to change behaviors at the individual level, leading to habituation. One participant reflected that as birdwatching tourism has grown,

> "Guides in some areas are constantly calling certain species, which might distract them from breeding."

Guides and tourists also sometimes feed wildlife, which can lead to behavior-altering habituation. Trash and waste disposal associated with tourism operations are issues mentioned by interviewees that can degrade wildlife habitat, leading to negative effects at the ecosystem level.

At a broader scale, humans are causing habitat conversion across Costa Rica. Nearly half of the nation's total forest cover is unprotected, leaving it vulnerable to fragmentation, degradation, and conversion to unusable habitat for many wildlife species. Forest fragmentation has been linked to declines in bird abundance and richness across a range of feeding guilds. Increased development linked to tourism (e.g., construction of hotels, restaurants, or other infrastructure) reduces habitat and increases pollution in the area. One interviewee stated,

> "The problem [with tourism] is that Cerro Plano and Santa Elena are getting more urbanized and they're just simply taking away the forest, taking away the trees. There are almost no trees on the way to Santa Elena and Cerro Plano."

Living in the landscape can also have negative effects on wildlife and habitat. Human presence, as well as the presence of pets such as dogs or cats, affects a wide range of species. Poaching is also a concern that stems from living in the landscape. In our study area poaching primarily occurs for subsistence reasons, and despite significant progress through outreach and enforcement on protected areas, remains a concern in certain areas, as one participant noted,

> "There used to be a lot of hunting, a lot of poaching on this property, because it was part of their lifestyle. In many cases, we've had neighbors just pass through, and just collect whatever, what's in front of them, and sometimes actually bring their dogs and hunt for peccaries and things of that nature."

Removal of wildlife through poaching can have detrimental effects on ecosystems and on wildlife-based tourism, demonstrating feedback interactions between quadrants 3 and 4.

3.4. Quadrant 4: negative outcomes for ecotourists and local residents

In our case study, interviewees referred to several types of human-wildlife conflict. Landowners mentioned the loss of livestock and pets attributed to wildlife living on or near their land. Human injuries from wildlife, such as snakebites, are also a perceived threat. Wildlife can damage crops, diminishing farmers' profits, as one participant shared,

> "Economic opportunities are … limited if you have birds that are eating crops, which happened with peppers over in La Fortuna."

Supporting wildlife-based ecotourism has also led to negative outcomes for residents and landowners. Conservation efforts can take land out of production and limit economic opportunities in communities without ecotourism resources. The expansion of the Monteverde Cloud Forest Reserve led to many farmers being bought out, which can have negative economic, social, and cultural impacts on those individuals. This exemplifies the importance of considering multiple scales of the social-ecological system: when policies at the national level cause farms to be bought out in support of conservation, this leads farmers to lose their long-term source of income. When people move to ecotourism hubs seeking new economic opportunities, this can lead to the decline of communities lacking in ecotourism opportunities, such as San Antonio and Veracruz in our study area. One interviewee stated,

> "[Farms] are abandoned because the farmers find it more profitable working with activities more related to tourism, biological research, or other activities. Then, why have cows?"

Finally, tourism can cause prices to rise, negatively affecting residents. Interviewees in our study cited the rising cost of food and housing:

> "Food is expensive, lodging is expensive, housing is really expensive and now it's even worse because now we have Airbnb and Booking so all the houses that were for rent for a local have disappeared."

4. Discussion

Applying the Costa Rica ecotourism case study to this existing SES framework highlighted interesting developments for the framework. Interpreting results from previous analysis of these data (Cox, 2022) in the context of this framework both demonstrated the relevancy of the framework and highlighted the need to add local landowners and land use organizations to nearby unprotected areas to this framework to improve its relevancy for the ecotourism system. We find that previous research also fits within this expanded SES system for ecotourism.

4.1. Quadrant 1: positive outcomes for ecotourists and local residents

In our case study, we found that locals receive income from ecotourism, a positive impact of ecotourism-supporting wildlife to residents. Local economic benefits of ecotourism and nature-based tourism is frequently cited by other researchers, particularly from wildlife-based ecotourism, including in Costa Rica (Troëng and Drews, 2004; Hunt et al., 2015) and other world regions (e.g., Gupta et al., 2023). Wildlife-based ecotourism supplements other income sources elsewhere in Costa Rica as well (Almeyda Zambrano et al., 2010; Hunt et al., 2015), such as for farmers (Brownson et al., 2021). Other studies have also quantified ecosystem services which boost agricultural productivity provided by wildlife and habitat conservation (Jindal et al., 2008; Townsend and Masters, 2015). In

turn, efforts to improve agricultural productivity can improve bird habitat (Brownson et al., 2021), an example of an interaction with quadrant 2 of our framework.

Our study demonstrated the benefits of wildlife to ecotourists as well, highlighting an example of a fulfilled tourist who traveled hundreds of miles to view a sloth. While observing a sloth in its native habitat has benefits for the individual tourist, the emissions from long-distance flights have negative effects at the global level compared to seeing the same species in a closer-to-home zoological park. Ecotourism has been found in some cases to have a higher ecological footprint than mass tourism (Marzouki et al., 2012). This illustrates the importance of considering the benefits and challenges of ecotourism at the systems level.

4.2. Quadrant 2: positive outcomes for wildlife and ecosystems

Our results demonstrated ecotourism support for wildlife conservation through incentivizing conservation efforts, which has been documented in other cases as well (Brownson et al., 2021). For example, in the Osa Peninsula of Costa Rica, ecotourism has led to incentives being provided to landowners who protect their land for wildlife habitat to support ecotourism pursuits, creation of new jobs for tourism providers such as lodging, restaurants, and guiding services, and further economic benefits from tourist spending (Almeyda Zambrano et al., 2010).

Conservation-supporting financial incentives can become institutionalized. Since the 1990s, Costa Rica has experienced large-scale forest regeneration, resulting from the emergence of the nature-based tourism industry and implementation of conservation-focused legislation (Snider et al., 2003; Donald and Evans, 2006; Calvo-Alvarado et al., 2009). Currently, 28% of Costa Rican lands are protected, made possible by the focus on ecotourism in land policy (Powell et al., 2000; Sánchez-Azofeifa et al., 2003; Evans, 2010). A network of biological corridors developed in the 1990s have arguably enhanced wildlife habitat connectivity in Costa Rica (Sánchez-Azofeifa et al., 2003; DeClerck et al., 2010). Collaborations between private land managers, government agencies, and NGOs to support the network of biological corridors in Costa Rica demonstrates the positive impacts that multiple levels of the ecotourism and local resident systems can have on wildlife.

Findings from our study correspond with the "forest land transitions" model, indicating a positive role of ecotourism in contributing toward the conservation of unregulated lands in the area. Research in other regions have indicated that when economic development creates enough non-farm jobs (such as ecotourism-related jobs) to pull farmers off the land, forests regenerate in old fields (Rudel et al., 2005). In our study, interviewees discussed how financial incentives related to promoting the ecotourism industry led to transition of previously farmed land to private conservation areas. This exemplifies one way in which ecotourism supports conservation on lands that are not protected by federal or local policy.

4.3. Quadrant 3: negative outcomes for wildlife and ecosystems

Human presence is widely found to disturb sensitive wildlife species, including bird watching (Şekercioglu, 2002; Steven et al., 2011). However, the hierarchical level, severity, geographic extent, and longevity of this disturbance varies substantially between species, ecosystem, type of recreational activity, and other factors (Miller et al., 2020). In our study region, tourism guides sometimes use playback to attract birds. While this may lead to habituation of individual birds (e.g., Harris and Haskell, 2013), the detrimental effects of playback are more widely expected than thoroughly tested. Watson et al. (2018) make strong arguments regarding the trade-offs of using playback in relatively confined areas and short time periods compared with what would be required for guides to help tourists see the same diversity of species without the use of playback. However, this should be used with caution particularly where species are potentially at risk, such as the Three-wattled Bellbird and the Resplendent Quetzal (*Pharomachrus mocinno*) in our study area. Feeding wildlife can also lead to habituation, causing wildlife to become reliant on humans and sometimes altering interactions between species and community structure (Geffroy et al., 2015). If tourism-related influences such as the use of playback or feeding wild animals leads to long-term community level changes, this can ultimately alter biodiversity and ecosystem functioning (Tilman et al., 2014; Arif et al., 2022).

Habitat conversion across Costa Rica reduces habitat that supports both wildlife (Q3) and ecotourism (Q4). In our case study area, forest fragmentation, degradation, and conversion of unprotected habitat are associated with negative effects to birds at the individual, population, and community levels across a range of feeding guilds (Stouffer, 2020; Cox, 2022). Fragmentation can decrease habitat connectivity, inter-patch dispersal, access to food resources, and genetic diversity, while increasing competition and predation, and altering microclimates (Hunter, 1996; Schumaker, 1996; Stratford and Stouffer, 1999; Robinson, 2001; Şekercioglu, 2002; Donald and Evans, 2006). While habitat conversion occurs for many reasons, development to support tourism is one contributing factor, although some ecotourism efforts in Costa Rica have led to reforestation (Almeyda Zambrano et al., 2010). Previous studies have also found negative effects of wildlife and habitat on those living in the landscape. For example, domestic dogs and cats both have widespread negative effects on wildlife at a global level (Hughes and Macdonald, 2013; Loss et al., 2022). As in our study area, poaching is also a concern in other lived-in ecosystems, primarily for subsistence reasons (Molina Murillo and Huson, 2014).

4.4. Quadrant 4: negative outcomes for ecotourists and local residents

Both tourism and protected areas can lead to negative economic outcomes for ecotourist and locals as well. For example, interviewees in our study described tourism causing prices to rise, negatively affecting residents, which has been found in other parts of Costa Rica (Almeyda Zambrano et al., 2010). Protected areas can conflict with poverty alleviation goals, reducing incomes or

perpetuating poverty traps such as when agricultural development or natural resource exploitation is limited by conservation goals (Adams et al., 2004). However, the opposite has also been found for Costa Rica as well as other world regions (Ferraro et al., 2011; Gupta et al., 2023).

Analyzing this case study of ecotourism in the upper Guacimal watershed of Costa Rica allowed us to demonstrate an application of the social-ecological systems framework for ecotourism. This analysis contributed toward further developing the relevancy of the SES framework for the ecotourism context, specifically in highlighting the importance of recognizing those living and working in the landscape as a critical and integrated part of the SES. Analyzing this case study within the SES framework also helped us understand the important role of ecotourism in the conservation of unregulated lands in our case study area.

5. Conclusion

Other authors have begun using SES as a framework for studying ecotourism in Costa Rica. Almeyda Zambrano et al. (2010) used a nested hierarchical approach to examine the benefits and impacts of ecotourism. Working across scales to examine these from the site to households to surrounding communities and beyond (i.e., employment, reforestation, support for conservation) provides a more comprehensive assessment of ecotourism. Positive and negative impacts and the tradeoffs may change as they are examined at different scales. Hunt et al. (2015) built on this research in the Osa peninsula interviewing a wider range of stakeholders both involved and not involved in tourism and present their positive assessment on local livelihood impacts derived from ecotourism directly and indirectly. Finally, Gutierrez et al. (2020) provide a definitive overview of how ecotourism can minimize the direct impact on wildlife and can facilitate an increase in reforestation and conservation support and reduce illegal poaching and logging all leading to greater biodiversity benefits. This was framed in-part as a response to Geffroy et al.'s (2015) single-scale one-directional negative analysis of tourism on wildlife. Their multi-scale study demonstrated how single scale analyses, focused on only one negative dimension of the impacts of tourism (wildlife), and with poor focus on the type of tourism being studied, can lead to false or simplistic conclusions (Fitzgerald and Stronza, 2016; Stronza et al., 2019; Gutierrez et al., 2020). While systems thinking first appeared in the tourism literature in the 1970s, a recent study concluded that "future progress will be severely hampered if more attention is not paid to progress in sustainable tourism development informed by a systems thinking approach" (Stone and Nyaupane, 2017, p. 3). The model we have presented builds on these previous studies and provides a framework to conceptualize many of the same hierarchically nested analyses these authors have captured. Like these authors, we have included the perspectives of those who live and work in the landscape, particularly representing organizations that are an integral part of managing for conservation, protected areas, and ecotourism as components of the same social-ecological system.

The SES framework we discuss in this article was originally developed as a concept of how to bridge recreation ecology more effectively with complementary fields. The model forces examination across scales, across systems, and to explore both positive and negative impacts. We find that the concept, with adjustments, is relevant to the ecotourism field as well. Our framework builds on these earlier presentations of ecotourism as SESs to highlight both the positive and negative potential interactions between the social and ecological systems, across scales. By applying this framework to the case study of wildlife-based ecotourism in the upper Guacimal watershed of Costa Rica, the most substantial development was to recognize the lived-in landscape outside of protected areas that contributes to conservation and local livelihoods directly related to ecotourism or livelihoods in the context of ecotourism opportunities and other conservation initiatives. We add local residency and landownership to the framework to extend it to ecotourism and beyond the traditional recreational approach of one-way mostly negative impact analyses of recreation ecology. Exploring the nested hierarchical levels of both social and ecological systems of the intertwined ecotourism and local residency systems brings our framework closer to the definition of ecotourism, toward its goals of simultaneously conserving the environment while benefiting and empowering local people (Honey, 2008; Stronza et al., 2019; Fennell, 2020).

Finally, applying results of this case study to the SES framework demonstrated the important role that ecotourism plays in contributing toward the conservation of unprotected areas in the landscape. We found numerous positive outcomes for wildlife and ecosystems through our interviews. Notably, we identified financial incentives for conserving wildlife habitat in unprotected lands to act as a positive feedback cycle that supports conservation efforts on these lands, corresponding with the forest transition model. This feedback involves multiple scales of the SES for ecotourism, and multiple quadrants of the framework, with national policies incentivizing individual landowners to support conservation that provides both wildlife habitat and ecotourism opportunities. Analyzing case studies such as ours through this SES framework can allow stakeholders from a range of backgrounds, perspectives, and priorities to gain common ground in discussing the complex social-ecological system of ecotourism in a landscape.

Data availability statement

Datasets are unavailable to protect the privacy of human subjects. Requests to access these datasets should be directed to codycox75@uga.edu.

Ethics statement

The studies involving human participants were reviewed and approved by University of Georgia Institutional Review Board (STUDY00005044) and conducted under research permits approved by the Costa Rican Ministerio de Ambiente y Energía (Ministry of Environment and Energy: 019-2017-INV-ACAT; M-P-SINAC-PNI-ACAT-048-2018). The participants provided their written informed consent to participate in this study. The animal study was reviewed and approved by University of Georgia's Institutional Animal Care and Use Committee (A2015 02-008-Y3-A0; A2018 04-015-Y1-A0).

Author contributions

AM: conceptualization, formal analysis, visualization, writing, and review. CC: conceptualization, funding acquisition, methodology, project administration, data collection, visualization, writing, and review. WM: conceptualization, formal analysis, writing, and review. All authors contributed to the article and approved the submitted version.

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Conflict of interest

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

Publisher's note

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