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IUCN WCPA WORLD COMMISSION ON PROTECTED AREAS

IUCN PROTECTED AREA DEFINITION, MANAGEMENT CATEGORIES AND GOVERNANCE TYPES

IUCN defines a protected area as:
A clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values.

The definition is expanded by six management categories (one with a sub-division), summarized below.

Ia Strict nature reserve: Strictly protected for biodiversity and also possibly geological/ geomorphological features, where human visitation, use and impacts are controlled and limited to ensure protection of the conservation values.

Ib Wilderness area: Usually large unmodified or slightly modified areas, retaining their natural character and influence, without permanent or significant human habitation, protected and managed to preserve their natural condition.

II National park: Large natural or near-natural areas protecting large-scale ecological processes with characteristic species and ecosystems, which also have environmentally and culturally compatible spiritual, scientific, educational, recreational and visitor opportunities.

III Natural monument or feature: Areas set aside to protect a specific natural monument, which can be a landform, sea mount, marine cavern, geological feature such as a cave, or a living feature such as an ancient grove.

IV Habitat/species management area: Areas to protect particular species or habitats, where management reflects this priority. Many will need regular, active interventions to meet the needs of particular species or habitats, but this is not a requirement of the category.

V Protected landscape or seascape: Where the interaction of people and nature over time has produced a distinct character with significant ecological, biological, cultural and scenic value: and where safeguarding the integrity of this interaction is vital to protecting and sustaining the area and its associated nature conservation and other values.

VI Protected areas with sustainable use of natural resources: Areas which conserve ecosystems, together with associated cultural values and traditional natural resource management systems. Generally large, mainly in a natural condition, with a proportion under sustainable natural resource management and where low-level non- industrial natural resource use compatible with nature conservation is seen as one of the main aims.

The category should be based around the primary management objective(s), which should apply to at least three-quarters of the protected area – the 75 per cent rule.

The management categories are applied with a typology of governance types – a description of who holds authority and responsibility for the protected area.

IUCN defines four governance types.

Governance by government: Federal or national ministry/agency in charge; sub-national ministry/agency in charge; government-delegated management (e.g. to NGO)

Shared governance: Collaborative management (various degrees of influence); joint management (pluralist management board); transboundary management (various levels across international borders)

Private governance: By individual owner; by non-profit organisations (NGOs, universities, cooperatives); by for- profit organsations (individuals or corporate)

Governance by indigenous peoples and local communities: Indigenous peoples' conserved areas and territories; community conserved areas – declared and run by local communities.

For more information on the IUCN definition, categories and governance type see the 2008 *Guidelines for applying protected area management categories* **which can be downloaded at: www.iucn.org/pa_categories**

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A full set of guidelines is available at: www.iucn.org/pa_guidelines
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For more information see: www.parksjournal.com

PARKS is published to strengthen international collaboration in protected and conserved areas development and management by:

- exchanging information on practical management issues, especially learning from case studies of applied ideas;
- serving as a global forum for discussing new and emerging issues that relate to protected and conserved areas;
- promoting understanding of the values and benefits derived from protected and conserved areas to communities, visitors, business and others;
- ensuring that protected areas fulfil their primary role in nature conservation while addressing critical issues such as ecologically sustainable development, social justice and climate change adaptation and mitigation;
- changing and improving protected and conserved areas support and behaviour through use of information provided in the journal; and
- promoting IUCN's work on protected and conserved areas.

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PARKS: THE INTERNATIONAL JOURNAL OF PROTECTED AREAS AND CONSERVATION

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CONTENTS

LETTER FROM THE EDITOR

As the new Managing Editor for PARKS, I want to express how honoured and excited I am to be taking on this important role. I have some big shoes to fill, following the very capable editorship of Dr Marc Hockings. Marc has graciously guided me through all the steps of producing this volume so I can fly more independently in the coming months. Flying more independently, however, is not flying solo – I will rely on the wisdom of my advisory board, the hard work of my co-editors and of course, all of those who volunteer their time to contribute to the peer-review process.

As I take on my new role, I'm deeply aware that we're navigating a global landscape marked by unprecedented environmental urgency – and facing a political environment that is throwing out enormous hurdles for protected and conserved areas. Even in the United States, home of the world's first national park and a nation once proud of and admired for its effective network of protected and conserved areas (PCAs), we're seeing environmental commitments deprioritised with razor-sharp budget cuts, regulatory rollbacks and weakened protections that threaten progress made over decades. And the recent shuttering of USAID has left many PCAs around the world in a state of uncertainty.

Yet, when I reflect on my long career in conservation, I must admit that PCAs are recognised now more than ever as critical strongholds for biodiversity, climate resilience and cultural heritage. I was one of the many who fought for the various targets outlined in the 2030 Kunming-Montreal Global Biodiversity Framework so I appreciate just how vital they are for the future of PCAs globally. And even though I feel the path forward is anything but straightforward, it is driving new momentum – resulting in innovative policy frameworks, alternative funding mechanisms and a stronger emphasis on Indigenous and community-led conservation. The challenges are huge but so are the opportunities to reimagine protected areas networks in ways that are more just, adaptive and enduring. As researchers, practitioners and policymakers, it is up to us to move beyond the boundaries of traditional conservation models. We need to better embrace interdisciplinary approaches, foster inclusive governance and ensure that the voices of those who live in and steward these areas are at the centre of decision-making.

My promise as Managing Editor is to ensure that PARKS continues to grow as an important forum in which to push those boundaries and embrace and debate new approaches. In a world where we face increasing scepticism towards scientists and the persistence of 'alternate facts', I feel it is crucial that PARKS is active in showcasing our science and providing a platform to hold honest conversations about the world's PCAs. I will do my best to continue to promote practical applications and lessons learned from working on-the-ground.

Ultimately, the success of PARKS depends on your participation, so please join in the conversation by contributing your research and opinions and please be willing to participate in the peer-review process. I hope this, and every future volume of PARKS, inspires renewed commitment and collaborative action towards safeguarding the world's natural and cultural landscapes for the benefit of nature and all of us.

Margaret F. Kinnaird, Ph.D.

MEASURING DIVERGENCE: THE CONCORDANCE FACTOR FOR WORLD HERITAGE COMMITTEE DECISIONS

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ABSTRACT

The UNESCO World Heritage Convention (1972) is an important international instrument for protecting cultural and natural heritage, with far-reaching diplomatic, economic and academic implications. However, increasing criticism has been directed at the decision-making processes of the World Heritage Committee, particularly its growing tendency to disregard the recommendations of its Advisory Bodies. Until now, such criticisms have largely been anecdotal, based on undocumented observations and lacking quantitative evidence. This paper addresses this gap by proposing a quantitative methodology to measure trends in the level of concordance between Advisory Body recommendations and World Heritage Committee decisions. The study introduces metrics such as step values, step increases and the Concordance Factor to assess the degree of concordance between Advisory Body recommendations and World Heritage Committee decisions between 2005 and 2024. The findings reveal a consistent decline in alignment, with the Concordance Factor averaging in the 60% range in the mid-2000s to a 25% range for more recent committee decisions. This reflects the World Heritage Committee's increasing tendency of inscribing despite Advisory Body recommendations for deferral, referral or even non-inscription. Such decisions undermine the credibility of the World Heritage system, risking the dilution of Outstanding Universal Value, inadequate site protections and long-term management challenges.

Keywords: credibility, politicisation, rigour, expert advice, scientific evaluation

INTRODUCTION

World Heritage Convention and its Advisory Bodies

On 16 November 1972, UNESCO adopted the *Convention Concerning the Protection of the World Cultural and Natural Heritage* (hereafter referred to as the Convention). It came into operation in 1975, upon reaching the threshold of 20 ratifications. This Convention, popularly known as the World Heritage (WH) Convention, provides a mechanism to identify the world's outstanding cultural and natural heritage properties and emphasises the need for their protection and management. The Convention provides for the establishment of the World Heritage List – a list of sites that have been adjudged to have met at least one out of ten selection criteria, conditions of integrity and/or authenticity, and adequate protection and management specified in the Convention's Operational Guidelines (see Cameron & Rössler, 2013, chap. 2).

The World Heritage Committee deliberates on the inscription of new World Heritage sites every year. Inscription is the outcome of two different phases – nomination and selection – and of the interacting input of three different actors – States Parties, Advisory Bodies (ABs) and the World Heritage Committee (Strasser, 2002). States Parties submit nominations following guidelines prepared by the Committee. These nominations are then evaluated by technical ABs: ICOMOS (International Council on Monuments and Sites) and ICCROM (International Centre for the

Adoption of the World Heritage Convention in 1972 at UNESCO © UNESCO

Study of the Preservation and Restoration of Cultural Property) for cultural heritage nominations, and IUCN (International Union for Conservation of Nature) for natural heritage nominations (Convention, 1972, article 8, paragraph 3). All three ABs are comprised of international experts on heritage studies, and their role is to advise on the implementation of the Convention in their field of expertise, including assistance in the development and implementation of the Global Strategy, Training Strategy and Periodic Reporting. ICOMOS and IUCN are responsible for the evaluation process, appointing qualified experts to evaluate properties and presenting the reports to the Committee as a basis for decision (UNESCO, 2024, articles 30–37). While ICCROM does not evaluate heritage sites for UNESCO, it rather focuses more on capacity building and technical assistance.

During the WH Committee's annual meetings, experts from ICOMOS and IUCN present technical evaluations of nominations dossiers proposed by States Parties. The Committee, composed of 21 member states elected for four-year terms, reviews these recommendations and makes the final decisions on inscriptions. Typically, for every WH Committee meeting, there are between 20 and 45 nominations to consider. For each nomination, and prior to the WH Committee meeting, the ABs carry out an extensive technical review through a rigorous evaluation process in an effort to establish whether or not the proposed WH site has what is known as 'Outstanding Universal Value' (OUV), the test a nomination must pass to be recommended for inscription. Based on Operational Guidelines (UNESCO, 2024, article 49), 'Outstanding Universal Value means cultural and/or natural significance which is so exceptional as to transcend national boundaries and to be of common importance for present and future generations of all humanity.' The review process for each AB comprises an in-depth on-site inspection which typically includes consultations with local stakeholders, and local and national authorities. The process involves the gathering of advice and opinions of regional or thematic experts, discussions with officials and experts from the nominating country, conducting a comparative analysis against similar properties worldwide, a bibliographic review, and the convening of a panel of experts which deliberates over the evidence collected.

Several weeks prior to the WH Committee meeting, the ABs publish the results of their technical evaluations. These results are distributed to WH Committee members for their consideration, so that their decisions during the WH Committee meeting may be well informed.

The ABs have four options when recommending a course of action to the WH Committee:

1. **Inscription:** The ABs have concluded that the nominated property has OUV. This implies that the ABs consider that one or more of the inscription criteria is/are fully met, and that the property meets the conditions of authenticity and integrity (cultural properties) or of integrity (natural properties), and that it is effectively protected and managed.

Advisory Bodies present findings to the World Heritage Committee © UNESCO

2. **Referral:** The ABs have determined that the OUV has been demonstrated, but that these nominations have minor issues that can be addressed within the 3-year timespan of a referral. Under these circumstances, the State Party may re-submit the same nominations, but with the improvements required. The re-evaluation of a referred property undergoes a similarly rigorous evaluation process and makes a recommendation in relation to inscription but without a further field mission to determine if the weaknesses identified have been corrected.
3. **Deferral:** The ABs have concluded that there is a lack of adequate justification of the OUV and/or the management regime for the proposed site is inadequate. The lack of evidence of OUV may be due to a weak comparative analysis which fails to make the case that a particular site is truly the most outstanding of its kind. It may also be due to poor or unclear argumentation for inscription under specific criteria, or other such fundamental weaknesses in the nomination or the management regime. The ABs consider that a significant restructuring of the nomination is required to address these issues. When a deferred nomination is revised and re-submitted, given that the changes are considered to be so important, it must be subjected to a new formal evaluation process by the ABs, including a new site inspection, background literature review, and expert panel deliberation. As this process is time consuming, the deferred nomination cannot be re-examined by the WH Committee until at least two years have elapsed after the original nomination but may be much longer.
4. **Non-inscription:** The ABs have determined that the nominated property has not been proven to have OUV which implies that one or more of the three pillars of OUV – criteria, integrity and authenticity, protection and management – cannot be met. As a result, no further re-nomination effort is warranted.

At the WH Committee meeting, ABs present each nomination one at a time, and explain the reasoning behind its recommendation to the WH Committee. The debate is then opened to the WH Committee members, who may ask for clarifications from the ABs, make statements of opinion, or even request clarifications from the State Party whose nomination is being considered. Typically, after up to an hour or more of deliberation, a decision is made, most often by consensus. In controversial cases the deliberation process can last much longer.

Implications of rejecting ABs' recommendations on nominations

The WH Convention is regarded as one of the most effective international legal instruments for protecting cultural and natural heritage (Strasser, 2002; Titchen, 1996). Decisions made by the WH Committee on the site inscriptions carry significant diplomatic, academic and economic implications (VanBlarcom & Kayahan, 2011).

In the early days of the Convention, there was a very high level of acceptance by the WH Committee of the ABs' recommendations but this has changed over time. There is growing criticism directed at the decision-making process for World Heritage site inscriptions and its credibility (Cameron, 2013; Cleere, 2011; Jokilehto, 2011; Meskell, 2013; Pressouyre, 1996; von Droste, 2011). Concern has been expressed by observers, WH Centre staff, States Parties to the Convention and WH Committee members that the decision-making process for inscriptions may be increasingly disregarding the expert advice and evidence provided by the ABs, and that the WH Committee may have a growing tendency to reject the recommendation of the ABs in a desire to provide more favourable outcomes. This is manifested by decisions to:

1. Inscribe sites that are recommended for 'referral' or even 'deferral' (or in rare cases 'non-inscription'), or
2. Refer sites that are recommended for 'deferral' or 'non-inscription', or
3. Defer sites recommended for 'non-inscription'.

For instance, some scholars pointed to the 34th Committee Session in Brasilia in 2010 as a turning point for this divergence (Brumann, 2022). The ABs recommended 14 sites out of 37 for inscription, which is 39% of the submitted nominations. However, the WH Committee ultimately inscribed 23 nominations, constituting 64% of the submitted cases (UNESCO, 34COM, 2010, Decisions). These decisions were made without adhering to the Committee's established rules, which require a formal process for reconsideration of ABs' recommendations. If the Committee disagrees with an ABs' evaluation, it should seek clarification or additional justification from the ABs rather than bypassing the established evaluation process. Brumann (2022) further points out that by 2015, overruling experts' advice in the session and swapping pre-negotiated support for this purpose have become common practice from which only a minority of Committee members refrain.

Though there is, no doubt, a general desire to have new sites inscribed in the most expedient manner, disregarding recommendations of the ABs has important repercussions. The WH Committee inscribing sites that, in the opinion of the ABs, do not exhibit OUV risks de-valuing the WH brand. Sites may also be inscribed despite an absence of clear boundaries or buffer zones, or without sufficient legal protections. In such cases, there is a greater risk of thorny and protracted management challenges arising over the years.

These problems may end up consuming a disproportionate amount of the increasingly limited resources available to the ABs, the WH Centre and the WH Committee. Such sites are more likely to be the source of complex issues that may not have arisen had the WH Committee waited until a technically robust nomination had been presented before making its decision on listing. For example, IUCN's WH Outlook data indicate that sites inscribed against IUCN's recommendations tend to have a disproportionally worse outlook than others (WWF, 2019).

Furthermore, there is also an impact on the people who have championed technically rigorous nomination proposals – having invested years of concerted effort on behalf of local and national stakeholders. When their nominations recommended for inscription are inscribed alongside other nominations recommended for deferral or referral, there is an understandable sentiment of double standards that undermines the well-deserved sense of accomplishment and prestige that should be felt by all those involved in preparing a strong nomination. Overall, decisions that do not consider ABs' nomination recommendations risk weakening the highly regarded WH brand.

Until now, the concern over an increasing disregard by the WH Committee for ABs' recommendations has been predominantly anecdotal, based on undocumented observations and unsupported by any quantitative published evidence. While some quantitative studies exist (see Meskell et al., 2014), they remain limited in number, and the methodology used to determine the concordance factor has not been demonstrated. This paper proposes an objective and quantitative methodology to measure the trends in the level of concordance between the ABs' recommendations regarding inscriptions of new WH sites, and the decisions taken by the WH Committee so that the anecdotal evidence can be either confirmed or refuted.

This paper only focuses on decisions regarding the inscription of nominations or re-nominations.[1] Minor or major modifications are not considered, for instance, a minor issue regarding boundary, naming or area clarifications. In addition, decisions for which the ABs' recommendation was 'inscription' were not considered, as it is assumed in such circumstances that there is effectively no possibility for disagreement by the Committee.[2]

1 A State Party may submit a renomination of a property to alter the criteria under which it is to be recognised, or to propose a major boundary modification.

2 There are very rare cases where the WH Committee decided to refer a nomination recommended for inscription by an AB due to delicate political reasons such as international boundary issues or at the request of the State Party. For instance, in 2001, in the 25th session of the WH Committee, 'The Bolgar Historical and Architectural Complex' recommended for inscription by ICOMOS was later deferred by the WH Committee. See https://whc.unesco.org/document/1228 and https://whc.unesco.org/document/1269.

METHODOLOGY

To quantitatively monitor the trend in decision-making by the WH Committee, AB recommendations and WH Committee decisions on nominations are first allocated a numerical step value as follows:

Numerical equivalencies	
Decision	**Step Value**
Inscription	1
Referral	2
Deferral	3
Non-inscription	4

These cases are not considered in this paper.

Hence, when an AB recommends deferral for a particular nomination, this is given a step value of 3 in the analysis. The WH Committee's decision for the same nomination is given its equivalent step value. For mixed properties, the step value of the AB recommendation is taken as the average between the recommendations of ICOMOS and IUCN (e.g. a Referral (value = 2) from one AB, and a Deferral (value = 3) from another, will result in a step value of 2.5). If either of the ABs recommend inscription of the site, then that site is treated as other sites recommended for inscription and not considered in this study. These step values are attributed for all nomination decisions during a WH Committee meeting, resulting in a table such as the one for the WH Committee meeting in 2010.

Table 1. WH nomination decisions and AB recommendations for WH COM34 in 2010

Property ID	Name	Country	AB Recommendation		WH COM Decision	
1335	China Danxia	China	D	3	I	1
1325	Phoenix Islands	Kiribati	D	3	I	1
1252	Tajik National Park	Tajikistan	D	3	D	3
1203	Sri Lanka Central Highlands	Sri Lanka	R-D	2.5	I	1
1204 rev	Dinosaur Ichnites	Spain / Portugal	N	4	D	3
1306	Convict Sites	Australia	R	2	I	1
1344	Wallonia Mining Sites	Belgium	D	3	D	3
1333	Konso	Ethiopia	D	3	R	2
1338	Janta Mantar	India	R	2	I	1
1295	Fort Jesus	Kenya	D	3	R	2
1352	Caves of Oaxaca	Mexico	R	2	I	1
1324	Korean Villages	Republic of Korea	R	2	I	1
1329	At Turaif, Saudi Arabia	Saudi Arabia	D	3	I	1
1313 rev	Mercury and Silver	Spain / Mexico / Slovenia	D	3	D	3
1247	Darwin's House	UK	N	4	D	3
1328	Thang Long Citadel	Viet Nam	D	3	I	1

AB recommendations and WH decisions and associated step values
I = Inscribe (1), R = Refer (2), D = Defer (3), N = Not inscribe (4)

Once attributed a numerical value, the degree of concordance between the AB recommendation and the WH Committee decision can also be quantified (the step increase). Simply, the step increase is the numerical difference between the AB recommendation value and that of the WH Committee's decision. For example, an AB recommendation for Deferral (value = 3) and a WH Committee decision to inscribe (value = 1) results in a step increase of (3 - 1). The larger the step increase, the lesser the concordance. Table 2 presents the step increase calculation for the COM 34 session in 2010.

Table 2. Step increases for WH Committee decisions

Property ID	Name	Country	AB Recommendation		WH COM Decision		Step Increase
1335	China Danxia	China	D	3	I	1	2
1325	Phoenix Islands	Kiribati	D	3	I	1	2
1252	Tajik National Park	Tajikistan	D	3	D	3	0
1203	Sri Lanka Central Highlands	Sri Lanka	R-D	2.5	I	1	1.5
1204 rev	Dinosaur Ichnites	Spain / Portugal	N	4	D	3	1
1306	Convict Sites	Australia	R	2	I	1	1
1344	Wallonia Mining Sites	Belgium	D	3	D	3	0
1333	Konso	Ethiopia	D	3	R	2	1
1338	Janta Mantar	India	R	2	I	1	1
1295	Fort Jesus	Kenya	D	3	R	2	1
1352	Caves of Oaxaca	Mexico	R	2	I	1	1
1324	Korean Villages	Republic of Korea	R	2	I	1	1
1329	At Turaif, Saudi Arabia	Saudi Arabia	D	3	I	1	2
1313 rev	Mercury and Silver	Spain / Mexico / Slovenia	D	3	D	3	0
1247	Darwin's House	UK	N	4	D	3	1
1328	Thang Long Citadel	Viet Nam	D	3	I	1	2

Average Step Increase (Av SI)

With this information, the quantitative analysis can now be carried out (Table 3). The sum of the step increase values (17.5 in the example below) is divided by the total number of nomination decisions taken, for an average step increase given by the committee.

Table 3. Avergage Step Increase Calculation

Property ID	Name	Country	AB Recommendation		WH COM Decision		Step Increase
1335	China Danxia	China	D	3	I	1	2
1325	Phoenix Islands	Kiribati	D	3	I	1	2
1252	Tajik National Park	Tajikistan	D	3	D	3	0
1203	Sri Lanka Central Highlands	Sri Lanka	R-D	2.5	I	1	1.5
1204 rev	Dinosaur Ichnites	Spain / Portugal	N	4	D	3	1
1306	Convict Sites	Australia	R	2	I	1	1
1344	Wallonia Mining Sites	Belgium	D	3	D	3	0
1333	Konso	Ethiopia	D	3	R	2	1
1338	Janta Mantar	India	R	2	I	1	1
1295	Fort Jesus	Kenya	D	3	R	2	1
1352	Caves of Oaxaca	Mexico	R	2	I	1	1
1324	Korean Villages	Republic of Korea	R	2	I	1	1
1329	At Turaif, Saudi Arabia	Saudi Arabia	D	3	I	1	2
1313 rev	Mercury and Silver	Spain / Mexico / Slovenia	D	3	D	3	0
1247	Darwin's House	UK	N	4	D	3	1
1328	Thang Long Citadel	Viet Nam	D	3	I	1	2
TOTAL				45.5		28	17.5

In this case, 16 nominations for which the advisory bodies did not recommend inscription were considered. The average step increase given by the WH Committee for nominations in 2010 is:17.5 / 16 = 1.09. This value is roughly equivalent to a systematic 'upgrade' of one step on all AB nomination recommendations (not including 'inscription') in 2010.

Maximum Possible Average Step Increase (Max SI)

Given that the margin for 'upgrading' by the WH Committee may vary from year to year, depending on the quality of nominations and the recommendations from ABs, the average step increase for a particular WH Committee meeting cannot be meaningfully compared from meeting to meeting. For instance, in one meeting the ABs may recommend all sites for referral, giving the WH Committee only the possibility of a step increase of 1 (e.g. referral to inscription). In another meeting, the ABs may recommend non-inscription for all nominations, giving the WH Committee the opportunity for greater step increases of up to 3 (non-inscription being attributed a value of 4, and inscription having a value of 1; 4 - 1 = 3).

By calculating the maximum possible average step increase (Max SI) for a particular WH Committee meeting, and comparing the actual average step increase given by the WH Committee at that meeting, one can better compare the extent to which WH Committee decisions have diverged from the AB recommendations between WH Committee meetings.

The Max SI is calculated by attributing the greatest possible step increase for each decision, and dividing the sum of these values by the number of nomination decisions subjected to the analysis. The greatest possible step increases occur when the WH Committee decides to inscribe a property. As inscription receives a quantitative value of '1'. In such circumstances, the maximum possible step increase when the AB recommends non-inscription, is 3 (4 - 1), deferral is 2 (3 - 1) and referral is 1 (2 - 1).

In the tables above, the WH COM decisions column illustrates the variation in decisions made by the Committee. This column adds up to a total of 28. The maximum divergence from the AB recommendations would have occurred should the Committee have decided to inscribe all sites. In such a case, the WH Committee decision column would have added up to only 16 (the value of Inscription is 1, and there are 16 nominations being considered).

Thus, calculating the Max SI is as follows: (45.5 - 16) / 16 = 1.84 for WH COM 34 (2010).

Concordance Factor

With the Max SI, one can now calculate the Concordance Factor (CF). The CF is a standardised measure of the extent to which the WH Committee has moved away from having validated all of the AB recommendations, to having inscribed all nominations. A CF of 0% implies inscription of all nominations, whereas a 100% concordance implies validation of all AB recommendations.

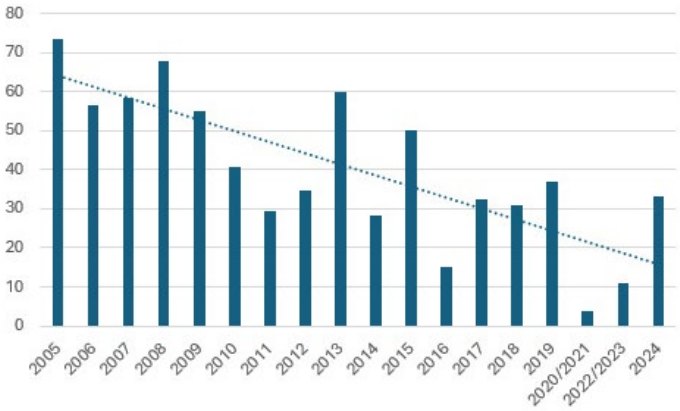

Figure 1. Concordance Factor for WH Committee decisions, 2005–2024. Dotted line = linear trend line

The CF, expressed as a percentage, is calculated as follows:

CF = [1 - (Av SI/Max Si)] x 100

Thus a CF of 100 indicates complete alignment between AB advice and WH Committee decisions and a CF of 0 indicates maximum divergence.

RESULTS

The Concordance Factor for each of the WH Committee meetings from 2005 (WH COM 28) to 2024 (WH COM 41) is presented in Figure 1.

The 20-year average is 42% and the trend is decidedly away from increased concordance.

DISCUSSION

Based on a quantitative assessment of the divergence of WH Committee decisions from ABs' recommendations relating to WH nominations, the anecdotal evidence is clearly corroborated. There is no longer any doubt over the reduced concordance between AB recommendations and WH Committee decisions. In fact, this decline in alignment is not limited to site nominations but extends to other areas, such as State of Conservation reports and the listing of sites as WH in Danger, although these fall outside the scope of this paper (see Hølleland et al., 2019; Meskell, 2014).

Reasons for reduced concordance

Several scholars have identified the increasing 'politicisation' of the selection process by States Parties as a key factor leading to this reduced concordance between ABs' recommendations and WH Committee decisions. Critics argue that the WH List is increasingly shaped by political influence and national strategic interests rather than objective criteria (Bertacchini et al., 2016). The growing dominance of career diplomats, instead of heritage experts, within the WH Committee has further shifted the decision-making towards political

The 43rd Session of the UNESCO World Heritage Committee meeting held in Baku, Azerbaijan, 2019 © Ministry of Culture of the Republic of Azerbaijan / M.Ragimov.

trade-offs, undermining professional judgement (von Droste, 2011). In some instances, WH designations have become political tools for advancing sovereign interests, with national self-interests driving more and more openly-conducted bilateral lobbying and deal-making (Brumann, 2022). This trend has raised concerns that heritage conservation demands, technical expertise and objective standards are being disregarded in favour of political considerations (Brumann & Gfeller, 2021; Hølleland et al., 2019; James, 2016; James & Winter, 2015; Liuzza, 2021).

Moreover, decision-making within the WH Committee has shifted towards greater multipolarity, reflecting broader geopolitical dynamics (Wade, 2011). As interest in WH grows, so does participation in Committee sessions. Attendance in each Committee session, which rarely exceeded 100 participants before 1992, reached 500 in 2000, and surged to nearly 2,900 by 2024 (including 1,400 delegates from 136 States Parties in the 46th Session). This increase in participation, coupled with the growing complexity of site evaluations, has placed more pressure on the decision-making process, where desirable outcomes increasingly outweigh the need to consider technical issues.

Inefficacy of previous solutions

The systemic issues surrounding the WH Committee's decision-making process were recognised as early as 2010, when Kishore Rao, then Deputy Director of the World Heritage Centre, noted that the Committee's criticism of the ABs highlighted inherent problems within the system (Rao, 2010). By 2012, dissatisfaction among certain States Parties led to proposals for alternative advisory mechanisms, should these tensions continue (Bertacchini et al., 2016). In response, the WH Committee initiated internal reflections, such as the creation of an informal working group in 2014, to address challenges in working methods and nomination evaluation processes (UNESCO, 2014, Decision 38 COM 13, 9).

Efforts to improve the effective use of the Tentative List have also been discussed, with scholars suggesting that it should serve not only as a procedural requirement but also as a strategic tool for assessing the feasibility of proposed nominations (Jokilehto, 2011). Although the Operational Guidelines identify the Tentative List as a prerequisite for submitting new nominations, there has been no formal evaluation of these lists to date.

However, despite past concerns and efforts to address these challenges, the continuing overall decline of the CF indicator value studied in this paper suggests that progress has been elusive. Systemic issues persist, underscoring the need for renewed efforts and innovative strategies. It is imperative to continue refining the nomination and evaluation processes to foster a more inclusive, transparent and effective World Heritage system.

CONCLUSION

Understanding the reduction in concordance between ABs and the Committee on WH nomination decisions is crucial, as this conflictual situation undermines both the viability and credibility of the WH List. According to the Budapest Declaration adopted in 2002, the '4Cs' — Credibility, Conservation, Capacity-building, and

Communication—are essential for the equitable and sustainable implementation of the WH Convention (UNESCO, 2002). Strengthening the credibility of the WH List is widely recognised as a priority to ensure it remains a representative and geographically balanced record of cultural and natural properties of Outstanding Universal Value (OUV). However, the disregard for scientific evaluations by the ABs, coupled with the rapid increasing number of WH sites, risks undermining the coherence of the WH List and its unique concept of the OUV, ultimately diminishing its credibility (Zunjic, 2023).

Jokilehto (2011) emphasises the importance of respecting each partner's role in the World Heritage process, warning that disregarding ABs' recommendations without justification risks fostering an environment of arbitrariness. This, in turn, could damage the credibility of the Convention and weaken conservation efforts. 'Over the years, the Committee has always encouraged the Advisory Bodies to be strict in their evaluations. Now, the Advisory Body is punished when making a special effort to do its job correctly.' (Jokilehto, 2011, p. 73). He raises a pertinent question: whether it is really in the interest of the States Parties to insist on inscriptions when ABs have determined that requirements are not yet adequately met?

To address these challenges, it is crucial to systematically monitoring the Concordance Factor between the WH Committee and ABs. This will transform anecdotal assumptions into documented evidence and provide a basis for evaluating measures aimed at reversing the trend. The quantitative methodology presented in this paper offers a rigorous and replicable tool for assessing recent trends, offering a foundation for future research and policy discussions aimed at safeguarding the credibility of the World Heritage List.

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Marc Patry spent 11 years at the UNESCO World Heritage Centre secretariat, where he helped organize and participated in most WH Committee meetings during that time. He now runs his own travel company, Cultural and Natural Heritage Tours.

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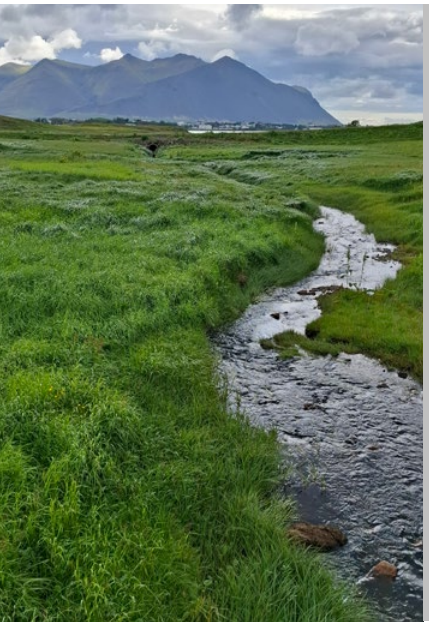
RESUMEN

La Convención del Patrimonio Mundial de la UNESCO (1972) es un importante instrumento internacional para la protección del patrimonio cultural y natural, con implicaciones diplomáticas, económicas y académicas de gran alcance. Sin embargo, se han dirigido cada vez más críticas a los procesos de toma de decisiones del Comité del Patrimonio Mundial, en particular a su creciente tendencia a ignorar las recomendaciones de sus órganos consultivos. Hasta ahora, estas críticas han sido en gran medida anecdóticas, basadas en observaciones no documentadas y carentes de pruebas cuantitativas. Este documento aborda esta laguna proponiendo una metodología cuantitativa para medir las tendencias en el nivel de concordancia entre las recomendaciones de los órganos consultivos y las decisiones del Comité del Patrimonio Mundial. El estudio introduce métricas como los valores de los pasos, los incrementos de los pasos y el factor de concordancia para evaluar el grado de concordancia entre las recomendaciones de los órganos consultivos y las decisiones del Comité del Patrimonio Mundial entre 2005 y 2024. Los resultados revelan una disminución constante en la alineación, con un promedio del factor de concordancia en el rango del 60 % a mediados de la década de 2000 y un rango del 25 % para las decisiones más recientes del comité. Esto refleja la creciente tendencia del Comité del Patrimonio Mundial a inscribir, a pesar de las recomendaciones de los órganos consultivos de aplazamiento, remisión o incluso no inscripción. Tales decisiones socavan la credibilidad del sistema del Patrimonio Mundial, con el riesgo de diluir el Valor Universal Excepcional, una protección inadecuada de los sitios y desafíos de gestión a largo plazo.

RÉSUMÉ

La Convention du patrimoine mondial de l'UNESCO (1972) est un instrument international important pour la protection du patrimoine culturel et naturel, avec des implications diplomatiques, économiques et académiques de grande portée. Cependant, les processus décisionnels du Comité du patrimoine mondial ont fait l'objet de critiques croissantes, notamment en ce qui concerne sa tendance à ne pas tenir compte des recommandations de ses organisations consultatives. Jusqu'à présent, ces critiques étaient largement anecdotiques, basées sur des observations non documentées et manquant de preuves quantitatives. Cet article comble cette lacune en proposant une méthodologie quantitative pour mesurer les tendances du niveau de concordance entre les recommandations des organisations consultatives et les décisions du Comité du patrimoine mondial. L'étude introduit des mesures telles que les valeurs d'étape, les augmentations d'étape et le facteur de concordance pour évaluer le degré de concordance entre les recommandations de l'organe consultatif et les décisions du Comité du patrimoine mondial entre 2005 et 2024. Les résultats révèlent un déclin constant de la concordance, le facteur de concordance se situant en moyenne autour de 60 % au milieu des années 2000 et autour de 25 % pour les décisions plus récentes du Comité. Cela reflète la tendance croissante du Comité du patrimoine mondial à inscrire des biens en dépit des recommandations de l'organisation consultative en faveur d'un report, d'un renvoi ou même d'une non-inscription. De telles décisions nuisent à la crédibilité du système du patrimoine mondial et risquent d'entraîner une dilution de la valeur universelle exceptionnelle, une protection inadéquate des sites et des problèmes de gestion à long terme.



ASSESSING LAND-USE GOVERNANCE SYSTEMS AS POTENTIAL OECMS IN ICELAND

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ABSTRACT

Protected areas (PAs) and Other Effective Area-based Conservation Measures (OECMs) are nation states' key conservation strategies to meet the 30 per cent area-based conservation target of the Global Biodiversity Framework (GBF). Iceland is updating its biodiversity strategy, aligning with the GBF targets. The objective of this study is to progress the development of OECMs and to examine their potential in Iceland. Iceland has multiple area-based governance systems with various objectives, additional to its formal PA estate. We identify and analyse relevant area-based governance systems in the country, employing a stepwise approach based on institutional analysis and application of the IUCN-WCPA OECM site-level tool. The study identifies eleven area types for consideration while the analysis reveals their different qualities and challenges and suggests eight of these as potential OECMs. This first study of terrestrial OECMs in Iceland illustrates a considerable potential to expand such area-based conservation efforts. OECMs are not yet included in Iceland's nature conservation policy framework, highlighting a need for national policy guidance, for which we provide recommendations.

Keywords: Global Biodiversity Framework, nature conservation policy, institutional analysis, governance

INTRODUCTION

The UN-CBD Global Biodiversity Framework (GBF) commits signatory countries to conserve at least 30 per cent of terrestrial and inland water areas, and of marine and coastal areas, within systems of protected areas (PAs) and Other Effective Area-based Conservation Measures (OECMs) before the year 2030, especially in areas of particular importance for biodiversity and ecosystem functions and services (CBD, 2022).

PAs are a well-established approach, generally set up under national legal frameworks, spatially defined with different systems of governance and have nature conservation as the primary objective, while also delivering multiple other ecosystems services to society (Dudley, 2008). Their coverage has been increasing and currently encompasses around 18 per cent of the global terrestrial area, still far from the 30 per cent target although with significant national differences (Maxwell et al., 2020; Robinson et al., 2024).

In addition to formal PAs, many other area-based governance arrangements have the capacity to deliver nature conservation (Gurney et al., 2021; IUCN-WCPA, 2019). Such potential can be found, for example, in forest reserves, military sites, recreational areas and water conservation areas (Cook, 2024a). Where such an area can demonstrate achievement of biodiversity conservation outcomes, it could be considered as an OECM (Dudley et al., 2018; Gurney et al., 2021; Robinson et al., 2024). OECMs are now a legitimate part of nation states' efforts to reinforce nature conservation in the new GBF, and are seen as additional and complementary to each country's formal PA estate (Jonas et al., 2018, 2024). Key differences between OECMs and PAs are that firstly, OECMs must demonstrate positive biodiversity outcomes, and secondly OECMs can be managed with primary objectives other than nature conservation (Jonas et al., 2018). Area-based governance systems that deliver conservation in addition to formal PAs can enable more inclusive conservation

efforts managed by a diverse set of stakeholders, which broadens the spectrum of area-based conservation measures.

A major challenge in nation states' efforts in recognising and including areas as OECMs within area-based conservation is defining the necessary qualities such areas must possess. In 2018, the Convention on Biological Diversity (CBD) adopted a definition of OECMs and provided the criteria an area must fulfil to be considered as an OECM (CBD, 2018). General guidelines that interpret these criteria (IUCN-WCPA, 2019) and a site-level tool (Jonas et al., 2023) have also been provided to support the application of the CBD decision. While this guidance is useful, the concept is still evolving, and there is ongoing discussion about their attributes and how they might be accommodated within diverse national contexts and systems (Fitzsimons et al., 2024a). Many nation states are evaluating which land-use governance systems can be recognised as OECMs (Cook, 2024a, 2024b; Dudley et al., 2018). Some apply the IUCN-WCPA (2019) criteria to screen possible OECMs (Cook, 2024a). Examples include Japan (Shiono et al., 2021), Spain (Rodríguez-Rodríguez et al., 2021), South Africa (Marnewick et al., 2021), UK (IUCN-UK, 2023) and Australia (Fitzsimons et al., 2024b).

This paper focuses on identifying potential terrestrial OECMs in Iceland, a country that is currently assessing its national biodiversity policy, seeking to align it with the new GBF commitments. This paper complements a recent study assessing the potential for marine OECMs in Iceland (Ólafsdóttir et al., 2024). The objective is to examine which area-based governance systems might qualify as terrestrial OECM candidates and to contribute to the policy development for including such areas into conservation efforts. The following research questions guided our analysis:

1. What area-based land-use systems of governance are likely to include individual areas suitable for consideration as candidate OECMs, and what are the associated challenges and opportunities?
2. What are the policy implications of the analysis for formalising OECMs in Iceland and beyond?

ICELAND'S PROTECTED AREAS AND OTHER AREA-BASED CONSERVATION GOVERNANCE

The first PA was established in Iceland in 1930 in Þingvellir National Park under site-specific legislation (Siltanen et al., 2022). After a quarter-century hiatus, the *Nature Conservation Act* was passed in 1956, prompting a gradual expansion of the PA estate (Petursson et al., 2016). After nearly a century of area-based conservation efforts, formal terrestrial PAs now cover approximately 25 per cent of the country's total terrestrial area of 103,000 km^2, divided into around 130 individual PA units of various size, established either under the Act or through site-specific legislation (URN, 2022). Notably one PA is by far the largest: Vatnajökull National Park, established in 2007, covers around 15,000 km2, is a World Heritage Site and the largest national park in Europe outside Russia (Petursson & Kristofersson, 2021).

Although Iceland has already developed a considerable terrestrial PA estate, much of it features glaciers and highlands; areas that do not necessarily possess high biodiversity conservation value. Ottósson et al. (2016) noted that there is a need to expand conservation efforts to encompass more biodiversity-rich areas, particularly in the lowlands. Supplementary Material 1 gives further detail on the Icelandic PA context.

Concurrent with the evolution of PAs, Iceland developed multiple other land-use area-based governance systems. These include areas reserved for forestry, land restoration, water conservation, religious purposes, recreation, local government purposes and single site-specific arrangements. We examined the extent to which such governance types might contain individual sites with potential to be designated as OECMs.

METHODS

We organised our analysis of possible OECMs in Iceland according to the following stepwise design (Table 1). The data used for the analysis come from both primary and secondary sources.

The first step was scoping area-based governance arrangements in Iceland. This was carried out by a systematic analysis of the key regulatory frameworks and policy documents that relate to land-use governance systems. This resulted in eleven possible area types that we deemed having potential to qualify as OECMs. The scoping approach was broad to ensure the inclusion of as many potential area types as possible.

The second step was an institutional analysis of the governance systems associated with the potential area types (Petursson & Kristofersson, 2021; Siltanen et al.,

Table 1. A stepwise analytical approach to assess area types as possible OECM candidates

Step	Approach	Description
1	Scoping	Review of policy and regulatory documents, examining possible area-based governance arrangements and identifying possible OECM candidates
2	Institutional analysis	Analysis of the qualities of the area-based governance systems identified in the scoping step
3	Application of the OECM framework	Adaptation of the IUCN-WCPA site-level tool for OECMs (Jonas et al., 2023) to assess the candidate area types
4	Interviews	Representatives of OECM candidate area types interviewed about their perceptions of potential OECM identification (see Supplementary Material 2 for details)
5	Ranking	Ranking area types according to suitability to be considered OECMs
6	Recommendations for identifying potential OECMs	Discussing opportunities and constraints for each area type and needs for a possible recognition as OECM

2022). This included analysis of governance components such as their key management objectives, legal and regulatory frameworks, lead actors, property rights, extent and coverage. This analysis provided information about the qualities of the respective governance systems and allowed for an understanding of suitability for OECM consideration.

In the third step we applied the guidelines and criteria from the IUCN-WCPA site-level tool for OECMs to the eleven area type candidates we had identified and analysed (Jonas et al., 2023). This framework served as a basis for determining the extent to which an area type is likely to meet the international OECM criteria. While these criteria are designed to be applied at the site-level, we have adapted them to assess governance types, leaving out those that cannot be deployed at this level. Our analysis is intended to identify the most promising governance types for follow-up site-based analyses.

The fourth step involved key informant semi-structured interviews with representatives from the governance authority responsible for each of the area types with potential to be OECMs. Given the voluntary nature of OECM establishment (Fitzsimons et al., 2024a), understanding governance authority perceptions is of critical importance because seeking free, prior and informed consent is an essential precursor to applying the site-level tool (Jonas et al., 2023). Questions focused on their understanding of OECMs, views on the various systems being considered as OECMs and reconciliation of biodiversity and nature conservation objectives with current management objectives.

The fifth step was to examine key opportunities and constraints for including each area as an OECM. We then ranked the area types from the most likely to the least likely to include suitable OECMs and grouped them accordingly.

As a final step, we provide policy and institutional recommendations on the area types that are well aligned with OECMs. We conclude the analysis with general comments and observations identifying potential OECMs within the context of Iceland's area-based nature conservation efforts.

RESULTS AND DISCUSSION

Scoping and assessing the attributes of area-based governance systems

The scoping of the area-based systems of governance in Iceland resulted in eleven area types deemed suitable for further analysis. Analysis of these eleven governance systems illustrates their different qualities and attributes relevant to OECM status, focusing on their institutional attributes such as policy objectives, key actors, legal frameworks, management regulations, land tenure and current extent (Table 2).

Table 2. Institutional analysis of area-based governance systems for potential terrestrial OECMs in Iceland

Area type	Primary policy objective	Biodiversity as secondary objective	Key actor	Legal framework	Management regulation	Land tenure	Current extent
1. Forest Reserve *(Þjóðskógar)*	Forestry and forest conservation	Yes, in the legal framework	Land and Forest Iceland*	*Forests and Forestry Act* 33/2019	By-laws for each site, management plans	Mainly central government	Ca 50 areas, less than 500 km², new sites can be added
2. Soil Conservation Areas *(Landgræðslusvæði)*	Land restoration, soil conservation	Yes, in the legal framework	Land and Forest Iceland	*Land Restoration Act* 155/2018	By-laws for each site, management plans	Mainly central government	Ca 77 areas, total 2,850 km², new sites can be added
3. Parsonage Land *(Prestsetursjarðir)*	Farms, sites for priests and churches	No	Church body, local priest	*National Church Act* 77/2021	Policy on parsonage	The National Church	35 farms
4. Public Lands *(Þjóðlendur)*	Site specific, or not specified	Yes, outlined in the public land policy	Prime Minister's office; local government	*Public Lands Act* 58/1998	Not specified	Designated public	Ca 250 units, ca 40 per cent of Iceland, some PAs
5. Nature Conservation Register *(Náttúruminjaskrá)*	Nature Conservation	Yes, in the law	Environment Agency	*Nature Conservation* Act 60/2013	Act imposes some rules for sites on the register	Multiple, designation does not require landowners' consent	Around 500 sites
6. Recreation Areas *(Heiðmörk Útivistarsvæði)*	Recreation, forestry, land restoration	No	Local government. Commonly in cooperation with local forest NGOs	*Planning Act* no. 123/2010	Management plans for many sites	Mainly local government	No register of number or area
7. Water Conservation Areas *(Vatnsverndarsvæði)*	Water protection	Yes, for aquatic ecosystems	Local government	*Water Management Act no. 36/2011, Sanitation and Pollution Prevention Act no.* 71/1998	By laws for each site	Multiple	No register of number or area
8. Municipal Spatial Planning Protection Areas *(Hverfisverndarsvæði)*	Multiple protection objectives; cultural and natural heritage	Yes, in legislation and associated by-laws	Local government	*Planning Act* no. 123/2010	Objectives for each site	Multiple, designation does not require landowners' consent	No register of number or area
9. Þingvallavatn Catchment Area *(Vatnasvið Þingvallavatns)*	Water protection in the Þingvallavatn catchment and lake	Yes, in legislation	Environment Agency, local government	*Law on the protection of Þingvallavatn and its catchment area no. 85/2005*	By-law under the legislation	Multiple	Fixed size of around 1,300 km², including a PA
10. Ramsar site in Mývatn & Laxá (*Ramsarsvæði í Mývatnssveit)*	Wetland protection for the only Ramsar site in Iceland that is not a PA	Yes, in legislation	Environment Agency, local government	*Conservation of Mývatn and Laxá and its Water Catchment Area Act* no. 97/2004	Act allows for formal management plan and policy	Mainly public land	Fixed size of around 200 km², includes a PA
11. Geoparks (*Reykjanes Jarðvangur)*	Geoheritage, nature-based tourism	No	Local government, diverse stakeholders	Established by agreement between local governments, NGOs and UNESCO	Geopark policy	Multiple, designation does not require landowners' consent	Reykjanes, 829 km² and Katla 9,542 km²

*Established in 2024 by merging the Forest Service and Soil Conservation Service

Public lands: The Þórsmörk area is public land that has been governed as a forest reserve for decades. The area has spectacular landscapes and biodiversity-rich native birch woodlands. This large area is not a protected area but might qualify as an OECM © Helga Hvanndal Björnsdóttir.

Forest reserves: The study finds many forest reserves with potential to be OECMs in Iceland. This is a native woodland in Litla-Skard forest reserve in West Iceland © Jón Geir Pétursson.

Parsonage lands: Parsonage properties are potential OECM candidates. This photo is one such property, Borg in West Iceland © Jón Geir Pétursson.

Potential of the area types to qualify as OECMs

We adjusted the IUCN-WCPA criteria specified in the site-level tool to refer to governance systems and assessed whether each of the eleven systems might include individual areas suitable for OECM status (Table 3). All governance systems met Criterion 1 “other than a protected area” and Criterion 2 “reasonable likelihood of containing biodiversity”, which are required to move to the stage of a full assessment. All area types likewise met Criterion 3 “The site is a geographically defined area”. We did not apply Criteria 4 and 7, as these require site-level analyses. Assessments against Criteria 5, 6 and 8 gave varied results.

Table 3. Analysis of area-based governance types as OECM candidates using the IUCN-WCPA site-level tool (Jonas et al., 2023)

	Criteria*							
Area type in Iceland	1	2	3	4	5	6	7	8
1 Forest Reserves								
2 Soil Conservation Areas								
3 Parsonage Lands								
4 Public Lands								
5 Nature Conservation Register								
6 Water Conservation Areas								
7 Recreation Areas								
8. Municipal Spatial Planning Protection Areas								
9 Þingvallavatn Catchment Area								
10 Ramsar Site – Mývatn and Laxá								
11 Geoparks								

*Assessment criteria

Key: Green – meets criteria. **Orange** – partially meets criteria. **Red** – does not meet criteria. **Grey** – not applicable to governance-level assessment

Screening assessment

Criterion 1: No individual site within the governance type is a PA

Criterion 2: There is a reasonable likelihood that the governance type includes individual areas that support important biodiversity values

Full assessment

Criterion 3: The individual areas within the governance type are all geographically defined

Criterion 4: Each individual area within the governance type is assessed as to whether it supports important biodiversity values

Criterion 5: Institutions or mechanisms exist to govern and manage the site

Criterion 6: Governance and management of the site achieve or are expected to achieve the in-situ conservation of important biodiversity values

Criterion 7: In-situ conservation of important biodiversity values is expected to be for the long-term

Criterion 8: Governance and management arrangements address equity considerations

Management authority perceptions of OECMs

We conducted semi-structured interviews with a key representative from all the area types (see Supplementary Materials 2). All key actors from the management authorities we assessed expressed a positive attitude towards potential OECM recognition. This is important since effective participation and consent of the respective governance authority is required for an OECM recognition (IUCN-WCPA, 2019). Many (8 out of 11) expressed an interest in exploring protection of biodiversity conservation values as an additional purpose for their respective areas, implying that currently some have biodiversity as a secondary or ancillary objective. None of the actors expressed a negative attitude towards evaluation of their areas as possible OECMs. The concept of OECM was however new to 9 out of the 11 representatives and their knowledge was limited. The only concern came from the two representatives of water conservation areas, as they considered delivery of clean drinking water should override any other objectives.

Ranking the area types as potential OECMs

Based on our analysis in Table 3, we ranked the eleven area types according to their potential as OECMs given how well they meet the seven assessment criteria, and examined related opportunities and challenges (Table 4).

Recreational areas: Some of the recreational areas around urban areas can be considered as OECMs according to the analysis. This is native vegetation in Heiðmörk, close to the Reykjavík capital area © Hugi Ólafsson.

Table 4. Potential land-based governance systems as OECMs in Iceland, ranked from most to least promising

Ranking order	Area types	Opportunity	Challenges
Most promising OECMs	Forest Reserves	• Strong legal framework • Enduring governance, capable management, extensive network of sites • Biodiversity conservation an explicit objective in law • Long-term security of tenure	• Sites have different qualities • Zoning needed for individual areas
	Soil Conservation Areas	• Strong legal framework • Enduring governance, capable management, extensive network of sites • Biodiversity conservation an explicit objective in law • Long-term security of tenure	• Sites have different qualities. • Zoning needed for individual areas
	Water Conservation Areas	• Strong legal framework • Long-term security of tenure	• Sites have different qualities • Concept lacks full confidence among stakeholders • Need to be assessed on case basis for biodiversity values
Area types that could qualify as OECMs pending minor reforms	Þingvallavatn Catchment Area	• Strong legal framework • Long-term security of tenure • Connects with a national park	• Lacks clear management responsibility
	Recreational Areas	• Well demarcated • Some management capacity exists	• Weak legal framework • Multiple land use
	Parsonage Lands	• Many farms in lowland Iceland	• Lack of policy • Sites have various values
	Ramsar Mývatn and Laxá	• The only Ramsar site in Iceland that is not fully recognised as a PA • Has existing management capacity	• Need case-specific attention and coordination between stakeholders
Area type that needs major reform to be considered as OECMs	Public Lands	• Strong legal framework • Large part of Iceland's terrestrial area	• Need consensus between central and local governments • Not clear who would serve as management authority
Area types that lack important attributes to be considered as OECMs	Municipal Spatial Planning Protection Areas	• Large areas, many important for biodiversity	• Weak legal framework • Lack of long-term security and management
	Geoparks	• Large areas with an objective to promote sustainable land use and highlight geological attributes	• Lack of governance and management, although some include PAs
	Nature Conservation Register	• Are defined as a precursor to being selected as protected areas	• Lack of governance and management

Most promising OECM candidates

The most promising area types were *Forest Reserves, Soil Conservation Areas* and *Water Conservation Areas*.

Forest Reserves and Soil Conservation Areas are national systems administrated by the central government and have similar legal status and the same government authority responsible for their management. The legal frameworks for both have recently been updated, which gives effective policy guidance for their management and promotes biodiversity conservation as a part of their objectives. As biodiversity conservation is a part of their legal objectives, it gives important impetus for those areas to be considered as OECMs. The primary objective of Forest Reserves is forestry and forest conservation, including the main native woodlands of Iceland, while ecosystem restoration is the primary objective of Soil Conservation Areas. However, these areas are many and diverse, some contain high biodiversity conservation values, while others may

allow activities harmful to biodiversity conservation. Some contain important natural ecosystems, such as some of the most biodiversity-rich native woodlands (Ottósson et al., 2016). Other Soil Conservation Areas contain commercial plantations or exotic species land reclamation areas, so individual site assessments are required to ascertain their suitability as OECMs. Some of the larger areas could be subject to internal zoning where sites for biodiversity conservation could be identified within the larger area. The legislation provides for by-laws and management plans that could formalise the role of such zones for biodiversity conservation and set long-term management objectives. Designating some Forest Reserves and Soil Conservation Areas as OECMs has the potential to add significantly to area-based conservation in Iceland, both in terms of biodiversity in unrepresented habitat types and land area. A representative from each of the Forest Reserve and Soil Conservation authorities expressed interest in considering their OECM potential.

Water Conservation Areas also have potential as OECM candidates. Area-based water conservation in Iceland is well formalised in legislation, with protective zoning around designated water sources enforced by local governments. The "well zone" protects the immediate surroundings of the water sources, a "near-zone" protects a wider water catchment and an extensive "distant zone" places various restrictions on human activities. Where they contain nature conservation values, the two first zones, which place strong restrictions on access and allowable activities, could qualify as OECMs. The "distant zones" have significantly weaker regulations and generally could not be considered as OECMs. Water Conservation Areas have considerable promise as OECMs, as they are long-term enduring systems of governance that could provide conservation outcomes, but would require assessments to determine their biodiversity values. Representatives from local governments expressed an interest in the potential of these areas to become OECMs, but also expressed concern that the key objective of water protection should not be jeopardised. It is encouraging that biodiversity conservation is typically compatible with maintaining water quality and quantity.

Promising area types pending minor reforms

We ranked four area types in the second most promising category for consideration as OECMs, based on how they meet the criteria (Table 4). However, each of these area types has constraints that need to be addressed before OECM recognition can be progressed.

The first two are rather extensive site-specific governance arrangements of high conservation interest, adjacent to long-established PAs. *Þingvellir Water Catchment Area* is established under a site-specific legislation that demarcates the whole of Þingvallavatn water catchment area and has the conservation of Þingvallavatn Lake as a primary objective but also addresses biodiversity conservation. This large area includes Þingvellir National Park, a PA. Our institutional analysis indicates that the area has long-term potential for biodiversity conservation due to its strong legal framework, with central and local government authorities having primary responsibility. However, the related legislation lacks provision for the development of management plans and related instruments, is unclear what restrictions apply within the area, and the legislation lacks clauses that allow for enforcement. To consider this area type as an OECM, legislative amendments would be desirable to address these limitations.

The *Mývatn and Laxá Ramsar Site* is situated within the water catchment area of Mývatn and Laxá. It has a site-specific legal framework that also establishes a PA in part of the area (mainly the lake and the river) and further, provides a legal basis for conservation of the whole water catchment. Notably, the other five Ramsar sites in Iceland are all PAs. The Environment Agency, a government agency, is the appointed governance authority for the Mývatn and Laxá PA and the administrative authority for the whole catchment area. The Agency works in cooperation with local governments. The site-specific Act has multiple provisions for conservation of the area, allows for by-laws and management plans and specifically stipulates biodiversity conservation. The legal framework also includes long-term management through the making of a specific conservation plan. We find the Mývatn and Laxá Ramsar site, outside the part that is a formal PA, a potential OECM candidate with most of the requirements already inscribed in the legal framework for the area. However, enhanced collaboration between the central and local government is needed to ensure its effectiveness.

Numerous designated *Recreational Areas* close to urban settlements are found in Iceland, although there is no systematic register available for their number or coverage. Most of these areas are established on land owned by local governments and have commonly been developed in cooperation with local forestry associations for outdoor recreation. These areas have become venues for tree planting, land restoration and infrastructure development, and for recreational facilities such as picnic sites and walking tracks. Our analysis indicates that key

Soil conservation areas: Gunnlaugsskógur is a soil conservation area that has many attributes that fulfil the requirements of an OECM. The same applies to many such areas in the country. The volcano Hekla is in the background © Hreinn Óskarsson.

constraints are their weak legal status and lack of active management in many of the areas. Although demarcated, their boundaries can be altered if the priorities of the responsible local government change. Some such as Heiðmörk have well established management plans that allow for zoning of the area to identify biodiversity values and limit activities that might be harmful, while many others have no such plans. Such management plans could also promote a long-term perspective on conservation of significant areas and exclude from OECMs areas that have been allocated to incompatible uses. A case-by-case analysis of each Recreational Area is required, with engagement and inputs from the relevant local governments.

Parsonage Lands are properties owned, governed and managed by the national church of Iceland. There are currently 32 such properties across multiple locations in Iceland that serve as a seat for a priest and commonly a church site, many of which are within large farms. As for the parsonages and other church properties, the primary management objective is to "preserve, own and lease properties that support its services and goal", which mainly includes accommodating priests and maintaining the services of the church according to formal operating rules. Additionally, there is a national church policy that specifies the primary objective of church property management is to preserve those properties, while simultaneously respecting other relevant values such as cultural heritage, environmental quality and nature conservation (The Church Assembly, 2018). The key decision-making on land-use policy for each parsonage is vested in the hands of the local priest along with the church assembly. Given their current management system, Parsonage Lands are potential OECM candidates. The operating rules of the national church show that there is effective long-term, sustained governance of these areas that is ensured by law and regulations. The institutional framework for the church Parsonage Lands is robust, allowing for development of flexible land-use policies and identifying a clear authority in decision-making. However, decisions on land use can be reviewed by the church should it decide to manage a property under different management objectives, thereby potentially undermining the long-term security of conservation management. If they are to be considered as OECMs, coordination would be required between church administration and local priests to commit to long-term biodiversity conservation as a land-use practice on those properties.

Area types that need major attention if they are to be considered as OECMs

Public Lands, covering approximately 40 per cent of Iceland's terrestrial area, are subject to an ongoing process designed to clarify property rights over these common lands (Solnes, 2017). Public Lands cannot be sold to private interests, and the related legislation outlines co-management arrangements between central and local governments, with the responsibilities of each defined under the Act. Management objectives of these 200+ individual sites vary, with a considerable number being already designated as a PA. For those that are not PAs, the current legal framework provides for management and specifies the rights and responsibilities of the relevant management authority. However, given the large number of areas, their varied characteristics

Þingvallavatn water catchment area: The whole water catchment of Þingvallavatn, the largest lake in Iceland, is protected by a specific act. This act has many attributes that make this large area an interesting OECM candidate © Hugi Ólafsson.

and the lack of management objectives in general, a well-developed management capacity is not in place. Individual public lands therefore need to be assessed on a site-by-site basis, with a focus on involvement of local government. Since the legislation authorises the promulgation of subsidiary management regulations, this opens up a potential for requiring management to be in accordance with OECM objectives. Further, the current Prime Minister's Policy on Public Lands specifically emphasises conservation objectives for the areas, including biodiversity and ecosystem services, indicating a will for sustained and effective conservation action. With strengthening of existing management structures and coordinated efforts between the central and local governments, some Public Lands might then be candidates for OECMs. There is a clear governance authority, and the existing legal framework offers the possibility of long-term management.

Area types that lack important attributes to be considered as OECMs

The governance systems for *Municipal Spatial Planning Protection Areas, Natural Heritage Register* and *Geoparks* are spatially defined and include nature conservation objectives, but fail to meet important criteria for OECM candidacy. Those area types are not designed to support sustained governance and effective management and cannot ensure long-term conservation outcomes. Further, designation of such areas does not require a consent from landowners, seen as essential for OECM recognition.

CONCLUSION AND IMPLICATIONS FOR POLICY

Iceland is currently working on updating its biodiversity policy to ensure national objectives align with the GBF commitments. This first study of the potential for terrestrial OECMs to be recognised in Iceland illustrates considerable opportunity to expand the country's area-based conservation efforts. It also illustrates that, given the differences between various governance systems, each land-use type needs its own assessment process, before progressing to the site-by-site assessment required by the site-level tool. Out of the eleven area types analysed, eight were found to have potential to be considered as OECMs.

Based on the analysis we suggest the following policy guidance for a process of designating terrestrial OECMs in Iceland and including them in its conservation efforts. Firstly, Iceland has not yet established a policy framework to guide OECM establishment and management and to formalise their registration as contributors towards national conservation efforts. There is also a need for policy guidance whereby a mandate is formally provided to a specified institutional actor to further develop OECMs at a national level. Secondly, the government needs to facilitate a process with key stakeholders from those management authorities of promising land-use types that have been identified in this paper as having characteristics that render them worthy of further consideration as OECMs. We identify eight such systems. For many stakeholders, there may well be a need to establish incentivising and facilitating structures. Thirdly, an analysis needs to overlay available information about biodiversity-rich areas with high conservation value on

the areas of the most promising OECM area types, thereby identifying initial priorities for OECM establishment in Iceland.

There may well be other OECM candidates in Iceland that we have not analysed in this study. Firstly, there are many privately owned areas that may have conservation potential. Some of these properties are large and are likely to contain significant biodiversity value. Identification of such areas and engagement with their owners would provide a further opportunity to establish a nation-wide OECM network. Secondly, there is a recent move to legally protect large areas, including entire landscapes, that contain significant cultural heritage. Some such landscapes may well satisfy the criteria for consideration as OECMs. Additionally, Iceland has a specific *Wildlife Conservation Act* that provides for conservation of wildlife habitats, including for example bird nesting areas. However, to date this Act has had weak institutional support, limited application and few management outcomes. However, amendments to this Act are currently under consideration, with the aim of strengthening its provisions. If this occurs, it could become an additional regulatory instrument contributing to the establishment and management of OECMs.

This study of OECMs adds to the growing number of studies from diverse countries that seek to inform and promote the development of these critical area-based contributions to the global nature conservation effort, in particular the meeting of GBF targets. Iceland's efforts in this regard are in their infancy, and we offer these findings as an initial contribution to supporting the development of an OECM network in this country.

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SUPPLEMENTARY MATERIALS

1. Icelandic protected area context
2. Key informant interviews

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RÉSUMÉ

Les zones protégées (ZP) et les autres mesures efficaces de conservation basées sur les zones (OECM) sont les principales stratégies de conservation des États-nations pour atteindre l'objectif de 30 % de conservation basée sur les zones du Cadre mondial pour la biodiversité(GBF). L'Islande est en train de mettre à jour sa stratégie en matière de biodiversité, en s'alignant sur les objectifs du cadre mondial pour la biodiversité. L'objectif de cette étude est de faire progresser le développement des OECM et d'examiner leur potentiel en Islande. L'Islande dispose de plusieurs systèmes de gouvernance par zone avec différents objectifs, en plus de son domaine officiel d'aires protégées. Nous identifions et analysons les systèmes de gouvernance par zone pertinents dans le pays, en employant une approche progressive basée sur l'analyse institutionnelle et l'application de l'outil OECM de l'UICN-WCPA au niveau du site. L'étude identifie onze types de zones à prendre en considération, tandis que l'analyse révèle leurs différentes qualités et défis et suggère huit d'entre elles comme OECM potentielles. Cette première étude des OECM terrestres en Islande illustre le potentiel considérable d'expansion de ces efforts de conservation par zone. Les OECO ne sont pas encore inclus dans le cadre de la politique de conservation de la nature en Islande, ce qui souligne la nécessité d'une orientation politique nationale, pour laquelle nous formulons des recommandations.

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RESUMEN

Las áreas protegidas (AP) y otras medidas eficaces de conservación basadas en el área (OECM) son estrategias de conservación clave de los Estados nación para alcanzar el objetivo de conservación basado en el área del 30% del Marco Global de Biodiversidad (GBF). Islandia está actualizando su estrategia de biodiversidad, alineándola con los objetivos del GBF. El objetivo de este estudio es avanzar en el desarrollo de las OECM y examinar su potencial en Islandia. Islandia cuenta con múltiples sistemas de gobernanza basados en áreas con diversos objetivos, además de su patrimonio formal de AP. Identificamos y analizamos los sistemas de gobernanza basados en áreas relevantes de en el país, empleando un enfoque gradual basado en el análisis institucional y la aplicación de la herramienta OECM a nivel de sitio de la UICN-CMAP. El estudio identifica once tipos de áreas para su consideración, mientras que el análisis revela sus diferentes cualidades y desafíos y sugiere ocho de ellas como potenciales OECM. Este primer studio de OECM terrestres en Islandia ilustra un potencial considerable para ampliar los esfuerzos de conservación basados en áreas. Los OECM aún no están incluidos en el marco político de conservación de la naturaleza de Islandia, lo que pone de relieve la necesidad de una orientación política nacional, para la que ofrecemos recomendaciones.

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DETECTING ILLEGAL CAMPFIRES BY DRONE-MOUNTED THERMAL SENSORS IN PROTECTED TROPICAL RAINFORESTS

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ABSTRACT

Thermal drones are increasingly used for conservation tasks such as biodiversity monitoring and wildfire management, but their utility in combating illegal activities in tropical rainforests remains underexplored. This study assesses the potential of thermal drones to detect campfires associated with illegal poaching and gold mining in Costa Rica's Osa Peninsula. We simulated illegal campfires placed under the forest canopy, and conducted 29 experimental thermal drone flights across five survey rounds along a 1-km riverbank. Hypothesised factors influencing detection success, including fire stage, time of day, and canopy cover, were analysed. The drone detected 21 of 23 campfires (91 per cent), with 73 per cent detected on the first flight. Increased canopy cover and older fires reduced detection success, but time of day had no significant impact. Detecting humans was more challenging than campfire detection. The findings suggest thermal drones can aid enforcement in tropical rainforests but should be used in repeated surveys to improve detection rates, especially in locations with dense canopies. Thermal drones could enhance efforts to monitor illegal hunting, mining and trespassing in remote protected areas, helping conservation teams save time and resources in challenging environments.

Keywords: remote sensing, neotropics, enforcement, trespassing, surveys, anthropogenic disturbance

INTRODUCTION

Drones provide a relatively low-cost tool, to rapidly and systematically observe both natural phenomena and anthropogenic disturbances at high resolution across broad temporal scales in challenging environments (Rodríguez et al., 2012). In recent years, thermal infrared sensors have been incorporated into drone camera systems enhancing their surveying capabilities. The technology relies on the contrasting temperatures of focal individuals or objects from their ambient environment, providing new opportunities for surveying wildlife and ecosystems, and surveillance in terms of both search and rescue and control and protection (Beaver et al., 2020, Mulero-Pázmány et al., 2014, Witczuk et al., 2018).

Thermal drone research has become increasingly popular in conservation and monitoring due to its ability to detect wildlife and habitat changes effectively. The list of species monitored using thermal drones increases each year including mammals (Gooday et al., 2018, Kays et al., 2019, Larsen et al., 2023, Whitworth et al., 2022), birds (Avila-Sanchez et al., 2024, Santangeli et al., 2020), and reptiles (Sellés-Ríos et al., 2022, Viljoen et al., 2023). Thermal drones have also been used to study land-use change across time in a variety of ecosystems such as grasslands, wetlands, savannas, riparian, coastal and marine habitats (Adedeji et al., 2015, Agarwal et al., 2019, Mancini et al., 2016, Natesan et al., 2018). Finally, terrestrial and maritime surveillance has improved by

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using this technology, focusing on forest fire alerts, rescue searches, fighting poachers and illegal gold miners, and detecting illegal logging in protected areas (Jeon et al., 2019, Jiménez-López & Mulero-Pázmány, 2019, Klimkowska & Lee, 2017, Mulero-Pázmány et al., 2014, Tang & Shao, 2015). Despite these advances, most studies have either been restricted to open areas or focused on the upper forest canopy itself, neglecting the dense understory where illegal activities occur and are harder to detect (Guimarães et al., 2020). As most of the world's biodiversity exists within tropical forest ecosystems (Pironon et al., 2020, Raven et al., 2020) and wildlife poaching remains a major challenge both inside and outside of tropical protected areas (Baillie et al., 2004, Lavadinović et al., 2021), having effective tools to monitor anthropogenic disturbances and illegal activities in these ecosystems is crucial. Therefore, there is a need to address the information scarcity on the utility of thermal drones to perform surveillance of illegal activities in closed-canopy tropical forest habitats.

A key challenge for wildlife professionals and Indigenous communities managing tropical forests is the difficulty in rapidly identifying and responding to illegal and destructive activities (Murrins-Misiukas et al., 2021). Protected areas are often large and management budgets small, leading to small ranger teams being tasked with patrolling vast areas that are difficult to access and patrol safely. As such, drones mounted with thermal cameras could prove a useful addition to the conservation toolkit, reducing arduous on-foot patrols and decreasing response times to environmentally damaging illegal activities. However, the efficiency of thermal drones in detecting illegal activities in tropical forests remains unknown.

Here we address the lack of information about the utility of thermal drones to detect illegal activities by assessing their ability to detect understory campfires and people in a closed-canopy tropical forest context. Specifically, we established campfires mimicking those used by poachers and gold miners in protected areas of the region along a 1-km stream bank, then flew test flights using a thermal drone to determine the detection probability for the fires and people. We first assess if campfires are detectable in forested environments, then determine the effects of three key variables hypothesised to influence fire detection probability: variation in fire stage (flaming fires should be easier to detect than embers), time of day (fires should be more detectable at night than in the day due to higher temperature differential), and canopy cover (increased canopy cover should decrease campfire detection probability). Finally, we assess the ability of the thermal drone to detect the people on the ground conducting illegal activities.

METHODS

Study site

The Osa Peninsula in the south Pacific of Costa Rica is home to one of the largest remaining tracts of Pacific lowland wet forest in Mesoamerica (Holdridge, 1967) and encompasses a system of protected areas (~80 per cent of the terrestrial surface has some degree of protection) containing both primary (of which less than half of the original area remains) (Weissenhofer et al., 2001) and secondary forest. Outside the protected areas is a landscape matrix of cattle farms, oil palm plantations, agriculture, and timber plantations. Before these protected areas were established, the Osa Peninsula experienced high levels of environmentally damaging activities, including logging, wildlife poaching and gold mining (Algeet-Abarquero et al., 2015, Borge & Herrera, 2006, Carrillo et al., 2000). Whilst illegal activities have decreased in the region since the economy has shifted towards ecotourism, both poaching and gold mining persist in some areas of the region (López-Gutiérrez, 2020, Wong, 2014).

The study site is on the Osa Conservation Campus (formerly known as Piro Biological Station, 8.40388 N, 83.33661 W, see Figure 1), embedded within the Golfo Dulce Forest Reserve that connects Osa's two National Parks – Corcovado and Piedras Blancas. Temperatures at the field site range between 23.4 °C and 28.8 °C (Whitworth et al., 2018). Rainfall averages 3,584 mm yr−1 and is seasonal, with a rainy season from June to November and a dry season from December to May (Taylor et al., 2015).

Based on local knowledge, illegal campfire activity is most likely to occur near small streams that lead into the main watersheds where there would be gold mining activities, and the campfires are known to be lit from dusk to dawn (17:00–7:00). To test if campfires could be detected by a drone mounted with a thermal camera in a tropical rainforest system, we ran a series of experimental flights. Our study flights were conducted in areas of > 40-year-old naturally regenerating secondary-growth forest within the Piro watershed.

Fire establishment

On five occasions (rounds) between May and August 2021, two members of the team were instructed to light up to three fires each at random locations at varying distances along the riverbank and stay in the region to maintain them (Figure 1A) imitating those used by gold miners and poachers in the tropical rainforest. Each one was built under black plastic tarpaulin to protect it from the rain (Figure 1B). During each round between one and six fires were lit, resulting in a total across all rounds of 23 fires. For each round, the fires were lit in two sets –

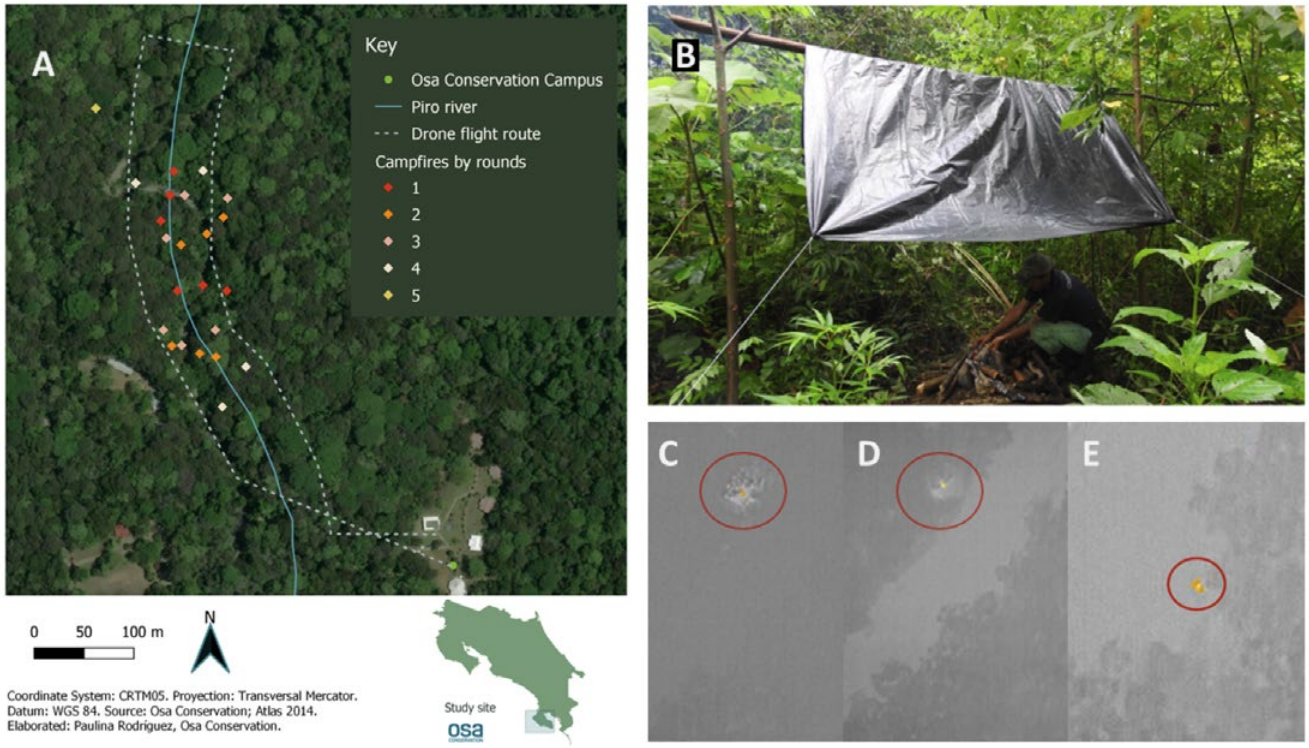

Figure 1. Survey area, location within Costa Rica, and examples of campfire simulation and its detection using a thermal-mounted camera. A = Campfires lit along the river and drone flight automated route, B = Campfire being lit prior to the drone flights imitating a fire of a gold miner or poacher in a tropical rainforest, C = Flaming campfire detected from the canopy using a thermal camera mounted on a drone (screenshot of a video recorded by the drone), D = Campfire embers detected from the canopy using a thermal camera mounted on a drone (screenshot of a video recorded by the drone), E = Person detected from the canopy using a thermal camera mounted on a drone (zoomed in screenshot of a video recorded by the drone).

morning and night – to reflect the times when fires were most likely to be lit in this region. Morning fires were lit at 04:30, night fires at 17:30. The fires were maintained in a 'flaming' state for the first two flights of each set (see Drone flights section below) and then they were left to turn into embers by the third flight (09:00 and 22:00), to mimic real campfire management and to test the effect of the campfire stage on its detectability. Location and quantity of fires were unknown to the drone pilot.

Drone flights

Flights were performed using the Autel Robotics drone, model EVO II DUAL CAMERA (registration number RPAS-1354-CR) flown by drone pilot Johan Ortiz (licence number 60-4140911). The model contains an Uncooled VOx Microbolometer sensor (field of view = H33° V26°, lens focal length 13 mm), the pixel size was 12 µm and wavelength range 8–14 µm. Five rounds of experimental flights were executed. During each round, six flights were completed. One flight was excluded due to an SD card error, resulting in a final sample size of 29 flights. Each round was split into two 'sets' of three flights, one set was completed at night-time (18:00, 20:00 and 22:00) and another set of three flights was completed in the morning (05:00, 07:00, 09:00).

We programmed the drone to automatically fly a planned route of 1 km (going up one side of the river for 500 m and then returning on the other side, the flight route taken was 15 m from the riverbank on each side – Figure 1A) at a speed of 10.8 km/h as this flight speed has been proven to increase detection rates of drone-based wildlife counts in this region (Whitworth et al., 2022) and an overall flight time of 20 minutes. The drone elevation was configured at a minimum height of 90 m and a maximum of 120 m from the ground, considering the changes in topography and maximum height of trees across the flight route. During experimental flights the 'Hottest' thermal camera setting was determined the most effective to spot campfires and people with orange marks highlighting the warmest points (Figure 1C–E), therefore this mode at an angle of 90 degrees was used. Before the flight round, the field of view of the thermal camera was tested at different flight heights to ensure optimal setting selection for campfire detection and the safe flight of the drone according to variations in topography and different tree heights.

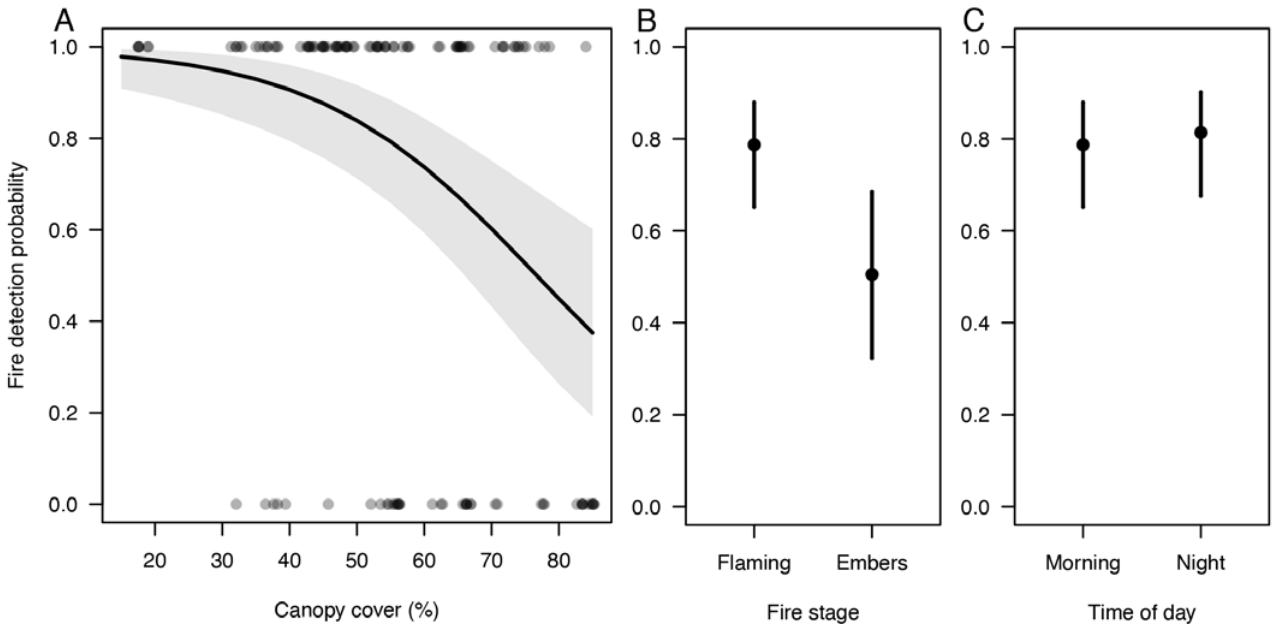

Figure 2. Predicted detection probabilities for fires in different contexts (canopy cover, fire stage, and time of day). A = detection probabilities (black line) and 95% confidence interval (grey area) across a natural range of canopy cover (for 'flaming' fires in the 'morning') and points showing the raw data for individual fire detections, B = detection probabilities (points) and 95% confidence interval (lines) at different fire stages (for 55% canopy cover in the 'morning'), C = detection probabilities (points) and 95% confidence interval (lines) at different times of day (for 55% canopy cover and 'flaming' fire).

Predictors of fire detection

We tested three covariates to reflect predictors of fire detection probability: fire stage, time of day, and canopy cover. To test the effect of the campfire stage on its detectability by a thermal drone, the fires were in a 'flaming' stage for the flights at 5:00, 7:00, 18:00 and 20:00 and then were left to turn into embers on the flights at 09:00 and 22:00, to mimic the real maintenance of gold miners' campfires in the region. To understand the effect of canopy cover on campfire detection, we used the natural heterogeneity in canopy cover at the fire locations. We quantified canopy cover by taking a photograph using the Canopeo 1.1.7 mobile app (http://www.canopeoapp.com/) parallel with the canopy at chest level, directly above the fire location. Mean canopy cover across all sites was 55 per cent (min = 18 per cent, max = 85 per cent). Surveys occurring between 5:00 and 9:00 were assigned as 'morning' and surveys occurring 18:00–22:00 as 'night'.

Data analysis

A single trained observer reviewed the video from the resultant drone flights, marking locations where they thought a campfire was present. These identifications were then compared with the known fire locations post-hoc. Events, where fires were successfully detected, were designated as 1, and events where the fire was missed were recorded as 0. To identify the factors (fire stage, time of day and canopy cover) that affected campfire detectability, we used a generalised linear model using the binomial family with a log link in the R statistical environment (R.4.4.0) (R Core Team, 2013). We applied a global model approach, including all the candidate covariates in a single model then using Wald tests to determine if there was statistical support for each given covariate. We used visualisations of effect size to determine if covariates had biologically meaningful effects. Model fit was assessed using standard residual plotting techniques.

RESULTS

Campfire detection using drones

Of the 23 campfires established across all five rounds, 21 were detected at least once on a given survey flight (overall detection probability of 91 per cent). Breaking this down into individual flights (six per round), 17 (73 per cent) had been detected after the first flight, 18 (78 per cent) after the second, 20 after the third and fourth (87 per cent), and 21 (91 per cent) after the fifth and sixth flights. No additional fires were detected on the sixth flight. There were no instances of 'fire' being designated by the drone observer when there was no fire present.

Predictors of campfire detection efficiency

We assessed three predictors of campfire detection probability: fire stage (flaming or embers), time of day (morning or night) and canopy cover. Increasing canopy cover had a strong negative effect on fire detection

probability (Figure 2A, regression coefficient = -0.06, $p < 0.001$), with detection probabilities declining steeply above 40 per cent canopy cover. Flaming fires were 29 per cent easier to detect than just the embers (Figure 2B, 'embers' regression coefficient = -1.29, $p = 0.003$) and there was no statistical support for a difference in detection probability between morning and night-time (Figure 2C, 'night-time' regression coefficient = 0.17, $p = 0.691$).

Human detection

During each flight, we also recorded if the people tending the fires were successfully detected. Human heat signatures were successfully detected on 13 of the 29 occasions (44 per cent).

Discussion

This study demonstrates that campfires can be detected using thermal drones in tropical rainforest ecosystems with reasonably high efficiency. Campfires were detected after a single pass on three-quarters of occasions, with the detection rate increasing to nine out of ten after multiple flight passes had occurred. However, detectability was reduced for late-stage campfires and fires located under denser canopy cover. We were also able to detect humans on over a third of patrol flights. Below, we discuss the implications of these findings for control and protection activities in tropical forests contexts.

Thermal drones are an effective tool for monitoring campfires

Thermal drones have the potential to enable rangers to safely cover large areas and then organise targeted patrols to capture intruders 'in the act'. Drones can determine the exact location of fires, but also the presence of the perpetrators involved, helping rangers to organise a response consistent with the size and scale of the illegal activity occurring. Whilst thermal drone use has become common in fire management strategies, especially in detecting forest fires (Chen et al., 2018, Tang & Shao, 2015), this is the first demonstration of their use to detect small sub-canopy fires in a tropical forest context. Although the detection probability of older fires was reduced by 37 per cent relative to flaming fires, they were still detectable, consistent with previous work showing thermal cameras are an effective tool to detect subterranean peat fires (Burke et al., 2019) – as the ground temperature directly above the fire remained hotter than the ambient ground temperature (Usup et al., 2004). This broadens the window of detection for rangers looking for evidence of illegal activities.

Previous work suggests that objects are usually easier to detect at night-time (Hwang et al., 2015) as there is a higher contrast between the target object in cooler ambient environments (Spaan et al., 2019). However, we found no strong effect of time of day on fire detection probability, flaming fires were detected just as well in the morning (79 per cent) as they were at night (81 per cent). This difference is likely driven by most of the previous work focusing on detection of wildlife, which typically have thermal signatures slightly above that of the background, whereas hot campfires have a more marked thermal difference. This suggests that campfire surveys can be effective in the daytime too, supporting findings by Hambrecht et al. (2019), who did not find time of day as a significant factor in object detectability. Previous research has also suggested that daytime surveys may have a higher number of false positive detections (Doull et al., 2021). The lack of false positives here was likely due to the high relative difference in temperature between the fires and the ambient environment making them easy to discriminate from hot rocks or branches – the most common false positive objects in wildlife studies (Burke et al., 2018).

Drone surveys could reduce illegal activities as intruders are discouraged by the risk of being detected (Reischig et al., 2018). However, consistent with previous studies (Doull et al., 2021, Hambrecht et al., 2019), the probability of detection was greatly reduced in areas of high canopy cover (98 per cent detection probability at 15 per cent canopy cover, versus 37 per cent at 85 per cent canopy cover). Concerningly, this suggests that illegal activities may be harder to detect in intact forests, the locations where protection is most needed. Furthermore, illegal intruders could better hide their campfires from drones mounted with thermal technology should they learn the shortfalls of the tools used to identify them. If this approach is adopted by protected area managers and rangers, we urge the use of continual surveys to assess if trespassers learn to evade detection.

Improving campfire detection methods

Regardless, this tool shows potential for applied use by protected area managers. Here we used a quadcopter drone with relatively limited battery life, flight time and survey range. Despite its limitations, it rapidly covered a 1-km patrol area in just 20 minutes, successfully detecting campfires and human heat signatures. We used a human-observer to determine signals in the thermal imagery, and while this was still effective, it was time consuming. Applying machine learning technology to develop automated detection algorithms may enhance the efficiency of the work, and perhaps even detect people and fires with higher probability (Davis & Sharma, 2007, Hwang et al., 2015, Yeom, 2021). Use of automated systems may also facilitate flying at faster flight speeds

and cover greater distances in patrols without the need to rely on human observers scanning the imagery. This would represent a valuable step forward in the development and use of this technology for protected area management scenarios.

The capability of these surveys would be further improved using drones with greater flight capacities. There are several fixed wing models with greater flight times and ranges (over 2 hours and 30 km, see Autel's Dragonfish models for example). While transmission to a handheld receiver would not be possible over that range, AI processing tools could be applied to footage once a patrol flight returns, allowing rapid identification and locations of illegal activities. In rainforest habitats this would be hugely beneficial in patrolling large areas where on-foot patrols might otherwise take many hours, or even days to complete. This technology could be critical for many national parks in tropical forests which are often restricted by tight funding budgets and limited personnel to protect large areas (Bruner et al., 2001, Watson et al., 2014). Crucial next steps for this work are to expand the assessment of campfire detection to include locations with different habitat types and topographies, fire sizes, environmental conditions (e.g. weather and seasonality), and assess the influence of increased drone path complexity. Extending these elements is essential in determining the transferability of our findings to other contexts and ecosystems.

Ultimately a major hurdle to widespread implementation of thermal drone technology remains the upfront costs of purchasing and maintaining the devices and getting sufficient training to utilise the tool safely and effectively. Such barriers could be overcome with investment in staff development and training, and through showcasing managers and decision-makers how drones might enhance the efficacy of ranger patrols. These efforts could be key to many countries in upholding their national and international commitments for protecting and safeguarding biodiversity. Crucially, thermal drones could help to detect and deter illegal activities, whilst simultaneously monitoring biodiversity (Gonzalez et al., 2016, Ivanova & Prosekov, 2024, McCarthy et al., 2021, Scholten et al., 2019, Witczuk et al., 2018). In fact, drone technology for biodiversity is fast becoming one of the most used tools in monitoring wildlife according to Ivanova et al. (2022).

In summary, this work marks a useful first step in the application of a burgeoning technology to assist with the control and protection efforts in tropical forest ecosystems and highlights the need for further testing and tool development. Similar surveys in other rainforest regions with different habitat conditions, or intruder behaviours, would be helpful to determine how broadly applicable and useful the technology could be. As a next step, this technology should be tested with real patrols in a protected area, to prove the real application alongside targeted follow-up patrols and arrests of intruders. Conservation funders, engineering departments, and drone technology companies could help to support and subsidise costs of the required trials and software development so that confidence and reliability can be established prior to broad-scale adoption for protected area management. This process needs to happen quickly given the rampant illegal resource extraction activities occurring throughout the world's tropical forest ecosystems.

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RESUMEN

Los drones térmicos se utilizan cada vez más para tareas de conservación, como la vigilancia de la biodiversidad y la gestión de incendios forestales, pero su utilidad en la lucha contra las actividades ilegales en las selvas tropicales sigue estando poco explorada. Este estudio evalúa el potencial de los drones térmicos para detectar hogueras asociadas a la caza furtiva ilegal y la minería de oro en la Península de Osa de Costa Rica. Simulamos hogueras ilegales situadas bajo el dosel del bosque y realizamos 29 vuelos experimentales con drones térmicos en cinco rondas de inspección a lo largo de una ribera de 1 km. Se analizaron las hipótesis sobre los factores que influyen en el éxito de la detección, como la fase del incendio, la hora del día y la cubierta de copas. El dron detectó 21 de 23 hogueras (91%), el 73% en el primer vuelo. El aumento de la cubierta de copas y los incendios más antiguos redujeron el éxito de la detección, pero la hora del día no tuvo un impacto significativo. La detección de personas fue más difícil que la de hogueras. Los resultados sugieren que los drones térmicos pueden ayudar a hacer cumplir la ley en las selvas tropicales, pero que deben utilizarse en estudios repetidos para mejorar los índices de detección, especialmente en lugares con copas densas. Los drones térmicos podrían mejorar la vigilancia de la caza, la minería y el allanamiento ilegales en zonas protegidas remotas, ayudando a los equipos de conservación a ahorrar tiempo y recursos en entornos difíciles.

RÉSUMÉ

Les drones thermiques sont de plus en plus utilisés pour des tâches de conservation telles que la surveillance de la biodiversité et la gestion des incendies de forêt, mais leur utilité dans la lutte contre les activités illégales dans les forêts tropicales humides reste sous-explorée. Cette étude évalue le potentiel des drones thermiques pour détecter les feux de camp associés au braconnage et à l'exploitation aurifère dans la péninsule d'Osa au Costa Rica. Nous avons simulé des feux de camp illégaux placés sous la canopée de la forêt et effectué 29 vols expérimentaux de drones thermiques au cours de cinq tournées d'étude le long d'une rive d'un kilomètre. Les facteurs hypothétiques influençant le succès de la détection, notamment le stade de l'incendie, l'heure de la journée et la couverture de la canopée, ont été analysés. Le drone a détecté 21 des 23 feux de camp (91 %), dont 73 % lors du premier vol. L'augmentation de la couverture végétale et les feux plus anciens ont réduit le succès de la détection, mais l'heure de la journée n'a pas eu d'impact significatif. La détection des humains a été plus difficile que celle des feux de camp. Les résultats suggèrent que les drones thermiques peuvent contribuer à l'application de la loi dans les forêts tropicales humides, mais qu'ils devraient être utilisés dans le cadre d'enquêtes répétées afin d'améliorer les taux de détection, en particulier dans les endroits où la canopée est dense. Les drones thermiques pourraient renforcer les efforts de surveillance de la chasse illégale, de l'exploitation minière et des intrusions dans les zones protégées éloignées, en aidant les équipes de conservation à gagner du temps et à économiser des ressources dans des environnements difficiles.

ASSESSING RECREATIONAL USE VALUE IN BRITISH COLUMBIA'S LARGEST URBAN PARK

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ABSTRACT

Urban parks play a vital role in improving daily life for residents and providing a range of ecological benefits. This study applies the Travel Cost Method to estimate the recreational use value of Kenna Cartwright Park, the largest municipal park in British Columbia, located in Kamloops. Based on survey and visitation data, the estimated consumer surplus per person per visit is CAD 19.23, resulting in an annual recreational use value of approximately CAD 4.19 million in 2021. The study also examines how recreational value responded to external shocks, such as the COVID-19 pandemic. In spring 2020, park visitation nearly doubled during the local lockdown, and the total annual recreational value rose to CAD 6.79 million. These findings highlight the value of accessible green spaces and the essential role of urban parks in supporting public well-being and resilience in times of disruption such as COVID-19.

Keywords: consumer surplus, green infrastructure, outdoor recreation, revealed preferences, travel cost method, welfare economics

INTRODUCTION

Urban parks, as semi-natural ecosystems, offer a wealth of health, ecological, environmental, social and economic benefits (Kolimenakis et al., 2021; Wilson & Xiao, 2023; Zhang & Qian, 2024). However, these green spaces also present a trade-off, occupying land that could otherwise accommodate buildings and roads to support growing urban populations (Du & Zhang, 2020; Huang et al., 2023; Kabisch et al., 2016; Reeve, 2024). Assessing the economic value of ecosystem services of urban parks informs policymakers about development, maintenance and preservation priorities.

A park's total value offers a broad estimate of its worth, but recreational use value provides detailed insights into how these green spaces function as leisure, sport hubs and during crises such as during the COVID-19 pandemic (Grzyb et al., 2021; Venter et al., 2020). This specificity is critical for informed decision-making and resource allocation. In this study, we estimate the recreational use value of Kenna Cartwright Park (KCP), the largest municipal park in British Columbia, Canada.

KCP is an 800-hectare municipal nature park located in the Southwest of Kamloops, a city of 100,000 people in the interior of British Columbia. The park includes over 40 kilometres of trails for various skill levels, making it a popular site for recreational activity. Ecologically, the park is diverse, with wetlands, hills, valleys, grasslands, sagebrush, Ponderosa Pine and Douglas Fir forests. It overlooks Kamloops, the confluence of the North and South Thompson Rivers and Kamloops Lake. KCP also supports a range of wildlife including insects, diverse bird species, chipmunks, Coyotes, deer and Black Bears. The park serves as a model of urban blue-green infrastructure, integrating ecological conservation with recreational use (City of Kamloops, 2021; Truscott & Tsigaris, 2022).

Despite KCP's appeal, its recreational use value has not been comprehensively studied. This omission leaves a gap in understanding its economic significance and role in urban life in British Columbia. KCP thus presents an important case study for assessing recreational value and for informing urban park policy in the region.

10.2305/IAKQ4577

Kenna Cartwright Park, looking west. © Panagiotis Tsigaris

In addition to its ecological and recreational value, KCP is a municipally designated protected area governed by long-term conservation and land-use objectives (Kamloops Museum and Archives, n.d.; Mt. Dufferin Land Use Plan, 1996). This designation supports the park's ecological integrity while maintaining public access. Such governance structures differentiate KCP from undesignated areas that may lack coordinated protection and are more vulnerable to land-use pressures. Protected areas like KCP also attract dedicated public investment and policy attention, making them especially suitable for welfare-based valuation. Measuring the recreational value of parks like KCP can help inform decisions about urban planning, conservation, and how public funds are allocated.

This study uses the Travel Cost Method (TCM) to estimate KCP's recreational value. Originally proposed by Hotelling in 1947 and refined by Clawson and Knetsch (1966), TCM assumes that the benefit of a recreational site visit is reflected in the cost incurred by visitors. These costs include travel expenses, such as fuel and parking, and the opportunity cost of time. By combining this with the frequency of visits, the method estimates the site's recreational value. TCM was selected because it provides a widely accepted and robust framework for valuing recreational benefits. However, TCM only captures the use value of the recreational site, as it excludes the non-use and option values, which may lead to an underestimation of the total value of ecosystem services provided by parks.

Importantly, this study's valuation approach, TCM, falls within the domain of welfare economics and estimates consumer surplus as a measure of direct recreational benefit. This contrasts with frameworks like the System of Environmental-Economic Accounting (SEEA) or the System of National Accounts (SNA), which focus on exchange values and market transactions (United Nations et al., 2014). As this research is designed to measure welfare-based recreational value rather than exchange values tied to GDP, it does not use SEEA or SNA approaches. This distinction is critical to correctly interpret the findings.

Data for this study were collected through a survey that captured variables such as visit frequency, parking availability, distance travelled, transport mode, conservation motivations and socio-demographic background. The survey was distributed via 600 leaflets containing a QR code and a cover letter: 200 were handed out at park entrances and 400 placed in residential mailboxes. The response rate was 24.3 per cent, yielding 146 responses, most of which came from the on-site distribution.

METHODOLOGY

The Travel Cost Method and refinements

TCM assumes a correlation exists between the benefits of a recreational site and the associated visitation cost. The method estimates the Marshallian consumer surplus by using the total cost per visit and the frequency of visits as inputs controlling for all other socio-economic, demographic and attitudinal confounding factors

Kenna Cartwright Park, overlooking the City of Kamloops and the confluence of the North and South Thompson Rivers.
© Arwinddeep Kaur

(Bateman, 1993). Travel costs included in TCM are unavoidable expenses such as fuel, parking and tickets, as well as the opportunity cost of travel time. Researchers typically estimate these costs from surveys and market prices. Recent refinements, such as point-to-point mapping to estimate travel time and cost, have improved its accuracy by mitigating traditional bias (Hanauer & Reid, 2017). The method used to estimate the demand for recreational services is the zero-truncated negative binomial (ZTNB) regression, which addresses the zero truncation in our on-site travel cost data, where individuals with zero visits are not observed (Martínez-Espiñeira & Amoako-Tuffour, 2008). This method adjusts for the fact that the dependent variable (number of visits) cannot be zero by design. We also compute 95 per cent confidence intervals for the consumer surplus using the delta method, which improves the statistical robustness of the welfare estimates (Hole, 2007).

Welfare economics and exchange-based accounting approaches

This study adopts a welfare economics approach to estimate the recreational value of Kenna Cartwright Park using the Travel Cost Method (TCM), a revealed preference technique that measures consumer surplus, the difference between what visitors are willing to pay and what they actually spend to visit the park. For instance, if someone spends CAD 10 but would have paid up to CAD 30, the surplus is CAD 20. Aggregated across all visitors, this surplus reflects the park's total recreational benefit, even though entry is free.

Unlike accounting-based approaches such as the System of Environmental-Economic Accounting (SEEA, United Nations et al., 2014), which value ecosystem services using market prices or replacement costs, TCM captures non-market values tied to personal well-being and user satisfaction. SEEA attempts to measure environmental stocks, such as biomes and their alterations, including coastal systems, open sea, forests, wetlands, rivers and lakes, and grasslands, as well as ecosystem service flows such as carbon sequestration, and uses market prices, replacement costs, or avoided damage costs. In contrast, our approach estimates non-market values that capture personal well-being and user satisfaction, which are not directly observable in economic transactions. For example, while SEEA might count the CAD 10 spent or estimate avoided healthcare costs, TCM focuses on the CAD 20 in perceived benefit, providing a different but complementary perspective. These are both valid perspectives, but they answer different questions: TCM asks how much value people receive, and SEEA asks how much value flows through the economy. The values reported here are not market transactions or revenues, but indicators of the well-being generated by access to green space. These estimates are especially relevant for urban planning and public health. In line with best practice, we also identify the beneficiaries, local residents, to inform policies that support equitable access to nature in urban settings.

Applying the Travel Cost Method in Kenna Cartwright Park

This study applies TCM to estimate the use value of KCP. We focus on determining the consumer surplus per person per visit while capturing the park's significance for residents and their willingness to pay for its preservation. To model the frequency of visits, we use a count regression model, specifically the zero-truncated negative binomial count (ZTNB) regression, which is suitable for this type of zero truncated and over-dispersed data (Cameron & Trivedi, 2013; Englin & Shonkwiler, 1995; Oh & Choi, 2020). We specify the expected demand curve for visiting KCP in the form of an exponential function.

$$AV_i = e^{(\beta_0+\beta_{TCost}TCost_i+\beta_1 HsSize_i+\beta_2 WalkBike_i*SingleTravel_i+\beta_3(HighInc_i*AgeGroup_i)+\beta_4 Ho_i)} \quad (1)$$

In this regression equation, AV refers to the average number of visits an individual makes. The variable TCost captures the unavoidable travel cost incurred by an individual, which is measured in Canadian dollars (CAD) and includes all expenditures associated with travel, such as fuel,= and the opportunity cost of travel time. Most studies value the opportunity cost of travel time at one-third of the estimated hourly wage. We approximated the hourly wage by dividing self-reported household income by an assumed 2,000 working hours per year, following standard practice in the travel cost literature (Freeman, 2014). HsSize denotes the household size reported by the respondent, which includes adults and children living in the same household. The WalkBike variable is a binary indicator denoting the mode of transportation used by the respondents. A value of 1 indicates that respondents travelled by walking, running, biking or using an e-bike to reach the site, while 0 signifies other means of transportation. The variable SingleTravel signifies the size of the visitor's group, with a value of 1 indicating a solitary visitor (group size of 1) and zero if the visitor was part of a group (group size of more than one). We include the interaction term WalkBike * SingleTravel in the model to differentiate between the visitation behaviours of different groups. Specifically, this term allows the model to distinguish the frequency of visits for those who walk or bike to the park and travel alone (i.e. WalkBike = 1 and SingleTravel = 1) from those who use other modes of transportation or travel in groups. Without this interaction term, the model would suggest that the impact of travelling alone on the visitation rate is consistent across all transportation methods. However, the frequency of visits may differ based on the transportation method and group size. The variable HighInc is a binary variable denoting the income group of the respondent. It is assigned the value of 1 if the respondent reported an income between CAD 100,000 and 150,000 and 0 otherwise. AgeGroup is an age group indicator variable. It is 1 if the respondent falls into the age group of 45 to 54 years and 0 for respondents in other age groups. The interaction term HighInc * AgeGroup captures the possible effects of being in a high-income category on the visitation rate for individuals, specifically within the 45–54 age group. Essentially, it allows us to examine whether the influence of higher income on park visit frequency differs for people in the 45–54 age bracket compared to those in other age groups. This approach allows us to test whether higher income affects park visit frequency differently for individuals aged 45–54 compared to other age groups. For example, people in this age and income group might have more leisure time or a stronger preference for outdoor activities, which could lead them to visit the park more often than others. Ho represents home ownership. If the respondent is a homeowner, this variable equals 1, and 0 if the respondent is a renter. We can calculate the Consumer Surplus (CS) per visit by using the following formula as suggested by Hellerstein and Mendelsohn (1993) and Englin and Shonkwiler (1995):

$$CS/AV = -1/\beta_{TCost} \quad (2)$$

For a detailed derivation of this formula, please refer to Appendix 1 (Supplementary Online Material).

SURVEY DESIGN, ADMINISTRATION AND DATA MANAGEMENT

Survey structure

The survey instrument (Supplementary Online Material) has three sections and attempts to capture the factors that influence the visitors' visitation rates and experience at KCP. The first segment of the survey addresses questions about parking amenities and the frequency of visits annually and during the four seasons. Figure 1 illustrates the distribution of these reported visits by season, highlighting an increase starting in spring, peaking in summer and fall, and declining significantly in winter due to cold weather and snow cover. This section also seeks to understand visitors' general views on urban encroachment of green space, significant alterations within the park area, and their satisfaction with the existing park amenities. The second segment aims to capture the visitors' revealed preferences. It incorporates questions about the travel distance, travel time, and the transportation the visitors use to get to the park. This part aims to estimate the travel cost of the visitors. The final section collects socio-demographic information about the respondents to control for socio-demographic factors which might affect park usage and attitudes toward park preservation.

Survey distribution and collection

The survey distribution plays an important role in ensuring a representative sample of the population of local residents that visit the park. To maximise the response rate, a two-pronged approach was adopted for survey distribution. An in-person distribution occurred during the initial three weeks of September 2022. Printed leaflets containing the online survey's QR code along with a cover letter were handed out at the entrance points of KCP and its parking lots. Mailbox distribution was also implemented, acknowledging that KCP is

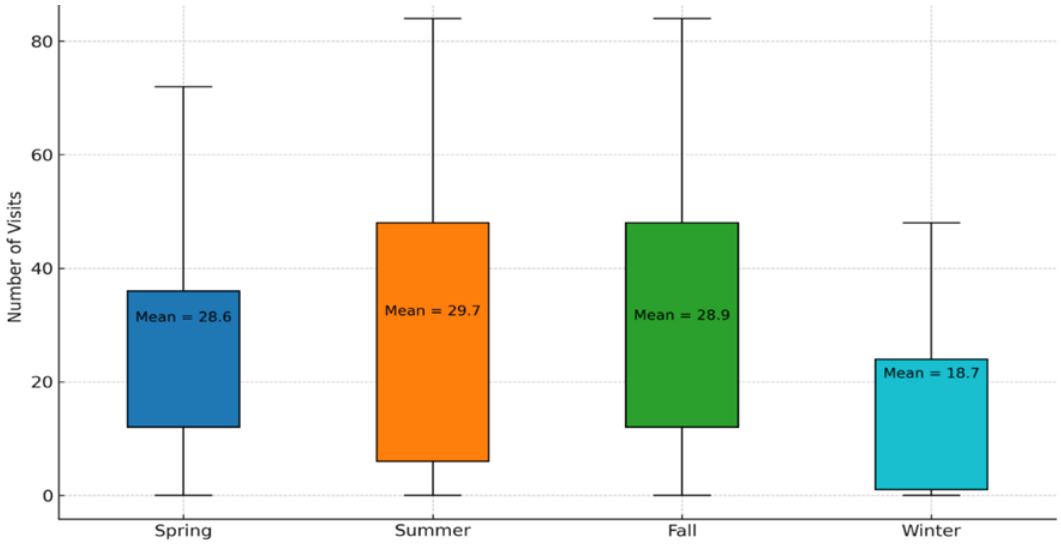

Figure 1. Distribution of park visits by season

surrounded by the Mt. Dufferin neighbourhood with various hidden trails preferred by local residents. Over the following two weeks, leaflets were distributed into neighbourhood mailboxes to reach those residents who might access the park via lesser-known entrances or trails.

Over the course of this exercise, 600 leaflets were distributed, 200 handed out in person and 400 delivered via neighbourhood mailboxes. Most responses came from in-person distribution, while relatively few resulted from mailbox delivery, leading to a response distribution skewed towards in-person interaction. This approach helped mitigate potential proximity bias associated with residents living near the park. It also improved the accuracy of travel cost data, which typically benefits from on-site collection. Notably, lower responses from the mailbox distribution could be due to residents perceiving the survey leaflets as advertisements.

RESULTS

The survey was live from 1 September to 15 October 2022, during which 146 responses were received, resulting in a response rate of 24.33 per cent. To ensure the study accurately reflected the value of the local park to Kamloops residents, responses from tourists were removed. These were identified as respondents reporting one-way travel distances of more than 30 kilometres. In addition, to enhance the accuracy of travel cost data, self-reported travel times and distances were compared with the fastest travel times and minimum distances from the respondents' postal codes according to Google Maps. Table 1 summarises the key variables used in the study,

Table 1. Summary statistics

Variable	Description	Mean	StDev	Obs
AV	Average number of visits made by an individual	103.88[1]	94.72	144
TCost	Unavoidable cost of travel and opportunity cost of travel time (CAD)	6.12	8.07	133
HsSize	Respondent's reported size of household (Adults+Children)	2.59	1.15	146
WalkBike	Respondents who reported walk/run/bike/Ebike = 1, other means = 0	0.46	0.50	146
SingleTravel	Group size of 1 = 1, group size more than 1 = 0	0.33	0.47	146
HighInc	Reported income between CAD 100,000–150,000, HighInc = 1	0.25	0.43	146
AgeGroup	Age group of 45 to 54 years = 1, other groups = 0	0.21	0.41	146
Ho	Homeowners = 1, renters = 0	0.72	0.44	144

1 An annual average of 103.88 visits may appear high but is reasonable given the park's urban location and its role in residents' daily routines.

Table 2. Zero-truncated negative binomial regression results

	Annual	Spring	Summer	Fall	Winter
TCost	-0.052***	-0.048***	-0.051***	-0.068***	-0.045*
	(0.013)	(0.013)	(0.016)	(0.014)	(0.026)
HsSize	-0.088	-0.122*	-0.072	-0.041	-0.242*
	(0.064)	(0.066)	(0.075)	(0.074)	(0.127)
WalkBike* SingleTravel	0.144	0.061	0.199	-0.073	0.662**
	(0.162)	(0.159)	(0.190)	(0.176)	(0.339)
HighInc* AgeGroup	0.844***	0.766***	0.849**	0.818***	0.855***
	(0.185)	(0.167)	(0.282)	(0.195)	(0.312)
Ho	0.632***	0.613***	0.552**	0.734***	1.216***
	(0.165)	(0.176)	(0.231)	(0.206)	(0.333)
Constant	4.485***	3.325***	3.190***	3.202***	2.036***
	(0.236)	(0.232)	(0.274)	(0.259)	(0.490)

Note: *** p<0.01, **p<0.05, *p<0.1. 95% robust standard errors in parentheses

providing a description and the mean value, standard deviation and number of observations for each.

Regression results

As the assumption of equal mean and variance required for Poisson regression is not satisfied in our data, and individuals with zero visits not being observed, we applied a zero-truncated negative binomial (ZTNB) model instead. This approach is appropriate for two reasons. First, the count data on park visitation are over-dispersed, with the variance exceeding the mean, making the negative binomial distribution more appropriate than the Poisson. Second, and more importantly, our survey captures only individuals who have visited the park, meaning that the dependent variable does not contain any zero values. In such cases, using a standard count model would produce biased estimates, as it assumes that zero outcomes were possible but not observed. The ZTNB model explicitly accounts for this 'truncation at zero', adjusting the likelihood function to reflect that the sample is drawn only from positive counts. This model allowed us to produce consistent estimates of the determinants of visitation. Table 2 presents annual and seasonal visit frequency results using the ZTNB specification.

It is important to note that because our sample includes only individuals who visited the park, the estimation is subject to endogenous stratification, a common issue in travel cost studies where observed users self-select into the sample. As a result, the estimated recreational values reflect conditional use values, which benefit actual park visitors rather than the general population. The literature widely accepts this approach and aligns with previous applications of truncated count models (Englin & Shonkwiler, 1995; Martínez-Espiñeira & Amoako-Tuffour, 2008).

The ZTNB regression results reveal several findings contributing to our understanding of urban park usage. Firstly, travel cost (TCost) shows a statistically significant negative relationship with visitation frequency across all seasons. As expected, the higher the travel cost, the less frequently individuals visit the park, suggesting that travel distance, time, or associated expenses deter recreational use. Household size (HsSize) shows a negative association but mostly insignificant relationship with park visits. The interaction term WalkBike * SingleTravel is positive in most models but not statistically significant, except in the winter model, where it reaches significance at p<0.05. This result suggests limited evidence that solo visitors using non-motorised transportation systematically visit the park more often than others. However, the significant effect observed in winter may point to a specific behavioural pattern, where individuals who walk or bike alone continue to engage with the park despite colder conditions. Although this finding warrants cautious interpretation, it may indicate that maintaining safe, accessible infrastructure for active transportation supports year-round usage. The

Kenna Cartwright Park, View of Kamloops Lake. © Panagiotis Tsigaris

Table 3. Estimated consumer surplus per person per visit

Variable	Annual	Spring	Summer	Fall	Winter
Consumer surplus (CAD $)	19.23	20.83	19.61	14.71	22.22
95% CI lower bound	9.81	9.77	7.55	8.77	-2.94
95% CI upper bound	28.65	31.89	31.66	20.64	47.39

Note: The consumer surplus per person per visit was calculated as the negative inverse of the coefficient for the variable *TCost* from the regression model. The 95% confidence intervals were derived using the delta method, based on the standard errors of the estimated coefficients. The delta method provides an approximate variance for nonlinear transformations of model parameters and is widely used in travel cost method (TCM) applications. Negative lower bounds, such as in the winter model, indicate high uncertainty and should be interpreted with caution rather than as negative welfare.

interaction term of HighInc * AgeGroup is significantly associated with a higher frequency of park visits across all seasons. This finding implies that individuals in the 45–54 age group with high incomes are more likely to visit the park more frequently. These findings align with previous studies (Ma et al., 2022; Reed et al., 2012; Sreetheran, 2017) that highlight how this age group uses urban parks more for physical activity than any other age group. Lastly, homeownership (Ho), which could serve as a proxy for wealth or income, is significantly and positively associated with the frequency of park visits across all seasons.

Assessing the recreational value of Kenna Cartwright Park[1]

Table 3 reports the estimated consumer surplus per person per visit for Kenna Cartwright Park, calculated as the negative inverse of the travel cost coefficient in each regression model. Confidence intervals are derived using the delta method, which accounts for the nonlinear transformation of the coefficient estimates. The seasonal estimates range from approximately CAD 14.71 in fall to CAD 20.83 in spring. The summer and annual models

1 All monetary values presented are non-market welfare estimates based on consumer surplus, and should not be interpreted as GDP, gross value added, or other market-based indicators.

Table 4. Recreational use value of the park and seasonal visits

	Recreational use value (in millions of CAD $)		
Year	**2019**	**2020**	**2021**
Spring	1.51	2.94	1.38
	(0.71-2.31)	(1.38-4.51)	(0.65-2.11)
Summer	1.48	1.63	0.83
	(0.57-2.39)	(0.63-2.64)	(0.32-1.35)
Fall	0.77	0.10	0.66
	(0.46-1.08)	(0.06-0.14)	(0.39-0.92)
Winter	1.03	1.33	1.43
	(-0.14-2.20)	(-0.18-2.85)	(-0.19-3.06)
Annual	4.75	6.79	4.19
	(2.42-7.08)	(3.47-10.12)	(2.14-6.25)
	Number of visits		
Year	**2019**	**2020**	**2021**
Spring	72,525	141,344	66,060
Summer	75,631	83,303	42,545
Fall	52,446	68,410	44,803
Winter	46,441	60,159	64,604
Total visits	247,043	353,216	218,012

Note: The visits data were provided by the Parks and Civic Facilities Department of the City of Kamloops. The recreational use value of the park was calculated by multiplying the estimated consumer surplus per person per visit by the total number of visits for each season. The values in brackets represent the 95% confidence interval

yield similar surplus values of CAD 19.61 and CAD 19.23, respectively. The winter estimate is slightly higher at CAD 22.22 but is not statistically significant at the $p<.05$ level as indicated by the wider confidence interval. These findings indicate that recreational value varies across seasons, with spring and summer providing relatively higher per-visit benefits, likely due to more favourable weather.

The recreational value of Kenna Cartwright Park and COVID-19

Table 4 highlights how the recreational value of Kenna Cartwright Park shifted during the COVID-19 pandemic, reflecting changing recreational preferences. In 2020, the year of the pandemic with public health restrictions, spring saw a dramatic increase in use value, rising to nearly CAD 2.94 million, double the 2019 and 2021 levels. This increase coincided with the initial lockdown period, when gyms, community centres and indoor venues were closed under provincial health orders (Government of British Columbia, 2020), and residents turned to outdoor spaces for physical activity, stress relief and safer social interaction (City of Kamloops, 2020; Geng et al., 2021; Honey-Rosés et al., 2020). Overall annual visits increased by more than 100,000, peaking at over 353,000 in 2020. Overall, the park's annual recreational use value reached CAD 4.75 million in 2019, increased to CAD 6.79 million in 2020, and declined to CAD 4.19 million in 2021.

Seasonal variation also changed in 2020. While spring use values rose in 2020, the summer, fall and winter visitations rates dropped sharply, likely due to softening of the public health restrictions and alternative leisure options resumed. In 2021, as pandemic restrictions eased further, both total visits and recreational value declined relative to the COVID-19 2020 year, except for the winter season. Urban green spaces played an important role during the pandemic (Venter et al., 2020). They were the essential public infrastructure for health and well-being (Hazlehurst et al., 2022). With an estimated recreational use value peaking at CAD 6.79 million in 2020, the data make a strong case for maintaining and expanding accessible parkland.

As cities plan for future resilience, whether in response to pandemics, climate change or urban densification, investments in parks should be viewed not just as aesthetic or recreational amenities, but as foundational components of public health and social infrastructure.

It is worth mentioning here that while our estimation focuses on visitors who used the park, it is important to acknowledge the potential for endogenous stratification

due to on-site sampling. Since our data does not observe individuals with zero visits, the sample is conditional on participation. However, this does not bias the welfare estimates derived from the travel cost method, as our objective is to evaluate the recreational use value conditional on visitation. This approach features prominently in empirical applications of on-site travel cost models (e.g. Martínez-Espiñeira & Amoako-Tuffour, 2008).

DISCUSSION

Our findings show that Kenna Cartwright Park offers significant recreational value, with observable seasonal patterns and a noticeable increase in use during the COVID-19 pandemic. In 2020, total visits increased by over 100,000 compared to 2019 and 2021, and the park's annual recreational value peaked at CAD 6.79 million. This highlights the park's vital role during public health emergencies, when indoor venues were closed and residents turned to outdoor spaces for physical and mental well-being.

Applying a welfare economics framework and the Travel Cost Method, we estimate a total recreational use value of approximately CAD 4.19 million in 2021, with a peak of CAD 6.79 million in 2020. While this study focuses specifically on use value derived through a revealed preference approach, other studies have assessed the broader ecosystem service value of Kenna Cartwright Park using different methods. For example, Truscott and Tsigaris (2022) employed a land value-based approach to estimate the park's total ecosystem services. Though the methodologies and objectives differ, these studies collectively reflect the multifaceted importance of protected urban green spaces.

Although not the primary focus of this study, it is worth noting that survey responses also revealed park users' concerns about development and environmental pressures, particularly the perceived threat of urban encroachment on Kenna Cartwright Park. Respondents expressed a strong desire to preserve the park's natural character, with greater concern voiced over future housing developments than over existing infrastructure projects such as the Trans Mountain Pipeline Expansion (Davies, 2020; Trans Mountain, 2020). These concerns are timely, as recent development proposals (Reeve, 2024) and ongoing urban growth illustrate the increasing tension between green space preservation and competing land uses. While outside the scope of the travel cost analysis, these perceptions highlight the need for integrated urban planning that protects natural areas from incremental encroachment and aligns with residents' clearly expressed values.

Beyond its role in estimating current recreational benefits, the welfare-based valuation approach used in this study offers strong potential for long-term application in park management. If repeated periodically, such valuations can track changes in use patterns, perceived value, or the effects of new infrastructure and policy decisions. This provides park authorities with a practical tool for evaluating how well their programmes support community well-being and equitable access to nature.

This study has several limitations. It includes only actual park users, excluding non-visitors and thus reflecting conditional rather than population-wide values. On-site sampling introduces endogenous stratification and may overstate average consumer surplus if visitors are systematically more motivated or able to access the park. Data were collected during a single period in early fall, which may not fully reflect seasonal variation. Self-reported travel behaviour may be subject to recall bias. The model also assumes homogenous preferences and does not account for substitute sites, which could affect estimated values.

Future studies could explore the park's impact on physical and mental health, estimate non-use values, and assess how further alterations may influence recreational behaviour. Such extensions would further inform policies aimed at optimising urban green spaces to enhance quality of life. Importantly, valuing parks through a welfare-based lens helps capture personal benefits, like enjoyment and satisfaction, that don't show up in market prices, making this approach a useful complement to traditional ecological or accounting-based assessments.

SUPPLEMENTARY ONLINE MATERIAL

Appendix 1. Derivation of the consumer surplus formula
Survey instrument

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Sagebrush and pine habitat in Kenna Cartwright Park, looking northeast. © Panagiotis Tsigaris

books with students, and mentored undergraduate and graduate research on sustainability, climate economics, and real-world public policy challenges.

Data Availability Statement: In line with the commitment to support replicable and transparent research, the survey, the derivation of consumer surplus in an appendix, and all data in excel supporting the findings of this study are available on the Open Science Framework (OSF). The datasets were fully anonymized to ensure privacy and ethical compliance. The primary dataset used for empirical analysis can be accessed directly via the following OSF link: http://doi.org/10.17605/OSF.IO/5MWBN

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RESUMEN

Los parques urbanos desempeñan un papel fundamental en la mejora de la vida cotidiana de los residentes y proporcionan una serie de beneficios ecológicos. Este estudio aplica el método del coste del viaje para estimar el valor recreativo del parque Kenna Cartwright, el mayor parque municipal de Columbia Británica, situado en Kamloops. Según los datos de la encuesta y las visitas, el excedente del consumidor estimado por persona y visita es de 19,23 dólares canadienses, lo que supone un valor recreativo anual de aproximadamente 4,19 millones de dólares canadienses en 2021. El estudio también examina cómo el valor recreativo respondió a perturbaciones externas, como la pandemia de COVID-19. En la primavera de 2020, las visitas al parque casi se duplicaron durante el confinamiento local, y el valor recreativo anual total ascendió a 6,79 millones de dólares canadienses. Estos resultados ponen de relieve el valor de los espacios verdes accesibles y el papel esencial de los parques urbanos para apoyar el bienestar público y la resiliencia en tiempos de perturbaciones como la COVID-19.

RÉSUMÉ

Les parcs urbains jouent un rôle essentiel dans l'amélioration de la vie quotidienne des habitants et offrent toute une série d'avantages écologiques. Cette étude applique la méthode du coût du déplacement pour estimer la valeur récréative du parc Kenna Cartwright, le plus grand parc municipal de Colombie-Britannique, situé à Kamloops. Sur la base d'une enquête et de données sur la fréquentation, le surplus du consommateur estimé par personne et par visite est de 19,23 dollars canadiens, ce qui représente une valeur récréative annuelle d'environ 4,19 millions de dollars canadiens en 2021. L'étude examine également comment la valeur récréative a réagi à des chocs externes, tels que la pandémie de COVID-19. Au printemps 2020, la fréquentation du parc a presque doublé pendant le confinement local, et la valeur récréative annuelle totale est passée à 6,79 millions de dollars canadiens. Ces résultats soulignent la valeur des espaces verts accessibles et le rôle essentiel des parcs urbains dans le soutien du bien-être et de la résilience de la population en période de perturbation telle que la COVID-19.

DECADE-LONG MONITORING IN LOMAKO-YOKOKALA FAUNAL RESERVE, DRC: IMPACTS OF RANGER PATROLS ON MAMMAL POPULATION STATUS

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ABSTRACT

Protected areas are crucial for biodiversity conservation, and effective monitoring of animal population trends is critical for proper management. However, sustaining long-term monitoring remains challenging. In 2023, we conducted a reserve-wide survey in the Lomako-Yokokala Faunal Reserve, Democratic Republic of Congo, to evaluate mammal population change over the past decade. This reserve, a Bonobo (*Pan paniscus*) study site since 1974, has been managed with ranger patrols since 2006. To ensure comparability, we replicated the methods of a 2010 survey, using index sampling and reconnaissance methods – cost-effective approaches for rainforest mammal monitoring. Encounter rates for most target species increased since 2010, with one monkey and four duiker species showing at least fourfold rises, while hunting signs declined. Some large mammals displayed uneven distributions, reflecting historical hunting pressures during periods of political instability, whereas others showed recovery even in areas with poaching signs. Although detectability differences between surveys cannot be excluded, the observed increase in encounter rate indicates the effectiveness of ranger patrols. Further research into detectability factors and thresholds for significant changes will enhance the reliability of indices as long-term monitoring tools in tropical forests.

Keywords: Bonobos, Index sampling, Long-term monitoring, Rainforest

INTRODUCTION

Protected areas are crucial for biodiversity conservation, playing an essential role in large-scale conservation programmes by maintaining ecological functions and providing sustainable land-use options for humans (Bruner et al., 2001; DeFries et al., 2007; Stokes et al., 2010). The presence of rangers and also long-term tourism and research activities significantly enhance the conservation status of protected areas (Campbell et al., 2011; Tranquilli et al., 2012). However, protected areas can only fulfil their conservation role if they are properly managed (Fischer, 2008; Kapos et al., 2009). Monitoring wildlife to track trends in animal populations is critical for assessing the impact of potential threats and the effectiveness of conservation interventions (Carrillo et al., 2000; Kühl et al., 2008). Despite its importance, long-term monitoring data are often scarce (e.g. Hoppe-Dominik et al., 2011). While absolute estimates of animal abundance are ideal, often practical and financial constraints limit surveys and monitoring programmes to estimating indices (Carrillo et al., 2000; Kühl et al., 2008). Monitoring mammal populations in tropical rainforests, for example, requires substantial effort and expense due to poor visibility in dense vegetation (Carrillo et al., 2000; Plumptre, 2000). In areas with hunting pressure, direct observation is further complicated, as animals tend to flee and hide from humans. Consequently, index sampling of indirect signs, such as dung and nests, is widely used in mammal population monitoring programmes (e.g. Barnes, 2001; Kuehl et al., 2007; Stokes et al., 2010).

Relative abundance indices can provide valuable information on spatiotemporal changes in distribution and population status when derived from standardised sampling methods. However, careful consideration must be given to the underlying assumptions (Kühl et al., 2008). Key assumptions are that population indices

and density have a linear relationship, and that the detection probability of the index remains constant over space and time, although these assumptions are invalid in many field studies (Kühl et al., 2008; Pollock et al., 2002). Detection probability may vary depending on the observer and vegetation type. Furthermore, translating the density of indirect signs (such as dung and nests) into animal density requires an understanding of production and decay rates of these signs, which can vary significantly with season, weather, habitat, diet and other factors (Kuehl et al., 2007; Laing et al., 2003; Walsh & White, 2005). Reuse of the same transects in subsequent surveys is one strategy to minimise variability in detection probability (Plumptre, 2000).

Conservation activities often face challenges such as political instability, shifting stakeholders and limited funding, making long-term monitoring difficult. The Lomako forest in the Democratic Republic of Congo (DRC) exemplifies these challenges. It has been a long-term study site for Bonobos (*Pan paniscus*), an endangered species of great ape endemic to the DRC (IUCN & ICCN, 2012), since the 1970s, with early recognition of the need for a protected area (Badrian & Badrian, 1977). Attempts to formally protect the Lomako forest in the 1980s were disrupted by political instability and warfare in the 1990s (Dupain & Van Elsacker, 2001). However, the Lomako-Yokokala Faunal Reserve (RFLY) was officially established in 2006 and has since been managed by the Congolese Institute for the Conservation of Nature (ICCN) (Sakamaki et al., 2020). Although anecdotal evidence suggests an increase in the number and distribution of large mammals (e.g. Maputla et al., 2020), there is limited data on trends in mammal populations.

In this study, we present the results of a reserve-wide survey conducted in 2023, assessing the populations of medium and large mammals, as well as human activities, within RFLY. The primary objective was to evaluate changes in mammal populations over the past decade by comparing our findings with data from previous surveys. Several surveys prior to RFLY's establishment focused on studying the region's flora (Boubli et al., 2004), large mammals, and human disturbances (Dupain et al., 2000; Omasombo et al., 2005). However, these surveys were limited to specific parts of the Lomako forest. The first comprehensive survey covering the entire RFLY was conducted in 2006 (Omasombo & Mpiana, 2006), followed by subsequent surveys. The earliest survey with comparable data was conducted in 2010 (Vosper, 2010). To enhance comparability, we used the same survey design as in 2010. The available 2010 data included encounter rates for medium and large mammals, collected via reconnaissance ('recce') methods, and Bonobo density estimates based on line-transect distance sampling (Kühl et al., 2008; Vosper, 2010). In this study, we also examined the distribution patterns of mammal populations, as events in the Lomako forest over several decades may have influenced their current distributions. The long-term study site, established in the 1970s (Dupain & Van Elsacker, 2001; Sakamaki et al., 2020), may have deterred commercial hunters from entering the area. A logging company operated in the north-western region until it abandoned its concession in 1987 (Dupain et al., 2000). During the political instability of the 1990s and 2000s, commercial hunters used old logging roads to enter the area from the west (Dupain & Van Elsacker, 2001). Since the creation of RFLY in 2006, ranger patrols have been implemented. We hypothesised that (1) if ranger patrols were effective, mammal populations that declined during the 1990s and 2000s would have improved over the past decade, and (2) mammal relative abundance would be higher near ranger patrol bases and long-term study sites. We examined the distribution of poacher signs and mammal populations relative to the locations of patrol bases, and we discuss overall population changes and the effectiveness of ranger patrols in RFLY.

METHODS

Study area

RFLY is located between the Lomako and Yokokala Rivers, covering an area of 3,625 km² (Supplementary Online Material 1). The terrain is flat, with an average elevation of approximately 400 m above sea level. The region receives over 2,000 mm of mean annual rainfall, with a drier period typically occurring between January and March (Boubli et al., 2004). The vegetation primarily consists of evergreen lowland tropical rainforest, categorised into four distinct physiognomic types: (1) Mixed forest – a 'primary' forest with various species, many large trees, and a high, continuous canopy without dominant species; (2) Monodominant forest – similar to mixed forest but dominated by a single tree species, typically *Gilbertiodendron dewevrei*, often found around inundated areas; (3) Secondary forest – areas previously used for human agriculture or affected by tree-fall gaps, characterised by dense undergrowth and an absence of large trees; and (4) Inundated forest – areas that are seasonally or permanently flooded (Boubli et al., 2004; White, 1992; White & Edwards, 2000). RFLY contains two long-term study sites: Ndele (also known as Isamondje), established in 1974, and Iyema, founded in 1995 (Dupain & Van Elsacker, 2001) (Figure 1). The reserve's headquarters are located at Lingunda, in the south-west, with two additional patrol stations at Bomponde (south-east) and Ekotombolo (north-west)

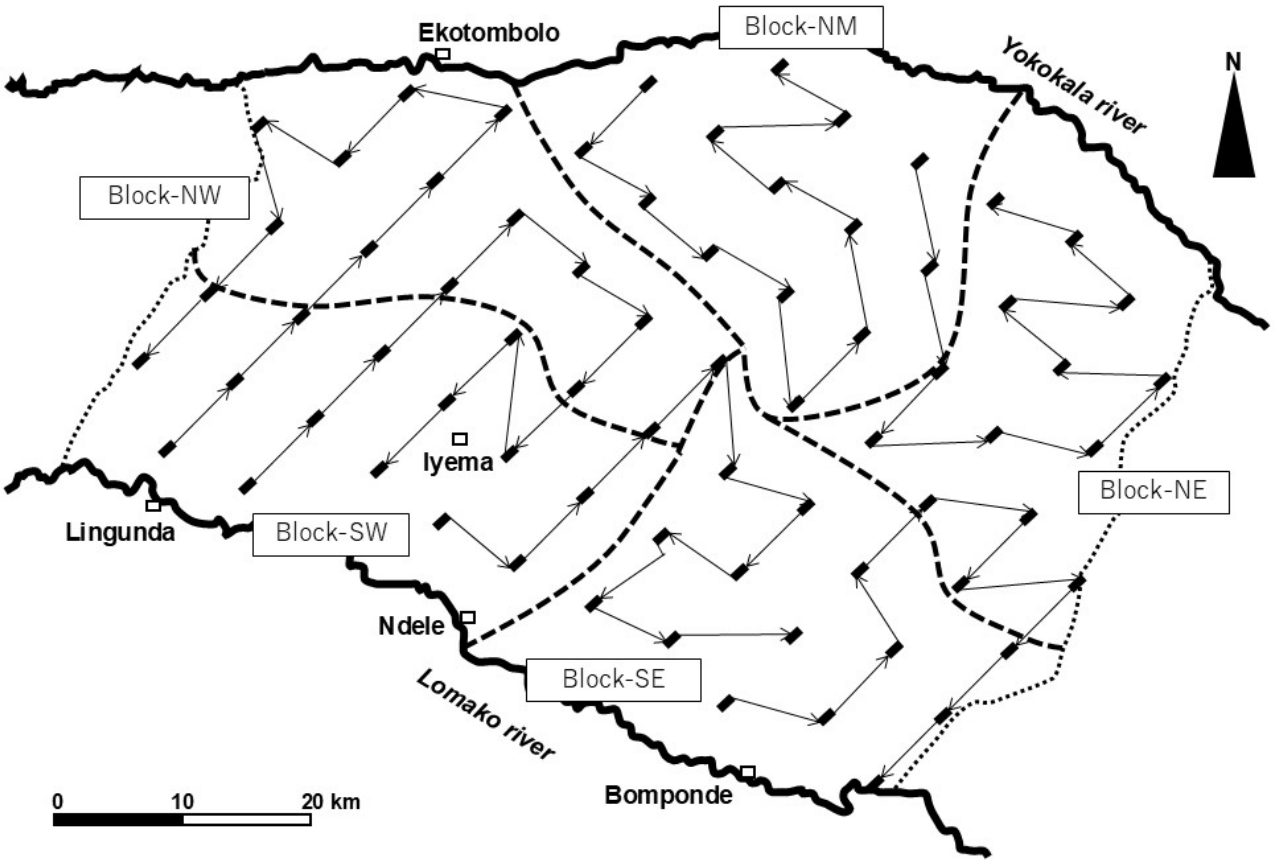

Figure 1. Map of RFLY showing 71 line transects (1 km each, bold straight lines) and 65 recces (straight arrows) from the 2023 survey. The northern and southern boundaries of RFLY are the Yokokala and Lomako Rivers, respectively, while the western and eastern boundaries are marked by dotted lines. The area is divided into five blocks (broken lines) based on three ranger patrol sectors (approximately SW, NW+NM, and NE+SE). Iyema and Ndele have been long-term study sites since 1995 and 1974, respectively. Lingunda serves as the RFLY headquarters, while Bomponde and Ekotombolo are additional ranger patrol stations.

(Figure 1). The area around Bomponde is inhabited by members of the Kitiwalists, a Christian religious group who live in isolated forest camps and are not governed by state authority (Dupain & Van Elsacker, 2001).

Survey design

We systematically placed 71 one-kilometre-long transects throughout RFLY (Figure 1). The number and length of transects were determined based on the encounter rate of Bonobo nests from a preliminary 2008 study and a time limit of two months for survey completion (Vosper, 2010). Reconnaissance walks (recces) were used to connect the end of one transect and the start of the next. The transects and recces were divided into six circuits (Figure 1), each containing 12 transects and 11 recces, except for one circuit, which had 11 transects and 10 recces. Some recce routes were adjusted from the previous layout due to logistical considerations, but the total number of recces remained the same as in the 2010 survey. We followed straight transects using a 50-metre tape measure, a compass and a GPS navigator (Garmin GPSMAP 65s), verifying the coordinates of every 100-metre point. Three transects were shortened due to relatively large rivers, resulting in a total transect length of 70.4 km. Along recces, we followed a straight path as closely as possible, with one major detour around a natural gap caused by fallen trees. The total length of recces was 461.5 km (N = 65 recces, mean = 7.10±SD 1.00 km, range = 6.35–10.22 km), and the total length of all census routes combined was 531.9 km.

Data collection

Two teams surveyed three circuits each from 13 March to 16 May 2023. Each team comprised a team leader (YM and LLF, respectively) and five ICCN rangers, including two observers – one focusing on detecting ground-based animal signs and the other on tree-dwelling animals and Bonobo nests. To improve inter-observer reliability, a training programme and preliminary survey were conducted in September and October 2022. Teams walked at approximately 0.5 km/h on transects and 1 km/h on recces, recording vegetation types, direct and indirect observations of mammals, and signs of human activity along the routes, while marking their positions

with GPS devices. Vegetation was categorised using the four physiognomic types described earlier, with changes noted whenever a transition occurred. For mammals, species were recorded along with the number of individuals and detection types, including direct observations, vocalisations, fleeing sounds, footprints, dung, food remnants or marks, digging holes and Bonobo nests. Species were identified by dung based on characteristics such as size, shape and colour, with at least two team members verifying each identification. Dung from three similarly sized duiker species (Black-fronted (*Cephalophus nigrifrons*), Weyns's (*C. weynsi*) and Bay Duikers (*C. dorsalis*)) was grouped into a single category. For diurnal monkeys, sightings were counted based on group detections. Indicators of human activity recorded included traps (both active and inactive), hunting camps, gunshot sounds, shotgun cartridges, poisoned arrows, agricultural fields, direct encounters with people, human trails and machete cut marks. To estimate Bonobo nest density, we used the standing crop nest count method and distance sampling (Thomas et al., 2010; Tutin & Fernandez, 1984), following the same approach as in the 2010 survey. For each nest group detected along transects, we recorded nest age class, group size, and perpendicular distance from centre of the group to transect line. Nest age was categorised into four classes (Tutin & Fernandez, 1984): Fresh – all leaves in the nest are green and fresh; Recent – leaves are drying and changing colour; Old – nest structure remains intact, with most leaves brown; and Very old – the nest has holes and few or no leaves but is still identifiable by bent twigs. Nests within the same age class and located within 30 m of each other were grouped as belonging to the same nest group.

Data analysis

To compare mammal indices, we calculated encounter rates (i.e. the number of detections per km) along recces, following the method used in the 2010 survey (Vosper, 2010). The target species included 15 mammals: Forest Elephant (*Loxodonta cyclotis*), detected through dung; Bonobo, detected through nest groups and individual nests; four species of diurnal monkeys – Angola Colobus (*Colobus angolensis*), Black Crested Mangabey (*Lophocebus aterrimus*), Wolf's Monkey (*Cercopithecus wolfi*) and Red-tailed Monkey (*C. ascanius*) – detected through direct observation and vocalisations; five species of duikers – Blue Duiker (*Philantomba monticola*), Black-fronted Duiker, Weyns's Duiker, Yellow-backed Duiker (*C. silvicultor*) and Bay Duiker – detected through dung; and three large and one small artiodactyl species – Red River Hog (*Potamochoerus porcus*), Bongo (*Tragelaphus eurycerus*), Sitatunga (*T. spekii*) and Water Chevrotain (*Hyemoschus aquaticus*) – detected through dung. For comparisons of Bonobo nest density, we used DISTANCE software (ver.7.5) (Thomas et al., 2010) to estimate density based on the number of nest groups along each transect, transect length, nest group size, and perpendicular distance. Several detection functions were tested, with the detection function using a uniform key providing the best fit based on Akaike's Information Criterion. We also examined other variables such as nest group size and nest age classes. For hunting signs, we calculated the encounter rates of traps, hunting camps, shotgun cartridges and poisoned arrows.

Rangers receiving training © Sakamaki-AZF

To analyse the distribution patterns of mammals, we divided the study area into five blocks: south-west (SW), south-east (SE), north-west (NW), north-middle (NM) and north-east (NE). Each block included 14 transects and 13 recces, except for the SW block, which had 15 transects and 13 recces (Figure 1). These blocks were based on three ranger patrol sectors (i.e. SW, north and east), with the north and east sectors further

Table 1. Potential factors affecting mammal distribution in RFLY. The study area was divided into five blocks based on the locations of ranger patrol bases.

	Block					
Factors	**SW**	**SE**	**NW**	**NM**	**NE**	**Total**
Ranger patrol bases	headquarters	station	station	no	no	---
Long-term study sites since the 1970s	yes	no	no	no	no	---
Old logging roads abandoned in 1987	no	no	yes	no	no	---
Vegetation types (%):						
- mixed forest / monodominant forest	67 / 17	65 / 11	71 / 16	72 / 17	65 / 16	68 / 15
- inundated forest / secondary forest	15 / 1	20 / 3	12 / 0	12 / 0	17 / 1	15 / 1

subdivided. The patrol sectors roughly correspond to the SW, NW+NM, and NE+SE blocks (Table 1). To assess patrol effort in each block, we obtained monthly patrol route data from 2017 to 2022 (excluding three months in 2021). The frequency of ranger patrols per year was calculated based on monthly records, and differences in yearly patrol ratios across the five blocks were tested using the Kruskal-Wallis test (N = 6 years, df = 4). Significant results ($P < 0.05$) were followed by Tukey's honestly significant difference (HSD) test for pairwise comparisons. All statistical analyses were performed in the R statistical environments (R Core Team, 2019). For poacher activity, we analysed not only hunting signs but also all other indicators of human presence, including human trails and machete cut marks, assuming that most intrusions into RFLY were hunting-related. Encounter rates along each recce were calculated, and differences among the five blocks were tested using the Kruskal-Wallis test (13 recces in each block, df = 4), followed by Tukey's HSD test. Regarding mammal distributions, encounter rates for each species were calculated along each recce and analysed similarly to poacher intrusions. Due to low detection numbers, Bongo and Water Chevrotain were excluded from the analysis. Elephant signs, including dung and other traces, were grouped together as there was no confusion with other mammals. For Bonobos, both nest groups and individual nests were analysed. Since vegetation type may influence mammal distribution, we calculated the proportion of each vegetation type along the survey routes in each block. However, vegetation variation among the blocks was minimal: mixed forest consistently occupied 65–72 per cent of each block, while secondary forest ranged from 0–3 per cent (Table 1).

RESULTS

Comparisons with the 2010 survey

Encounter rates of mammal signs increased for most target species compared to the 2010 survey, with rates for one species of diurnal monkey and four species of duikers rising fourfold or more (Supplementary Online Material 2). It was difficult to assess changes for less frequently encountered species, such as Elephants, Water Chevrotains and Bongos (Supplementary Online Material 2). The encounter rate of Bonobo nest groups showed a modest 5 per cent increase, while that of individual nests increased by over threefold (213 per cent) (Supplementary Online Material 2). This comparison is based on data collected along recces, as the number of nest groups along transects was not reported in Vosper (2010). The number of transects where Bonobo nests were detected was higher in 2023 than in 2010 (26 out of 71 transects vs. 17 out of 70) (Supplementary Online Material 2). The average nest group size was approximately threefold larger than in the 2010 survey (9.98 vs. 3.36 nests). The age class distribution of detected nest groups also differed: in 2010, most nests were classified as "old" rather than "fresh" or "recent" (Vosper, 2010), whereas in 2023, "fresh" and "recent" nests dominated observations (31 per cent and 55 per cent, respectively). Nest density increased more than fivefold (25.5 vs. 133.5 nests/km2). In contrast, encounter rates of hunting signs decreased compared to the 2010 survey (traps: -82 per cent; hunting camps: -40 per cent) (Supplementary Online Material 2).

Distribution patterns

The frequency of ranger patrols varied significantly across the five blocks (Kruskal-Wallis test, $P = 0.00014$), with the highest patrol frequency observed in the SW block, and higher frequencies in the SE and NW blocks compared to the NM and NE blocks (Figure 2). Similarly,

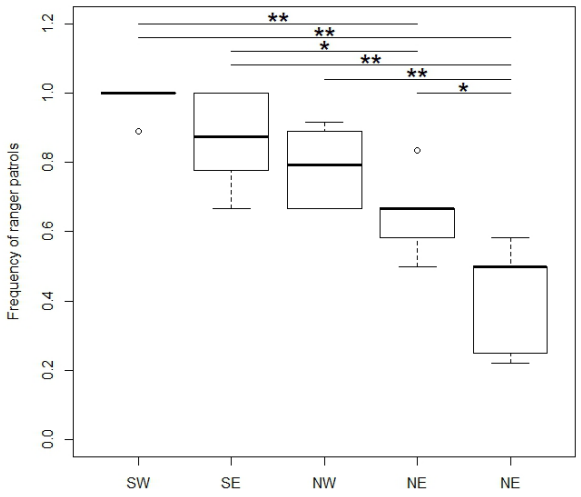

Figure 2. (a) Frequency of ranger patrols (yearly ratios) in five blocks (SW, SE, NW, NM and NE) of RFLY in 2017 to 2022.

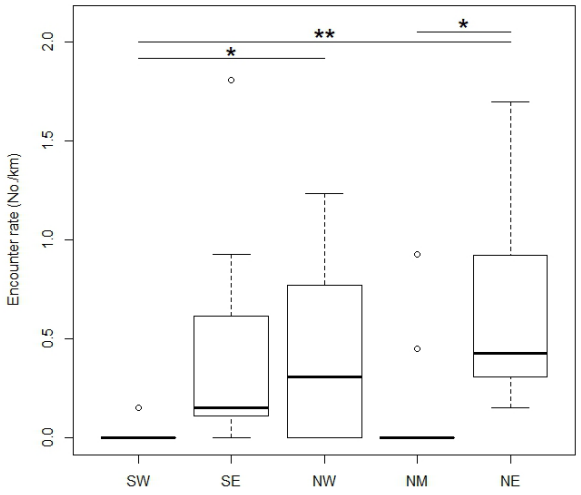

Figure 2. (b) Encounter rates of poacher signs along each recce in five blocks (SW, SE, NW, NM and NE) of RFLY. There was a significant difference in encounter rates among the five blocks (Kruskal-Wallis test, $P < 0.01$). Significant differences between pairs of blocks are indicated (Tukey's HSD test, *: $P < 0.05$, **: $P < 0.01$).

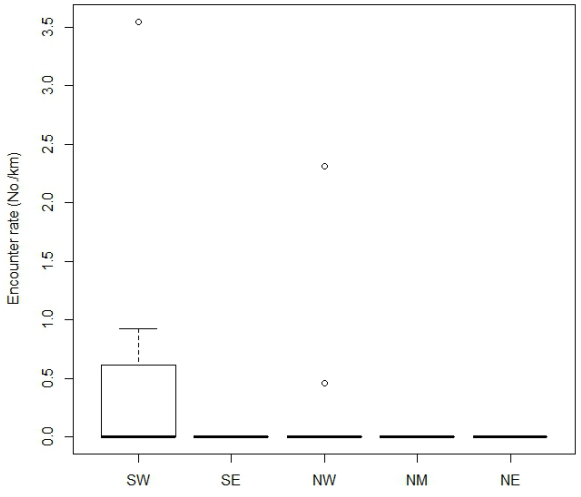

Figure 3. Encounter rates of (a) Elephants

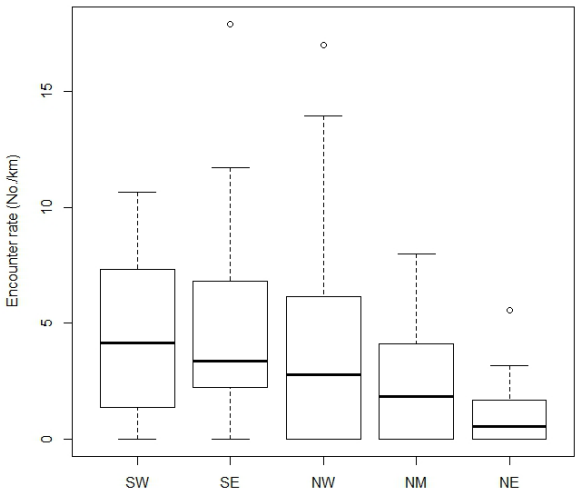

Figure 3. Encounter rates of (b) Bonobos (individual nests)

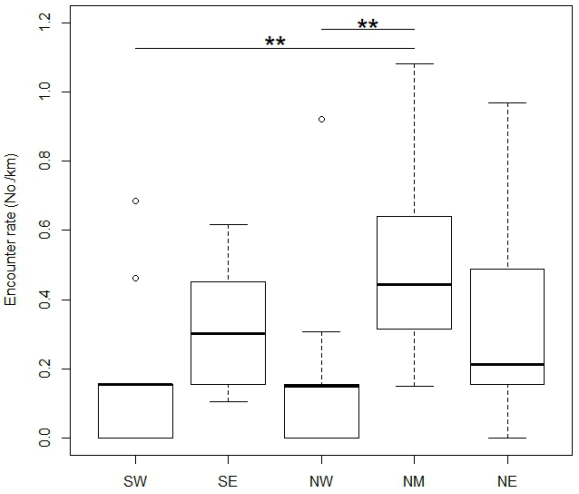

Figure 3. Encounter rates of (c) Red River Hogs

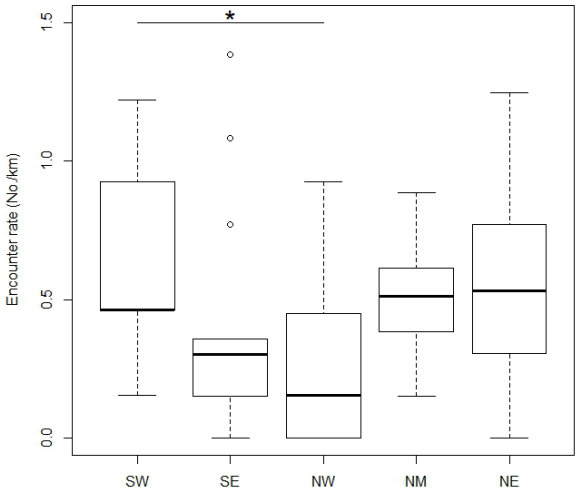

Figure 3 Encounter rates of (d) Yellow-backed Duikers along each recce in five blocks (SW, SE, NW, NM and NE) of RFLY. Significant differences among the five blocks were found for all four species (Kruskal-Wallis test, $P < 0.05$). Significant differences between pairs of blocks are indicated (Tukey's HSD test, *: $P < 0.05$, **: $P < 0.01$).

encounter rates of poacher signs differed significantly across the blocks (P = 0.00001), with the highest rate recorded in the NE block and the lowest in the SW block (Figure 2). Significant differences in encounter rates were found among the five blocks for four mammal species: Elephants (P = 0.0046), Bonobos (individual nests, P = 0.041), Red River Hogs (P = 0.00085) and Yellow-backed Duikers (P = 0.014) (Supplementary Online Material 2). Distribution patterns varied among these species: Elephants, Bonobos and Yellow-backed Duikers showed the highest encounter rates in the SW block, while Red River Hogs had the highest rates in the NM block (Figure 3).

DISCUSSION

Overall changes in mammal populations

In 2023, we conducted a reserve-wide survey of medium and large mammals, as well as human activities, in RFLY, facilitating a direct comparison with the previous survey from 2010 (Vosper, 2010). Our findings show that encounter rates for most mammal species have increased, with rates for one species of diurnal monkey and four species of duikers rising by more than fourfold. This suggests a steady growth in mammal populations in RFLY over the past decade. Additionally, indices of hunting signs have decreased substantially. During the political instability of the 1990s and 2000s, we assume that mammal populations in this area – particularly in the northern parts of RFLY – were severely impacted by commercial hunting (Dupain et al., 2000; Dupain & Van Elsacker, 2001). However, our results suggest that ranger patrols, implemented following the establishment of RFLY in 2006, have been effective. These findings are particularly significant, given that large mammals, as well as duikers and monkeys, are prime targets for both local and commercial hunters (e.g. Fa et al., 2005), and that large mammal populations have continued to decline even in protected areas across Africa (e.g. Craigie et al., 2010).

The substantial increase in mammal indices suggests growing mammal populations. However, when making temporal comparisons, it is important to consider whether detection probabilities remain consistent (Kühl et al., 2008; Pollock et al., 2002). Although the same survey design was employed as in the previous study, several factors could still influence detection probability. First, the ability of observers to detect animal signs may have improved due to accumulated experience, as the observers in this study were rangers who regularly patrolled the area, collecting data on animal signs and human activities for law enforcement purposes. Second, the likelihood of directly observing some animals may have increased as a result of behavioural changes. Specifically, diurnal monkeys tend to flee and hide from humans in areas with hunting pressure, while in well-protected areas like the Iyema site, they do not exhibit such behaviours (Sakamaki, personal observations). Consequently, detectability through direct observation may increase in response to effective ranger patrols. Third, unlike direct observation, the detection of terrestrial mammal dung remains a reliable indicator for temporal and spatial comparisons, as it is unlikely to be influenced by conservation interventions or hunting, provided that survey routes are randomly set. One concern, however, is the potential impact of rainfall, as even a single rain event can affect dung decay rates. Although both the 2010 and 2023 surveys included a drier period between January and March, specific rainfall data for the survey periods are unavailable. In any case, to enhance the utility of indices for temporal and spatial comparisons, it is crucial to validate a linear relationship between indices and abundance. This can be achieved by comparing them with independent absolute density estimates from alternative methods, such as camera traps and genetic surveys (Barnes, 2001; Bradley et al., 2008; Guschanski et al., 2009; Nakashima et al., 2013). Furthermore, it is essential to establish the threshold of index variation that constitutes statistical significance (e.g. Crawford, 1991; Plumptre, 2000).

The Bonobo nest density, based on distance sampling along line transects, increased fivefold compared to the 2010 survey. However, this drastic rise seems questionable given the long birth interval of wild Bonobos (4.8 years: Hashimoto et al., 2022). While the encounter rates of nest groups remained nearly unchanged, the encounter rates of individual nests rose substantially, indicating that the average nest group size increased threefold. This discrepancy could be partially attributed to variations in nest age classes between surveys: in 2010, more “old” nests were detected, whereas in 2023, “fresh” and “recent” nests dominated the observations. Since older nests are more likely to disappear, the 2010 survey may have underestimated the actual number of nests. However, this factor alone is unlikely to fully explain the threefold increase in nest group size. Human disturbance may have contributed to the smaller nest group sizes observed in 2010. Unhabituated Bonobos often disperse into smaller parties when encountering humans or experiencing disturbances, especially in areas where they are hunted (Sakamaki, personal observations). In contrast, the Bonobos in RFLY appear to have adapted their behaviour and grouping patterns to more natural conditions as human threats have diminished. Although

further research is needed to assess the effects of human disturbance on nest group sizes and its impact on density estimation, our findings suggest that the Bonobo population in RFLY has increased over the past decade.

Distributions and patrol effectiveness

We divided RFLY into five blocks based on the locations of patrol bases and observed a gradient in patrol efforts. Patrol frequency was highest in the SW block, where the headquarters and long-term study sites are located, and higher in the SE and NW blocks, where patrol stations are situated, compared to the NM and NE blocks. The rate of poacher signs was highest in the NE block, suggesting that poachers may have entered the area from the east, and second highest in the NW block, where old logging roads are present (Dupain et al., 2000). Interestingly, poacher activity was low in the NM block, which lacks a patrol base, suggesting that this area is the most difficult to penetrate. Significant differences in mammal indices among the five blocks were found for Elephants, Bonobos, Red River Hogs and Yellow-backed Duikers – all relatively large mammals. Some of these distributions may reflect the legacy of past hunting impacts. For example, Elephants likely survived in only a small portion of the Lomako forest during or even before the period of active commercial hunting in the 1990s and 2000s (Dupain et al., 2000). Since previous surveys recorded their range in the same area (Maputla et al., 2020; Vosper, 2010), it appears that Elephants have not significantly expanded their range. Bonobo indices were slightly higher in the southern blocks, likely reflecting past hunting pressures along the northern Yokokala River (Dupain et al., 2000).

It is important to note that other mammals were distributed more evenly throughout RFLY, suggesting that historical population declines caused by commercial hunting have had a limited impact on their present-day distributions. The high rates of increase observed for certain species indicate the effectiveness of ranger patrols, even in areas with frequent poacher intrusions. Future surveys comparing these indices will help determine whether these populations continue to grow and reach their carrying capacity under well-protected conditions.

CONCLUSIONS

This study demonstrates that replicating the design of a previous survey, along with relatively simple and inexpensive methods, is practical for evaluating overall changes in mammal populations and assessing the effectiveness of ranger patrols over a decade. However, detection probabilities for some mammal indices may have varied during this period. Furthermore, the range of statistically significant index changes remains unclear due to the lack of statistical assessment. For example, integrating regular patrols that collect encounter rate data using the Spatial Monitoring and Reporting Tool (SMART) could help quantify the inherent variability in indices and identify factors beyond animal density that influence this variability. Addressing these limitations in future studies would enhance the reliability of index sampling for long-term monitoring of mammal populations and the evaluation of conservation interventions. We emphasise that indices should ideally be complemented with alternative methods such as camera traps and genetic surveys to obtain precise population estimates, while still benefiting from the cost-effectiveness of standardised index approaches.

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SUPPLEMENTARY ONLINE MATERIAL

Supplementary Online Material 1. Additional figure of study area

Supplementary Online Material 2. Tables for Results and Discussion section

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RESUMEN

Las áreas protegidas son cruciales para la conservación de la biodiversidad, y el seguimiento eficaz de las tendencias de las poblaciones animales es fundamental para una gestión adecuada. Sin embargo, mantener un seguimiento a largo plazo sigue siendo un reto. En 2023, realizamos un estudio de toda la reserva en la Reserva Faunística de Lomako-Yokokala, República Democrática del Congo, para evaluar los cambios en la población de mamíferos durante la última década. Esta reserva, lugar de estudio del Bonobo (*Pan paniscus*) desde 1974, ha sido gestionada con patrullas de guardabosques desde 2006. Para garantizar la comparabilidad, reprodujimos los métodos de un estudio de 2010, utilizando muestreo índice y métodos de reconocimiento, enfoques rentables para el seguimiento de mamíferos de la selva tropical. Las tasas de encuentro de la mayoría de las especies objetivo aumentaron desde 2010, con un mono y cuatro especies de duiqueros que mostraron un aumento de al menos cuatro veces, mientras que los indicios de caza disminuyeron. Algunos grandes mamíferos mostraron distribuciones desiguales, lo que refleja presiones históricas de caza durante periodos de inestabilidad política, mientras que otros mostraron recuperación incluso en zonas con indicios de caza furtiva. Aunque no pueden excluirse diferencias de detectabilidad entre los distintos estudios, el aumento observado en la tasa de encuentros indica la eficacia de las patrullas de guardabosques. Nuevas investigaciones sobre los factores de detectabilidad y los umbrales de los cambios significativos aumentarán la fiabilidad de los índices como herramientas de seguimiento a largo plazo en los bosques tropicales.

RÉSUMÉ

Les zones protégées sont essentielles à la conservation de la biodiversité, et un suivi efficace de l'évolution des populations animales est indispensable à une bonne gestion. Cependant, le maintien d'un suivi à long terme reste un défi. En 2023, nous avons mené une étude à l'échelle de la réserve dans la réserve de faune de Lomako-Yokokala, en République démocratique du Congo, afin d'évaluer l'évolution des populations de mammifères au cours de la dernière décennie. Cette réserve, site d'étude du Bonobo (*Pan paniscus*) depuis 1974, est gérée par des patrouilles de gardes forestiers depuis 2006. Pour assurer la comparabilité, nous avons reproduit les méthodes d'une étude de 2010, en utilisant l'échantillonnage indiciel et les méthodes de reconnaissance - des approches rentables pour le suivi des mammifères de la forêt tropicale. Les taux de rencontre pour la plupart des espèces cibles ont augmenté depuis 2010, avec un singe et quatre espèces de céphalophes qui ont au moins quadruplé, tandis que les signes de chasse ont diminué. Certains grands mammifères présentaient des distributions inégales, reflétant les pressions historiques de la chasse pendant les périodes d'instabilité politique, tandis que d'autres ont montré un rétablissement même dans les zones présentant des signes de braconnage. Bien que l'on ne puisse exclure des différences de détectabilité entre les enquêtes, l'augmentation observée du taux de rencontre indique l'efficacité des patrouilles de gardes forestiers. Des recherches plus approfondies sur les facteurs de détectabilité et les seuils de changements significatifs permettront d'améliorer la fiabilité des indices en tant qu'outils de surveillance à long terme dans les forêts tropicales.

THE PROTECTED AREA SYSTEM OF ETHIOPIA: DEVELOPMENT, PRESENT STATE AND PERSPECTIVES TOWARDS THE '30X30 TARGET'

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ABSTRACT

Ethiopia is well-known for its outstanding biodiversity and importance as a water tower for surrounding countries. In the mid-1960s, conservation efforts focused on creating protected areas (PAs) that excluded human exploitation and targeted tourism. National Parks, Wildlife Reserves and especially Hunting Areas dominated the country's first PA map from 1973. Fifty years later, the map for Ethiopia on the World Database on Protected Areas, showing 17 per cent of Ethiopia's land cover as PAs, is outdated. While several PAs have been added over the years, there are non-functioning and de-gazetted PAs, especially non-operational hunting areas, that have not been removed from the database. We present updated maps, showing that 14 per cent of Ethiopia is currently protected by wildlife PAs (10 per cent) and Forest Priority Areas (4 per cent). With its declining wildlife and international tourism, and the under-funding of its PAs, Ethiopia's response towards the Global Biodiversity Framework '30x30 target' should prioritise improving PA quality by i) diversifying PA governance allowing increased community ownership, ii) diversifying PA management for increased efficiency, iii) promoting investments in PAs, and iv) setting realistic management objectives. There is considerable long-term potential (post-2030) to increase the number of conservation areas by recognising the many tiny church forests and vast pastoral territories as Other area-based Effective Conservation Measures (OECMs), while stimulating PAs' economic rationale beyond international tourism.

Key words: church forests, conservation overstretch, delegated management, OECMs, protected area map

INTRODUCTION

Ethiopia has some of the richest biodiversity in Africa, occurring across a highly diverse topography (Fashing et al., 2022). The country hosts 325 mammal species, including 64 endemic species such as Walia Ibex (*Capra walie*), Mountain Nyala (*Tragelaphus buxtoni*) and the monotypic genus of Gelada (*Theropithecus gelada*). Ethiopia's avifauna includes over 881 bird species, 18 of which are endemic including the monotypic genus of Stresemann's Bush Crow (*Zavattariornis stresemanni*), making Ethiopia a premier bird-watching destination. About 253 reptile, 79 amphibian and 177 fish species are known to occur in Ethiopia, of which 26, 38 and 41 species, respectively, are endemic (Asefa et al., 2024). Ethiopia's indigenous flora includes 5,219 species of plants, 647 of which are endemic, with economically important species such as frankincense and myrrh (Demissew et al., 2021). Ethiopia is home to two of 36 global biodiversity hotspots: the Afromontane hotspot and the Horn of Africa drylands.

Ethiopia's natural resources are of great economic importance (Van Zyl, 2015). With 72 per cent of the continent's landmass above 3,200m, Ethiopia's Afromontane ecosystems are critical catchments for the Nile and Shebelle-Juba river systems on which some 100 million and 15 million people in Egypt and Sudan, as well as Somalia depend.

In the 1960s, Ethiopia started developing a protected area (PA) network to conserve its wildlife and cater for international tourism. By 2024, the network had grown to 87 wildlife PAs and 58 forest reserves called Forest

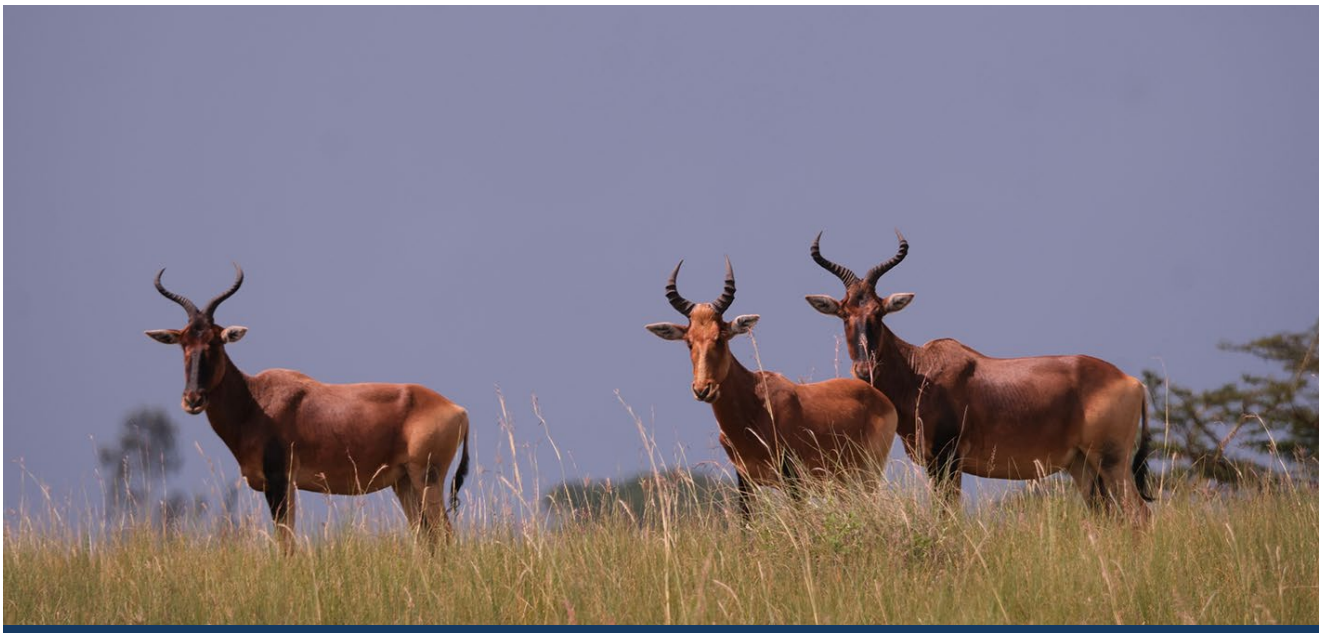


Photo1. Senkelle Swayne's hartebeest Sanctuary. Many of Ethiopia's protected areas have been created for the protection of (near-) endemic large mammals. Swayne's hartebeest is one of the few wildlife populations that are stable or increasing, likely because these parks have more (human & financial) resources © Paul Scholte, July 2024

Priority Areas (FPA). In recent years, reports have underscored the rapid decline of Ethiopia's wildlife, particularly its large mammals, even in the country's most iconic national parks (NP) (Admasu et al., 2023; Asefa et al., 2024). Several interacting factors are driving this decline, related to increasing human pressures such as livestock intrusion, agricultural expansion and habitat loss as well as limited financing for conservation (Admasu et al., 2020; Van Zyl et al., 2024). The combination of increasing human pressure and minimal financial resources resembles the situation in Central Africa where conservation is similarly overstretched (Scholte et al., 2022).

In December 2022, 188 countries, including Ethiopia, agreed to increase the area of well-managed protected and conserved areas from a global target of 17 per cent in 2020 to 30 per cent by 2030, Target 3 of the Global Biodiversity Framework (GBF), also called the 30x30 target. While evaluating national targets, it was clear that maps showing the present extent of Ethiopia's PA network were incomplete and erroneous due to outdated databases. To assist in Ethiopia's response to the 30x30 target, we charted the PA network from its creation in the mid-1960s to gain a better understanding of its present state and challenges. We present an updated map of the various PA categories in the country, setting a baseline for future efforts. We subsequently summarise ongoing discussions on improving the quality and quantity of Ethiopia's PAs. As all present PAs, including Community Conservation Areas, are under governmental governance (see below), we use 'PAs' throughout the text.

DEVELOPMENT OF ETHIOPIA'S PROTECTED AREAS SYSTEM

Ethiopia's history of intensive land use dates back centuries. This history shows examples of conservation practice, such as in 530 CE, when the Byzantine ambassador to Aksum (North Ethiopia) noted that elephants were not allowed to be harassed (Phillipson, 2012). A millennium later, Emperor Zera Yaqob (1434–1468) brought seedlings of Juniperus trees from the woodland of Wof-Washa to the Wechecha Mountain close to present Addis Ababa (Pankhurst, 1989). Many of the country's c. 35,000 church forests date back centuries (Aerts et al., 2016).

In the mid-1960s, much later than in neighbouring countries, Ethiopia began formally setting aside land areas that excluded human exploitation (Debella, 2019). At the time, Emperor Haile Selassie visited Kenya where he saw the economic benefits of PAs through tourism (Blower, 2005). In 1963, Ethiopia invited UNESCO to recommend a PA network, that with subsequent surveys by mostly Kenya-based experts, led to the establishment of Awash NP, Omo NP and Simien Mountains NP in the late 1960s (Blower, 2005; Huxley et al., 1963). Follow-up surveys paved the way for the establishment of a suite of national parks including Abijata-Shalla Lakes NP, Bale Mountains NP, Gambella NP, Mago NP and Nech Sar NP in the early to mid-1970s (Blower, 2005; Bolton, 1976; Brown, 1969). The development of Ethiopia's PA network included the creation of a marine national park and several other PAs in what has since become Eritrea (Figure S1), while wildlife sanctuaries and reserves

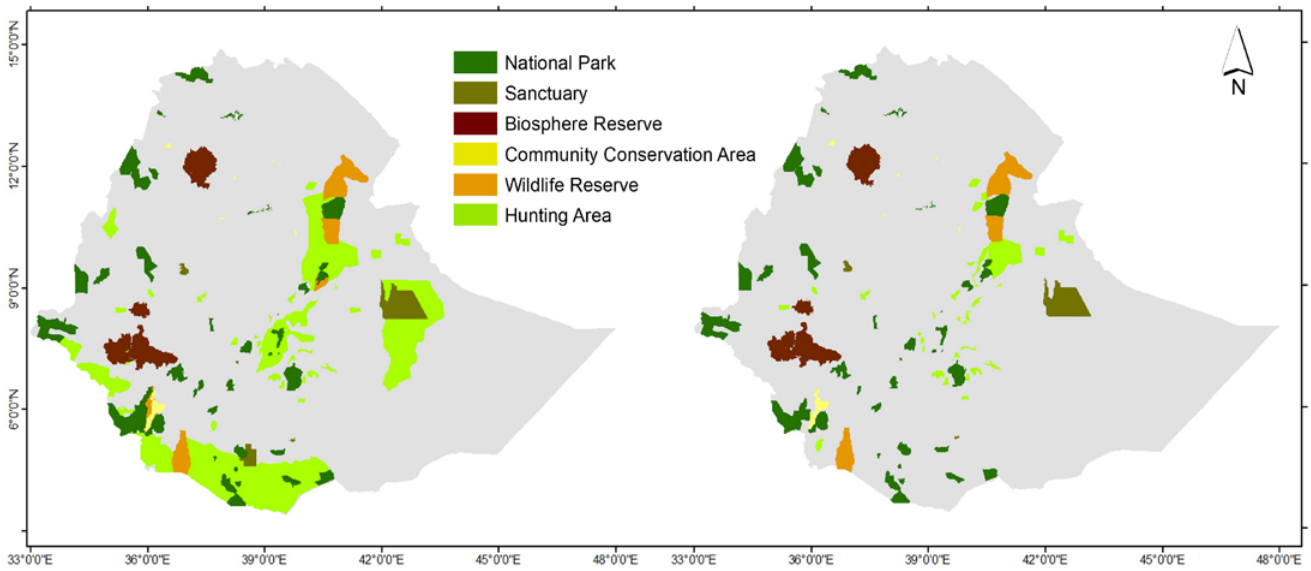
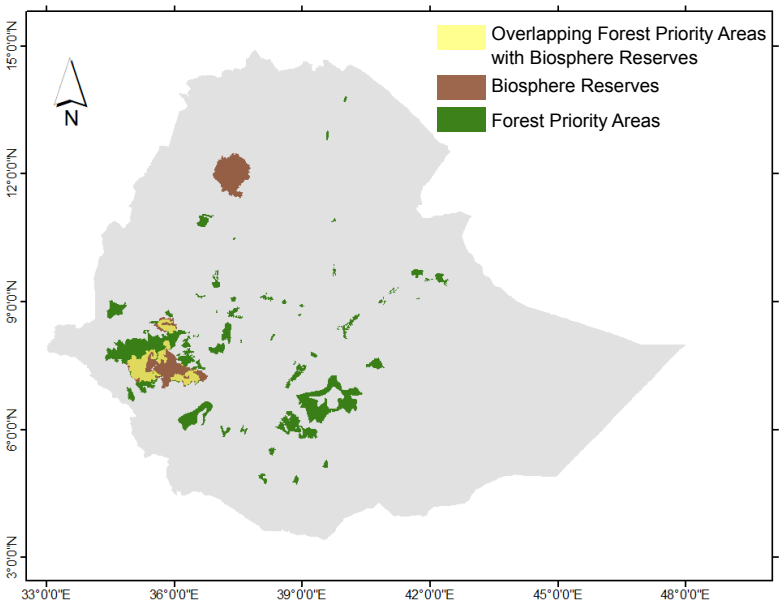


Figure 1. Wildlife Protected Area Map of Ethiopia
Figure 1A (left). Map of Ethiopia's Protected Areas as presented by the World Database on Protected Areas (UNEP-WCMC and IUCN 2024), (downloaded 25-05-2024)
Figure 1B (right) Actual wildlife protected area network in Ethiopia



Sources: https://ebi.gov.et/biosphere/ https://afri-res.uneca.org/apps/ethiopia-national-forest-priority-areas

Figure 2. Forest Priority Areas and overlapping Biosphere reserves

were planned in the more inaccessible parts of the country. Most of Ethiopia's PAs were created to protect large mammal populations, such as the endemic Walia Ibex (Simien Mountains NP), Mountain Nyala (Bale Mountains NP), Ethiopian Wolf (*Canis simensis*) (Simien Mountains and Bale Mountains NPs) and Swayne's Hartebeest (*Alcelaphus buselaphus swaynei*) (Senkelle Swayne's Hartebeest Sanctuary, Maze NP), (Photo 1). Controlled Hunting Areas, catering for trophy hunting mostly by international tourists, played an important role in the drier and sparsely inhabited parts of the country (Figure S1).

The development of Ethiopia's PA network during the 1960s and 1970s had some poorly documented antecedents (Petrides, 1961). Prior to the designation of Awash as a National Park, it was part of the larger Mata Hara Game Reserve, established during the Italian occupation (1936–1941), and later continued as 'Imperial Preserve'. The areas of present day Alledeghi Wildlife Reserve (WR) and Kafta-Sheraro NP seem to have held a similar status (Figure S2).

Photo 2. Bilen Hunting Area, with the only permanent water source for adjacent Alledeghi Wildlife Reserve. Almost all Ethiopian PAs are confronted with increasing livestock pressure, competing with wildlife and causing degradation of soil and vegetation © Paul Scholte, October 2023

PRESENT STATE OF ETHIOPIA'S PROTECTED AREA SYSTEM

Extent of Protected Area Network

The map of Ethiopia's PAs presented by the World Database on Protected Areas (WDPA) (UNEP-WCMC & IUCN, 2024) has been used and referred to in authoritative publications (e.g. Fashing et al., 2022; IUCN ESARO, 2024), see Figure 1A. However, the database is outdated, as a result of repeated additions without withdrawals. With the Controlled Hunting Areas and National Parks at the southern border, the WDPA map superficially resembles the 1973 Imperial Ethiopian government map (Figure S1).

We reviewed the existing database of federal and regional PAs (National Parks, Wildlife Reserves, Sanctuaries, Community Conservation Areas, Biosphere Reserves and Hunting Areas), removing non-existing hunting zones, and adapting for changing national park boundaries. Here we present the results. As of 2024, 14 per cent of Ethiopia's land area of 1.1 million km² is protected, 10 per cent through wildlife PAs and 4 per cent in Forest Priority Areas (Figures 1B and 2).

Ethiopia has three governance-based categories of wildlife PAs: a) Federal PAs; b) Regional PAs; c) UNESCO Man and Biosphere Reserves. The 13 federal PAs (33,232 km², or 3 per cent of Ethiopia's land cover) include two wildlife sanctuaries, one wildlife reserve and 10 national parks, all the responsibility of the Ethiopian Wildlife Conservation Authority (EWCA), under the Ministry of Tourism (Government of Ethiopia, 2007). These federal PAs are of i) outstanding importance, such as World Heritage sites (Bale Mountains NP, Simien Mountains NP) or exceptional importance (Abijata-Shalla Lakes NP, Omo NP, Senkelle Swayne's Hartebeest Sanctuary), ii) are covering or bordering two regional states (Alledeghi WR, Awash NP, Babile Elephant Sanctuary, Nech Sar NP) and/or iii) at international borders (Alatash NP, Gambella NP, Geralle NP, Kafta-Sheraro NP).

At regional level, 67 PAs are managed (52,538 km², 5 per cent), including several community conservation areas. Oromia, Ethiopia's largest regional state, has started a process of redesigning 30 PAs, reclassifying several hunting zones into other categories such as national parks. This will likely result in an increase of the PA coverage, estimated at *c.* 1 per cent of the country's territory

Five UNESCO Man and Biosphere reserves (MAB), four in forested south-west Ethiopia (13,928 km²), in addition to Lake Tana (6,959 km²), cover a total area of 20,887 km² or 2 per cent of the country's territory. Although labelled with the international UNESCO MAB status, they have no federal legal provisions or budget but are managed at the regional or local level, although reporting to UNESCO is managed at the federal level.

Recently, the size and importance of the Hunting Areas have been greatly reduced, with the few remaining operational hunting zones concentrated around Bale NP, targeting Mountain Nyala (Young et al., 2020). None of the other Hunting Areas are actively managed and have no effective conservation presence on the ground, See Photo 2.

Photo 3. Ranger outpost in Nech Sar NP. With only limited investments, working conditions in protected areas in Ethiopia remain basic © Paul Scholte, February 2024

Photo 4. Coffee ceremony inside Nech Sar NP. With c. 60 000 domestic visitors annually, this is the best visited national park in Ethiopia © Paul Scholte, June 2024

Ethiopia has 58 forest reserves, called Forest Priority Areas (FPA), that are state forests with the protection of biodiversity or land cover as their primary goal (Government of Ethiopia, 2024). They are identified at the national level by the Forest Development Authority (under the Ministry of Agriculture) and generally managed by regional state authorities. The extent of the FPA is 40,064 km², overlapping with the four forest UNESCO-MAB reserves over an area of 7,468 km², roughly half of their total area (Figure 2).

Ethiopia has identified 92 Key Biodiversity Areas, including 69 Important Bird Areas and 17 Important Plant Areas, most of which overlap with the PA and FPA categories mentioned above[1].

Challenges

Sixty years after their creation, Ethiopian PAs are struggling with declining wildlife and loss of habitat (Admasu et al., 2023). With Ethiopia's growing population, competition between agriculture and conservation is increasing (Tessema et al., 2019). There are also rising human–wildlife conflicts, especially with the highly threatened Savanna Elephant population in Babile Elephant Sanctuary and the regional Chebera-Churchura NP.

Systematic data on management effectiveness exist for only a few Ethiopian PAs. Management Effectiveness Tracking Tool (METT) scores are available, but generally not repeated over time. Only Simien NP (51.5 per cent in 2018) and Bale NP (57 per cent in 2017) have moderate scores, with Kafta-Sheraro NP (46 per cent, prior to the northern war), and much lower scores for Omo NP (32 per cent in 2021), Chebera-Churchura NP (30 per cent), Mago NP (15 per cent) and Babile Elephant Sanctuary (13 per cent).

Ethiopia's PA network is under considerable financial strain. Corrected for inflation, operations budgets (minus staff salaries) of all 13 federal PAs combined, declined from *c.* 1.3 million US$ in 2017 to *c.* 0.5 million US$ in 2023 (Van Zyl et al., 2024). A spend of 15 US$ per km² is amongst the lowest on the African continent, and a fraction of what is deemed necessary (Lindsey et al., 2018; Scholte et al., 2021; Van Zyl et al., 2024) (Photo 3).

While tourism was a driving motivation for the creation of Ethiopia's PAs, international tourism has declined considerably since COVID-19 and the following period of insecurity, and has not recovered since, whereas domestic tourism has rebounded (Van Zyl et al, 2024) (Photo 4). It is a struggle for PAs to balance the needs of domestic and diaspora tourists, who have expectations such as social interactions, different from the classical wildlife focus of international tourism; both have cultural heritage as common interest (Scholte et al., 2023). Large-scale tourism development (roads, luxury lodges, fences) have recently been initiated in Awash NP, Bale Mountains NP and Chebera-Churchura NP as part of the home-grown economic reform programme. Special attention will be required to limit negative impacts on wildlife and its habitat.

Recognition of the financial value of PAs by the scientific and conservation community has increased, especially for the provision of ecosystem services, such as water provision, pollinator services and carbon stocks. The

Table 1. Federally managed PAs: their present and proposed IUCN categories

Name of protected area	Existence of management plan?	Present[1]	Proposed IUCN PA category Scenario 1 Upscaled protection[2]	Proposed IUCN PA category Scenario 2 Improved protection[3]	Proposed IUCN PA category Wardens & HQ-staff Workshop[4]
Abijata-Shalla Lakes National Park	Yes	II	IV	IV (lakes and shores) V (terrestrial parts)	II
Alitash National Park	No	II	NA[5]	NA[5]	NA[5]
Alledeghi Wildlife Reserve	No	IV	II	IV	II
Awash National Park	Yes	II	II for the southern parts IV for the northern parts	IV III for Fantale Crater	II
Babile Elephant Sanctuary	Yes	IV	IV	V	II
Bale Mountains National Park	Yes	II	NA[6]	II	NA[6]
Gambella National Park	No	II	NA[6]	II	NA[6]
Geralle National Park	Yes	II	NA[6]	II	NA[6]
Kafta-Sheraro National Park	Yes	II	NA[7]	NA[7]	NA[7]
Nech Sar National Park	Yes	II	II	II for western and central parts V for eastern parts	II
Omo National Park	Yes	II	NA[6]	II	NA[6]
Senkelle Swayne's Hartebeest Sanctuary	Yes	IV	IV	IV	NA[6]
Simien Mountains National Park	Yes	II	NA[6]	II	NA[6]

[1] Although several documents assign IUCN PA categories to Ethiopia's PAs, they are all preliminary and informal.

[2] Under upscaled protection, we define this as a **significant improvement** of the management compared to the status quo, by upscaling it to another level of impact on the ground, e.g. by increasing funding by an order of magnitude.

[3] Under improved protection, we define this as a **slight to moderate improvement** of the management compared to the status quo, addressing the main weaknesses of management with funding remaining in the same order of magnitude.

[4] A workshop with park wardens and HQ staff was held in Addis Ababa in May 2024 to review these categories.

[5] Not assessed because of lack of information.

[6] Not assessed as no need: either relatively well managed (Bale, Simien), management outsourced (Gambella) or otherwise without major challenges (Geralle, Omo, Senkelle).

[7] Not assessed because of lack of information. Since the finalisation of the management plan, Kafta-Sheraro has been overrun during the northern war.

value of the ecosystem services of federal Ethiopian PAs has been estimated at an annual 325 million US$ in 2015. Despite PAs bringing an estimated five to thirty-fold return on investment (Van Zyl, 2015), PA budget allocations continue to shrink. Apparently, the message of the financial value of PAs has not reached decision makers yet.

Given the challenges of increasing anthropogenic threats and limited funding for conservation, wildlife populations have been in decline over recent decades, a trend mirrored globally (WWF, 2024). Only relatively well-resourced PAs, such as the relatively large Bale Mountains NP with financial-technical support from Frankfurter Zoological Society, or the small Maze NP and tiny Senkelle Swayne's Hartebeest Sanctuary with proportionally larger governmental budgets, have large mammal populations that remained stable or even increased.

With the above-mentioned challenges and a human population of 130 million, increasing annually by 2.6 per cent, the expansion of Ethiopia's PA network to meet the 30x30 target seems unrealistic.

Photo 5. Church forest, Tigray. Conserved for centuries as holy sites, the trees in these church forests are the only remaining natural vegetation, surrounded by agricultural or bare land. The 35 000 church forests in Ethiopia are candidates to be considered as OECMs
© Paul Scholte, October 2008

PERSPECTIVES TOWARDS 30X30: PA MANAGEMENT QUALITY

Following the CBD-COP 15 in December 2022, the Ethiopian Wildlife Conservation Authority (EWCA) declared that it would prioritise improved management (quality) over expansion (quantity) of its PA network. We present four approaches, to be pursued concurrently, that may enhance the quality of PA management in Ethiopia.

Diversifying PA governance

Ethiopia's wildlife PAs, including Community Conservation Areas, are under governmental governance (Figure 1B). Diversified PA governance can bring more ownership for local communities, guaranteeing legitimacy and voice, achieving transparency and accountability and enable governance vitality and capacity to respond, criteria of the IUCN Green list (IUCN, WCPA & ASI, 2019)[2].

The status and governance (state versus communities) of Community Conservation Areas needs to be further developed as they lack clarity on respective roles, leading to power struggles between regional authorities and local communities. This is further complicated as local communities rely on government officials to enforce the law.

Although Ethiopia has earmarked PAs at its international borders as PAs under federal governance, this has not led to systematic transboundary collaboration. For example, Gambella NP shares with Boma NP (South Sudan) the annual migration of over six million antelopes, making it Africa's largest and longest large mammal migration (Kauffman et al., 2021). There is no formal collaboration between the countries, however. Successful transboundary initiatives such as the Mountain Gorilla parks in East-Central Africa could be used as inspiration, starting locally with transboundary multinational anti-poaching teams, gradually developing into more formal inter-governance structures (COMIFAC, 2013).

Diversifying PA management

Collaborative Management Partnerships (CMPs) have been deployed to enhance PA management effectiveness (Baghai et al., 2018). With the Global Biodiversity Framework, CMPs have received new impetus, requiring protected and conserved areas to be 'effectively conserved and managed'.

In Africa, some 277,515 km² (12 per cent) of PAs are under co-management or delegated CMPs, with African Parks managing an area larger than the UK (Scholte, 2022; World Bank, 2021). The three CMP models are i)

financial-technical-support, ii) co-management, and iii) delegated management (Baghai et al., 2018). The co-management model can be differentiated into bilateral co-management with parties working side by side, and integrated co-management based on a special purpose vehicle such as a nationally registered trust, foundation or not-for-profit company, to undertake PA management.

The financial-technical support of the Frankfurt Zoological Society (FZS) (Bale NP), African Wildlife Foundation (Simien NP) and till recently German Technical Cooperation (Nech Sar NP) have been a lifeline to these parks. FZS expressed the ambition to develop its support into integrated co-management or delegated management. Delegated management involves the transfer of management responsibilities from a public partner (generally a government body) to another partner (generally an international NGO). These partnerships, also called public-private partnerships (PPP), are characterised by a long (≥10 year) contractual base, under which the public partner delegates all or some of its mandate, with the private partner having autonomy over finances, with a transparent accounting system, as well as human resources, allowing it to attract competent staff and flexibility to discipline personnel (Baghai et al., 2018; Scholte et al., 2021; Scholte, 2022; World Bank, 2021). Delegated management has a bumpy past in Ethiopia, starting in 2004 with African Parks taking up the management of Nech Sar and Omo NPs, an arrangement that lasted only two years. However, in December 2024, African Parks signed a 10-year contract with the Gambella regional state government and EWCA for the management of Gambella NP, see Supplementary Online Material for a historic review.

The Gambella delegated management contract follows the 2008 Wildlife Proclamation that gives EWCA the mandate to contract private partners for services inside PAs, referred to as the 'concession model'. According to staff of the Ministry of Finance, this concession model does not allow private partners to benefit from privileges such as revenue retention, tax exemption, etc. The 2018 Private-Public Partnership (PPP) proclamation provides this possibility, however. A pre-feasibility study is prepared by EWCA for approval by the PPP Board, which includes representatives of the relevant ministries conferring governmental support of any approved PPP project. Subsequently, EWCA may invite, through public tendering or direct demand, private partners to present business plans for selected PAs to be under delegated management. These business plans form the basis for a feasibility study, including results of negotiations with regard to tax exemption and revenue retention, to be approved by the PPP Board.

Other elements considered to establish a PA-PPP are the status of government employees, human–wildlife conflicts (role for the government versus private partner), trophy hunting activities, benefit sharing schemes, etc.

Several Ethiopian national private companies and NGOs have shown interest in the PPP PA model, which would unlock this national capital for PA management, a model that Nigeria has successfully adopted[3].

Promoting private investment in PAs

Recently, we analysed the potential of long-term financing mechanisms for federally managed PAs (Van Zyl et al., 2024). The mechanisms included increasing park entrance fees and the expansion of concessions, establishing Payment for Ecosystem Services (PES) schemes, including carbon storage, a conservation trust fund and increased operational efficiency.

The recently initiated Digital Matchmaking Platform[4] aims to assist EWCA and regional PA authorities in attracting private investments as an alternative financing instrument. The platform is a management tool within EWCA that connects PA investment opportunities with prospective investors. The involvement of private actors in the financing of PAs is guided through clear rules, roles and responsibilities, guided implementation processes, and monitoring. In addition, an illustrated investment catalogue was developed to attract potential investors in tourism and other services in Ethiopia's federally managed PAs[5].

Improving PA management by setting realistic management objectives

Defining realistic management objectives, supported by the (re-)assignment of the appropriate IUCN PA categories, may guide better PA management. Given the overwhelming challenges facing Ethiopia's PA management, for several PAs, neither current management plans nor IUCN PA categories consider the full implications of these realities. PAs with unrealistic management objectives will struggle to achieve them as PA staff will lack motivation and scarce resources will likely be used inefficiently and ineffectively. For example, with *c.* 66,000 people living in the 887 km² Abijata-Shalla Lakes NP, it is difficult to enforce park regulations and decide which activities should be tolerated, resulting in the paralysis of the PA management. By accepting realities on the ground and adapting the management objectives accordingly, these objectives may become more achievable, motivating the PA staff and channelling available resources more efficiently.

We conducted an assessment of the federal PAs to evaluate the IUCN PA categories based on two scenarios (Table 1). Scenario 1 assumed significantly upscaled (human and financial) resources for PA management, whereas the more realistic scenario 2 assumed improved management based on present resources. Park wardens and EWCA headquarter staff hesitated to propose PA categories other than II (National Park), possibly because of a reluctance to 'downgrade' the PA. Bridging the gap between 'aspiration' and 'realism' will require further consideration by EWCA management.

In addition, considering the challenges linked with the 30x30 target, with adapted IUCN categories, the reporting on Ethiopia's PAs to the WDPA, UNESCO and others will be more specific.

PERSPECTIVES TOWARD 30X30: QUANTITY

To date, Ethiopia only has PAs and does not have conserved areas with conservation outcomes as secondary management objectives. Such 'Other Effective area-based Conservation Measures' (OECMs) have become critical for reaching the 30x30 target.

Despite their small size (average 2.5 ha), but with their large number (c. 35,000), Church Forests represent an important area for conservation on the largely denuded montane plains of North and Central Ethiopia (Aerts et al., 2016), see Photo 5. This potential could be further increased through restoration measures that enlarge their size and interconnect where possible. In November 2023, the Ethiopian Orthodox Church opened a (voluntary) national register, an essential step for recognition as an OECM. Although the contribution of Church Forests to the total conserved area will be limited (<0.5 per cent), the close association between faith and forest may provide an important stimulus to conservation.

In Ethiopia, community conservation areas are few and small, and incorporated into the (regional) PA networks (Figure 1B). Community conservation areas have the potential to enhance community well-being while protecting biodiversity, as frequently demonstrated. If communities collaborate to manage natural resources, recognition of these areas as OECMs could be an appropriate alternative, allowing recognition of community rights, and triggering the development of community conservancies.

The largest contribution OECMs could make are in the extensive drylands in eastern Ethiopia where Indigenous pastoral communities have successfully managed their territories for centuries, yet whose lives are under stress from climate change and rangeland degradation, see Photo 6. Moreover, East Ethiopia is poorly represented in the PA network (Figures 1A, 1B), despite its exceptional botanic richness (Demissew et al., 2021). Experiences from Kenya show the potential of conservancies that invest in wildlife toursim by strengthening community organisational development, alongside the continuation of pastoralism. Reconciling conservation with pastoralism has challenges however, as changing grazing strategies may lead to land fragmentation (Lesorogol & Lesorogol, 2024).

Photo 6. Somali Region, Eastern Ethiopia. For centuries, pastoral communities have managed this area, the botanically richest part of the country, including myrrh and frankincense species (depicted in the background). Covering approximately one third of the country, their potential contribution towards the 30x30 target is considerable © Paul Scholte, October 2023

UNESCO-MAB reserves in their totality (core, periphery and transition zones) have been incorporated into the Ethiopian wildlife PA network as well as under the Forest Priority Areas (Figures 1 A, 1B). This not only creates overlap (Figure 2) but seems inaccurate, given the non-protection objectives of periphery and especially transition zones, which are predominantly agricultural lands. These periphery and transition zones could become OECMs, although discussions continue in South Africa where UNESCO-MAB reserves have earlier been proposed as OECMs (Paterson, 2023).

CONCLUSIONS AND RECOMMENDATIONS

Over the past 60 years, Ethiopia has developed a system of 87 PAs covering most of its ecosystems, except for the eastern drylands, and formally protecting its emblematic wildlife. At federal and regional levels, institutions and procedural frameworks have been established, however Ethiopia's PA system is under growing pressure due to competing land uses and limited funding. The 2022

Global Biodiversity Framework (GBF) and its 30x30 target is a unique occasion to draw (inter-) national attention to the importance of Ethiopia's biodiversity and ecosystem services, and support appropriate measures, listed below, to counter the downwards trend.

- With 14 per cent of land area under protection, the current size of Ethiopia's PA network is lower than earlier reported, and below the GBF global 30x30 target. This should not divert attention from prioritising improving the quality of Ethiopia's PAs, including several de facto paper parks. We recommend the integration of the revised Wildlife PA and Forest Priority Areas databases into international databases such as the WDPA. This may also clarify the situation of UNESCO-MAB Reserves.
- Collaborative Management Partnerships (CMP) have played an important role in Ethiopia, mainly through technical and financial support to government-managed PAs. Delegating PA management has had a challenging history in Ethiopia, but there is renewed optimism with African Parks recently signing (December 2024) a management contract for Gambella NP. Simultaneously there is an initiative for the development of a systematic PPP approach, following a new PPP law and regulations. EWCA and private partners can develop a PPP project, subject to approval by the PPP Board, that could stimulate new private partners and increased investments. Ethiopia has national private companies and individuals with adequate (financial and human) resources that have shown interest in taking a role in PPP.
- Multiple long-term financing mechanisms have been identified for Ethiopian PAs, including payment for ecosystem services, although they are expected to take some years to develop. To complement accrued financing through forthcoming CMPs (see above), a digital matchmaking platform and investment catalogue have recently been initiated to attract (private) investment into Ethiopia's federally managed PAs. It is too early to propose follow-up steps, but a close involvement of EWCA is important.
- For federally managed PAs, we stress the need to set more realistic management objectives to drive efficient use of scarce management resources. This may help to address the required change in focus of PAs with the rise in domestic and diaspora tourism, in contrast to the slow recovery of international tourism.
- Ethiopia has limited experience in diversifying the governance of protected areas, in particular including communities, that is expected to increase the quality of PA management. In addition, the global 30x30 target and the central role that OECMs may play offer a unique possibility to revisit and expand its PA and conservation area network, including in the country's poorly covered east. There is a need to evaluate the importance of biodiversity and ecosystem services in and outside the network, including Key Biodiversity Areas. Potential OECMs, offer complementary services to PAs, as church forests (combining faith and conservation) and pastoral territories (livestock production and botanical diversity) show. To avoid any confusion with more restricted PA management, the special conditions of OECMs need to be communicated clearly to communities and authorities, and supported by international definitions and up-to-date databases, particularly the WDPA.

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SUPPLEMENTARY ONLINE MATERIAL

Supplementary text. History of delegated management in Ethiopa (2004–2024).

Figure S1. 1973 Imperial Ethiopian Government Map, showing Ethiopia's Conservation and Controlled Hunting Areas.

Figure S2. 1961 map, presenting areas of potential value as national parks and related reserves in Ethiopia, including those established, or indicated during Italian occupation (cf. Petrides, 1961).

ENDNOTES

[1] https://www.keybiodiversityareas.org; /https://tipas.kew.org/; https://datazone.birdlife.org/country/factsheet/ethiopia

[2] https://iucngreenlist.org/

[3] https://www.africanatureinvestors.org/

[4] http://dmmp.ewca.gov.et/

[5] PDF) WILDLIFE INVESTEMENT CATALOGUE Final Version compressed (researchgate.net)

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RESUMEN

Etiopía es bien conocida por su extraordinaria biodiversidad y su importancia como depósito de agua para los países circundantes. A mediados de la década de 1960, los esfuerzos de conservación se centraron en la creación de áreas protegidas (AP) que excluían la explotación humana y se orientaban al turismo. Los Parques Nacionales, las Reservas de Fauna Silvestre y, sobre todo, las Zonas de Caza dominaban el primer mapa de AP del país de 1973. Cincuenta años después, el mapa de Etiopía de la Base de Datos Mundial sobre Áreas Protegidas, que muestra el 17% de la superficie de Etiopía como AP, está obsoleto. Aunque se han añadido varias AP a lo largo de los años, hay AP que no funcionan y AP desclasificadas, especialmente zonas de caza no operativas, que no se han eliminado de la base de datos. Presentamos mapas actualizados, que muestran que el 14 por ciento de Etiopía está actualmente protegido por AP de vida silvestre (10 por ciento) y Áreas Forestales Prioritarias (4 por ciento). Con su fauna silvestre en declive y el turismo internacional, y la falta de financiación de sus AP, la respuesta de Etiopía hacia el objetivo «30x30» del Marco Global de Biodiversidad debería dar prioridad a mejorando la calidad de las AP mediante i) la diversificación de la gobernanza de las AP permitiendo una mayor propiedad comunitaria, ii) la diversificación de la gestión de las AP para una mayor eficiencia, iii) la promoción de inversiones en AP, y iv) el establecimiento de objetivos de gestión realistas. Existe un potencial considerable a largo plazo (después de 2030) para aumentar el número de áreas de conservación a través de reconociendo los numerosos y diminutos bosques eclesiásticos y los vastos territorios de pastoreo como Otras Medidas de Conservación Efectiva basadas en el área (OECM), al tiempo que se estimula la razón económica de las AP más allá del turismo internacional.

RÉSUMÉ

L'Éthiopie est bien connue pour sa biodiversité exceptionnelle et son importance en tant que château d'eau pour les pays environnants. Au milieu des années 1960, les efforts de conservation se sont concentrés sur la création de zones protégées (ZP) qui excluaient l'exploitation humaine et ciblaient le tourisme. Les parcs nationaux, les réserves de faune et de flore et surtout les zones de chasse ont dominé la première carte des aires protégées du pays en 1973. Cinquante ans plus tard, la carte de l'Éthiopie figurant dans la base de données mondiale sur les zones protégées, qui indique que 17 % de la couverture terrestre de l'Éthiopie sont des zones protégées, est dépassée. Bien que plusieurs aires protégées aient été ajoutées au fil des ans, il existe des aires protégées non fonctionnelles et des aires protégées déclassées, en particulier des zones de chasse non opérationnelles, qui n'ont pas été supprimées de la base de données. Nous présentons des cartes actualisées, qui montrent que 14 % de l'Éthiopie sont actuellement protégés par des aires protégées de faune et de flore (10) et des zones forestières prioritaires (4 %). Avec le déclin de la faune sauvage et du tourisme international, et le sous-financement de ses aires protégées, la réponse de l'Éthiopie à l'objectif « 30x30 » du Cadre mondial pour la biodiversité devrait donner la priorité à l'amélioration de la qualité des aires protégées en i) diversifiant la gouvernance des aires protégées pour permettre une plus grande appropriation par les communautés, ii) diversifiant la gestion des aires protégées pour une plus grande efficacité, iii) promouvant les investissements dans les aires protégées, et iv) fixant des objectifs réalistes pour la gestion. Il existe un potentiel considérable à long terme (après 2030) pour augmenter le nombre d'aires de conservation en reconnaissant les nombreuses petites forêts d'églises et les vastes territoires pastoraux comme d'autres mesures de conservation efficaces basées sur les aires (OECM), tout en stimulant la raison d'être économique des aires protégées au-delà du tourisme international.

IN THE LINE OF FLOODS: RANGERS AS FIRST RESPONDERS TO AN EXTREME WEATHER EVENT IN PAKISTAN

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ABSTRACT

Rangers play a vital role in biodiversity conservation, but their critical contribution as first responders in natural disasters has been overlooked. We assess the essential role played by rangers as first responders during the 2022 extreme flooding events in Pakistan, and evaluate their vulnerabilities in responding. Our study involved structured interviews and focus group discussions with 194 rangers in seven flood-affected districts along the Indus River in Pakistan. All surveyed rangers reported increased intensities of extreme weather events and that they were negatively affected by floods. Flooding disrupted their regular duties and caused personal losses, including damage to homes, agricultural lands and other possessions. Despite this, rangers participated in emergency relief efforts, supporting affected communities, rescuing livestock, aiding in evacuations, and distributing food to local communities. Our study highlights the role played by rangers in Pakistan as first responders, and underscores how rangers around the world, particularly in resource-constrained environments, should be acknowledged and supported as planetary health workers. Future research should evaluate ranger roles and vulnerabilities to other climate change-induced extreme weather events across ecosystems, providing insights to inform policy development, support mechanisms, and global recognition of the ranger profession.

Keywords: protected and conserved areas, working conditions, planetary health workers, disaster risk reduction, emergency response

INTRODUCTION

Rangers, referred to by various titles across contexts, are defined by the International Ranger Federation (IRF) as frontline professionals who play a critical role in biodiversity conservation, safeguarding nature, cultural and historical heritage, and protecting the rights and well-being of present and future generations (Galliers et al., 2022; International Ranger Federation, 2018, 2019a, 2019b, 2021).

They comprise a highly diverse group, including government staff, volunteers, members of local communities, and Indigenous peoples (International Ranger Federation, 2019c). Rangers assume a wide range of responsibilities, including visitor management, environmental education, community engagement, managing environmental risks, and providing aid during natural disasters (Violanti et al., 2017).

A frequently overlooked role of rangers is their work as first responders during extreme weather events such as floods and cyclones, and in preventing and responding to pandemics (Gunn et al., 2021; Singh, Galliers, Moreto, et al., 2021; Stolton et al., 2023). While the roles of emergency medical personnel, firefighters and law enforcement officers in disaster response have been relatively well-documented (Perry, 2004; Violanti et al., 2017), the contributions and vulnerabilities of rangers remain largely overlooked despite their frontline presence in climate-induced crises.

Rangers often lead preparedness efforts, guide evacuations, and play key roles in post-disaster damage

Ranger working with communities in flood-affected districts of South Punjab © Janan Sindhu/WWF-Pakistan

assessment, recovery, and environmental mitigation. During Cyclone Idai in Mozambique in 2019, rangers from Gorongosa National Park worked tirelessly to support affected communities, offering critical medical aid, food and shelter to those in need (African Parks, 2019). During the 2020 California wildfires, park rangers assisted with evacuations, providing vital guidance to residents and visitors, while closely collaborating with firefighting agencies (Wong et al., 2021).

In their role as first responders, rangers often work under challenging conditions with limited resources. The Ranger Line of Duty Death (RLODD) database, compiled by the International Ranger Federation (IRF), shows an alarming upward trend, with 1,535 ranger casualties recorded from 2006 to 2021 (Galliers et al., 2022; International Ranger Federation, 2018, 2019a, 2019b, 2021). While many of these deaths are linked to homicides and fatal wildlife encounters, a significant proportion, such as those resulting from drowning and firefighting (10.2 per cent) and work-related illnesses (12 per cent), reflects the growing exposure of rangers to extreme weather events and associated hazardous working conditions (Galliers et al., 2022).

This increasing exposure to climate-related hazards was clearly demonstrated during the 2022 floods in Pakistan which disproportionately impacted southern provinces (Nanditha et al., 2023; Wang et al., 2024) affecting 33 million individuals and leading to nearly 8 million displacements. The floods claimed over 1,700 lives and led to 94 districts being declared 'calamity-hit' (Nanditha et al., 2023; Waseem and & Rana, 2023). Rangers operating in these regions played a key role in supporting both conservation management and humanitarian response. We refer to vulnerabilities as conditions such as limited institutional support, hazardous environments, risk of disease and injury, equipment damage and loss, and lack of access to insurance and management plans, while challenges refer to the operational and situational difficulties.

Our study aimed to provide baseline data on the contributions by rangers in managing a humanitarian catastrophe of the magnitude experienced in Pakistan, and vulnerabilities and challenges faced by rangers working in regions severely affected by these floods. The term 'ranger' is not consistently defined across wildlife, forest and fisheries departments involved in biodiversity protection in Pakistan. It is often used to refer only to specific job titles, which creates ambiguity about who qualifies under this category. Therefore, for the purpose of this study, we adopted a broad definition aligned with the IRF's definition, encompassing all frontline personnel engaged in biodiversity conservation. Our research employs a holistic approach to evaluate the extent of exposure, and the current adaptive capacity of rangers and their employers in mitigating natural disasters in Pakistan and globally. Additionally, the study examines how the role of rangers has expanded to include first response responsibilities, despite these duties often falling outside their official mandates.

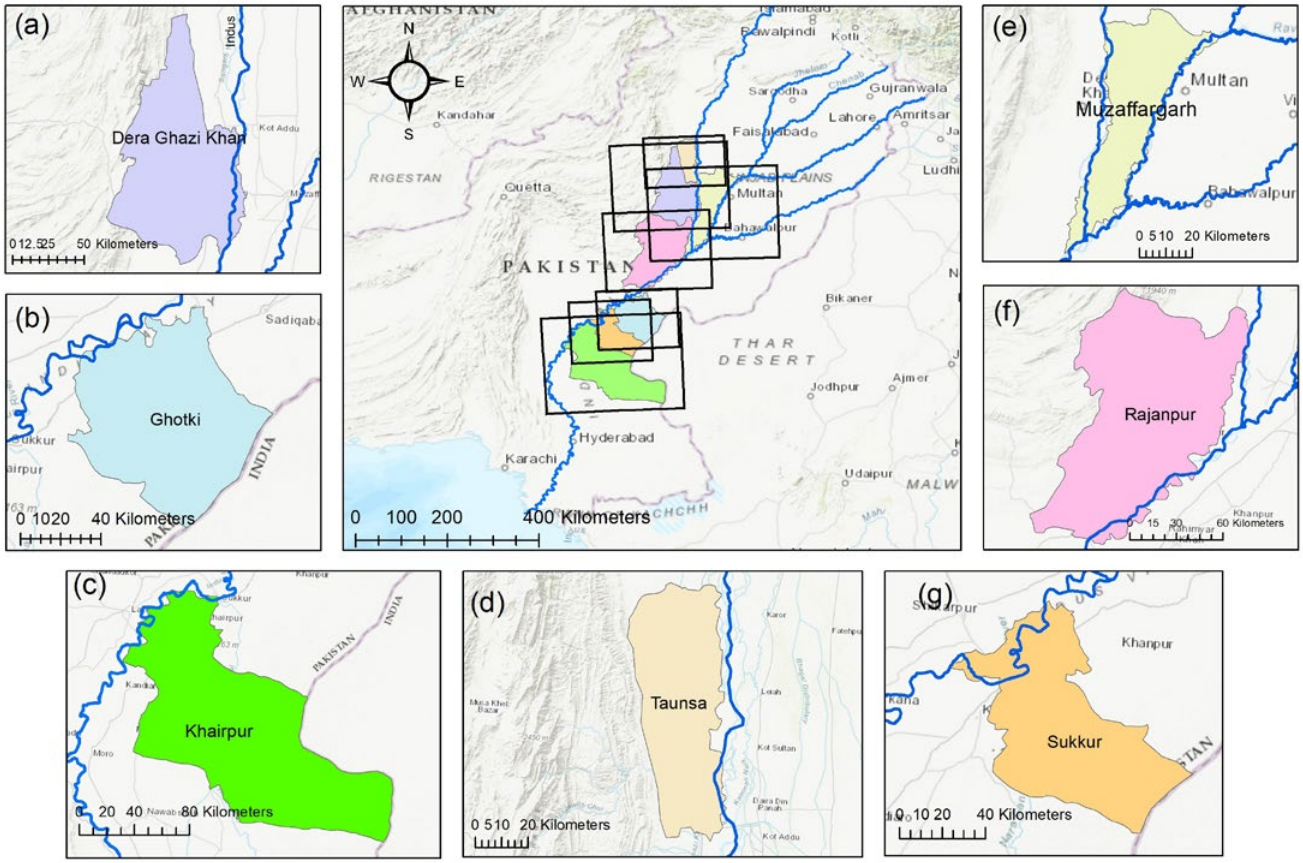

Figure 1. Study area map (centre) showing location of the study sites along the Indus River in Pakistan; and individual maps of each site (a) Dera Ghazi Khan; (b) Ghotki; (c) Khairpur; (d) Taunsa; (e) Muzaffargarh; (f) Rajanpur; (g) Sukkur in Sindh and Punjab; Central map highlights the proximity.

METHODS

Study area

The study area included seven adversely flood-affected districts in southern Pakistan along the Indus River: Khairpur, Taunsa, Sukkur, Rajanpur, Ghotki, Dera Ghazi Khan, and Muzaffargarh (Figure 1) (UN-OCHA, 2023).

Data collection

We used questionnaire-based interviews and focus group discussions (FGDs) with both closed- and open-ended questions. The questionnaire addressed specific aspects such as ranger roles, vulnerabilities, job-related and personal challenges, and current adaptive capacity that rangers possess in response to natural disasters like floods (Figure 2). The questions were developed by WWF in collaboration with subject experts and rangers. The questionnaire was endorsed by the Bio-Ethical Committee of the College of Earth and Environmental Sciences, University of the Punjab, Pakistan. The questionnaires and informed consent forms were translated into Urdu and Sindhi languages.

Data collection approach

We used a mixed-method approach involving FGDs and interviews with rangers from the wildlife, forest and fisheries departments in flood-affected districts. The data were compiled in Microsoft Excel and analysed using SPSS-Software and ARCGIS. Satellite information was derived from Landsat time series datasets (July–September 2022) with a spatial resolution of 30 m to determine the extent and severity of flooding across districts. The satellite images were downloaded from the United States Geological Survey (USGS) (https://earthexplorer.usgs.gov/).

A GIS-based vulnerability assessment was conducted integrating selected variables from FGDs/interviews together with flood data. The Analytical Hierarchical Process method (Fernandez et al., 2022) was applied to normalise the assigned weights of thematic layers by taking the cumulative sum of highest percentile values with corresponding assigned weights. Vulnerability-index (VI) values were divided into classes from high vulnerability to low vulnerability. The values were assigned based on published data and expert input informed by ranger responses. Table 1 presents the weight values for parameters selected for their relevance to flood impacts.

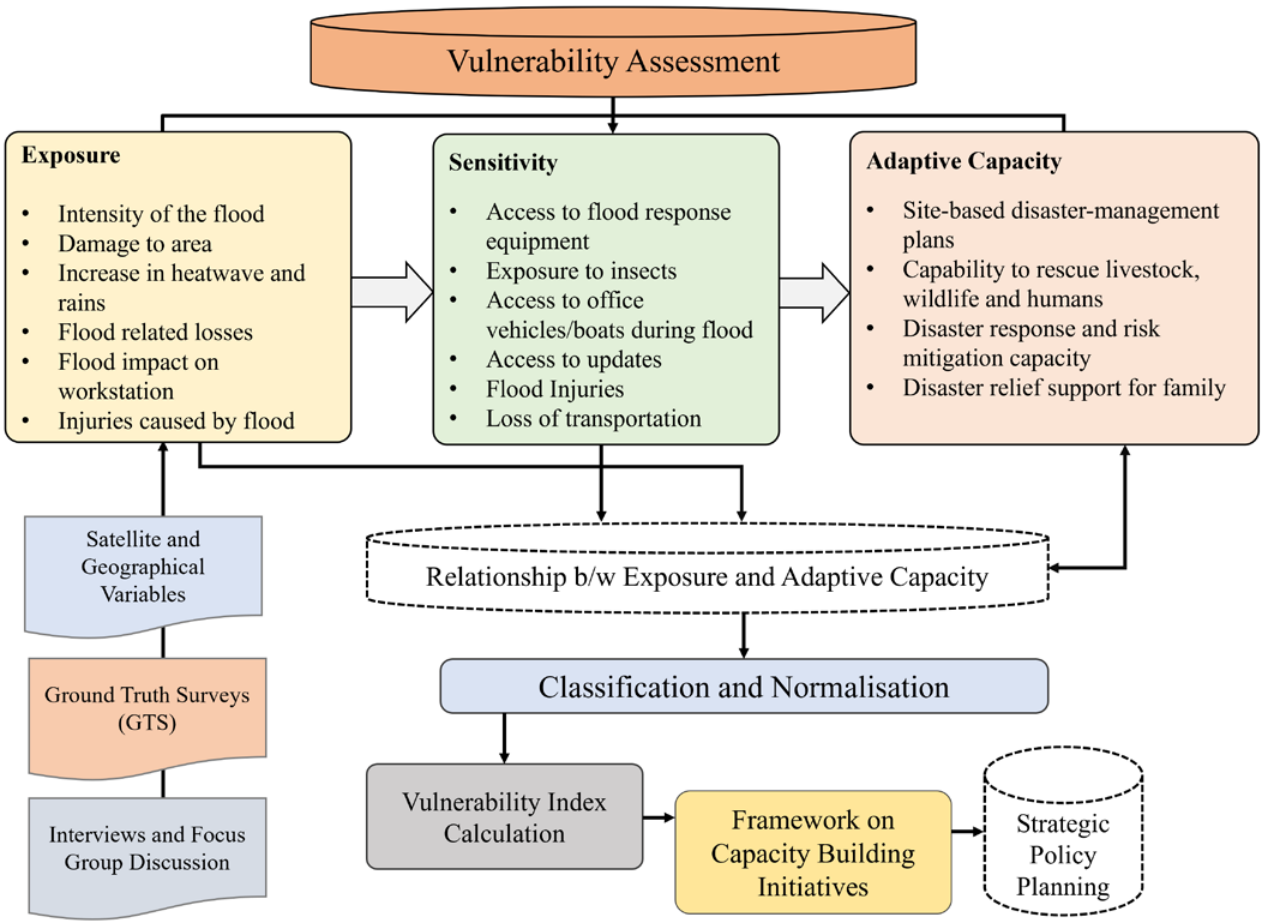

Figure 2. A schematic diagram indicating the flow of various research components for flood impacts and vulnerability assessment in rangers across the seven flood-affected districts of Pakistan.

Children from families displaced by floods in Sukkur, Pakistan © WWF-Pakistan

Table 1. Weighted averages of the scores assigned to each different variables/response

Score	Importance
1	Equally important
2	Moderately important
3	Strongly important

For the vulnerability assessment, cumulative scores were calculated using the highest percentile values and their corresponding weights. The resulting Vulnerability Index (VI) values were then categorised as follows: very low to low ($0 \leq VI < 0.3$), medium ($0.3 \leq VI < 0.6$) and high to very high ($0.6 \leq VI < 1$).

$$VI = I_1 W_1 + I_2 W_2 + I_3 W_3 + I_4 W_4 + I_5 W_5 + I_6 W_6 + I_7 W_7 + \ldots\ldots\ldots\ldots + I_n W_n \quad \text{Eq.1}$$

As shown in Equation 1, the Vulnerability Index (VI) is calculated as a weighted sum of indicator values ($I_{\_1}$, $I_{\_2}$, I_3...., I_n) and their corresponding weights (W_1, W_2, W_3, ..., W_n), with Table 2 presenting the categorized indicators, their relationship to sensitivity and adaptive capacity, and their directional influence on vulnerability (↑/↓).

Ranger working with communities in flood-affected districts of South Punjab © Janan Sindhu/WWF-Pakistan

Table 2. Spatial temporal exposure indicators used for vulnerability assessment

Index	Indicators	Relationship
Exposure	Increased floods-intensity	Vulnerability ↑ Indicator ↑
	frequency of extreme-weather events	Vulnerability ↑ Indicator ↑
	Flood-extent	Vulnerability ↑ Indicator ↑
	Flood-impacting ranger-workstation	Vulnerability ↑ Indicator ↑
	Ranger-injuries	Vulnerability ↑ Indicator ↑
	% rangers residing within flood-affected-zone	Vulnerability ↑ Indicator ↑
Sensitivity	% rangers low accessibility to flood-response-equipment	Vulnerability ↑ Indicator ↑
	% increase in poisonous-insect-bites	Vulnerability ↑ Indicator ↑
	% rangers with access to vehicles/boats during flood	Vulnerability ↑% contribution in decision ↓
	% of rangers with access flood early-warning information	Vulnerability Indicator
	% of rangers facing (Water, Sanitation, and Hygiene) WASH-borne diseases	Vulnerability ↑ Indicator ↑
	Vulnerability to job loss due to budget cuts	Vulnerability↑ Indicator ↑
	% of rangers experiencing a loss of transportation modes and access to the main road	Vulnerability ↑ Indicator ↑
Adaptive Capacity	Rescue capacity during floods	Vulnerability ↓% rangers adaptive-capacity ↑
	Site-based disaster-management plans	Vulnerability ↓% adaptive-capacity additional responsibilities ↑
	Capability to rescue (livestock, wildlife and humans)	Vulnerability ↓% rescue livestock capability ↑
	Access to food, water, and blankets for disaster-displaced individuals	Vulnerability ↓% of additional responsibilities ↑
	Access to disaster relief support for family	Vulnerability ↓% of additional responsibilities ↑

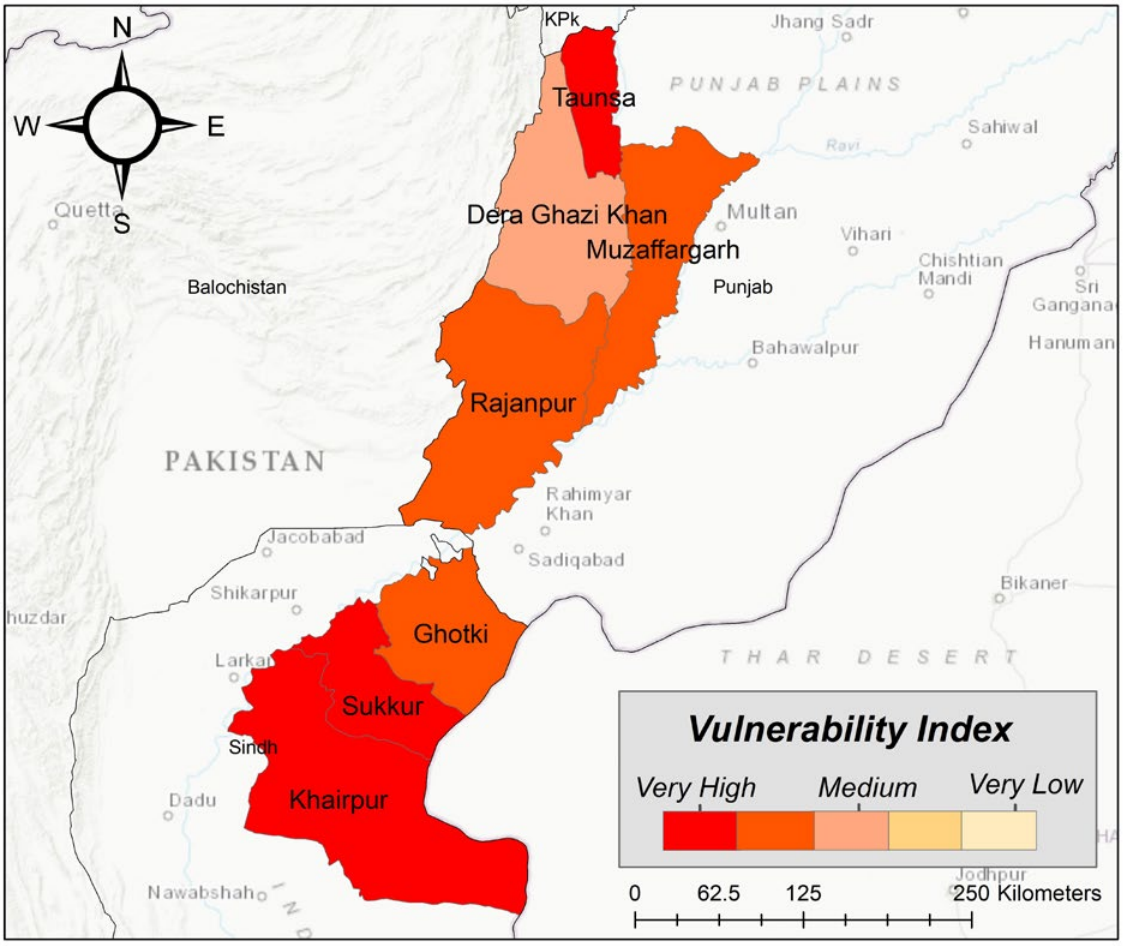

Figure 3. Vulnerability Index of the district indicates that six out of seven districts fall within the 'Very High' to 'High' Vulnerability range for rangers.

RESULTS

Geographic context and site-level Exposure

We interviewed 194 rangers across seven flood-affected districts of southern Pakistan, spanning Punjab and Sindh provinces along the Indus River. These included Khairpur, Taunsa, Sukkur, Rajanpur, Ghotki, Dera Ghazi Khan and Muzaffargarh, most of which experienced very high levels of flooding. The vulnerability assessment, based on sensitivity, exposure to floods and extreme weather events, and adaptive capacity, showed that six of the seven assessed districts were classified as having high to very high vulnerability, while only one site, Dera Ghazi Khan, was rated as moderately vulnerable (Figure 3).

The responses of rangers indicated that all sites across the seven districts were affected by the floods (100 per cent). According to the respondents, 65.5 per cent of sites were heavily impacted by the floods, 24.7 per cent experienced a medium level of flooding, and 9.8 per cent experienced partial flooding. Rangers were in agreement across all sites that the intensity of extreme weather events has increased manyfold in the past two to three years.

Demographic characteristics and experience of rangers

Respondent ages ranged from 22 to 58 years; all were men, as no women field rangers were working in the target sites. The rangers had a range of experience, spanning from 8 months to 39 years. All the respondents were based in the field and held various roles including wildlife watchers, field assistants, forest guards, game inspectors and wildlife inspectors, among others. On average, rangers spent four days per week in the field. The majority of rangers (99.6 per cent) included in the study were from the same areas where they were working, living with their families in nearby villages; 88.7 per cent had children.

Impact of floods on rangers: Work stations and operations

Ranger workstations were impacted by floods, with the level of damage varying from intense to none. A total of 32 per cent of rangers experienced complete damage to their workstations, 46.4 per cent faced partial damage, and the remaining 21.6 per cent did not face any damage. In addition to infrastructure loss, 56.3 per cent of rangers lost either one or multiple essential items of equipment

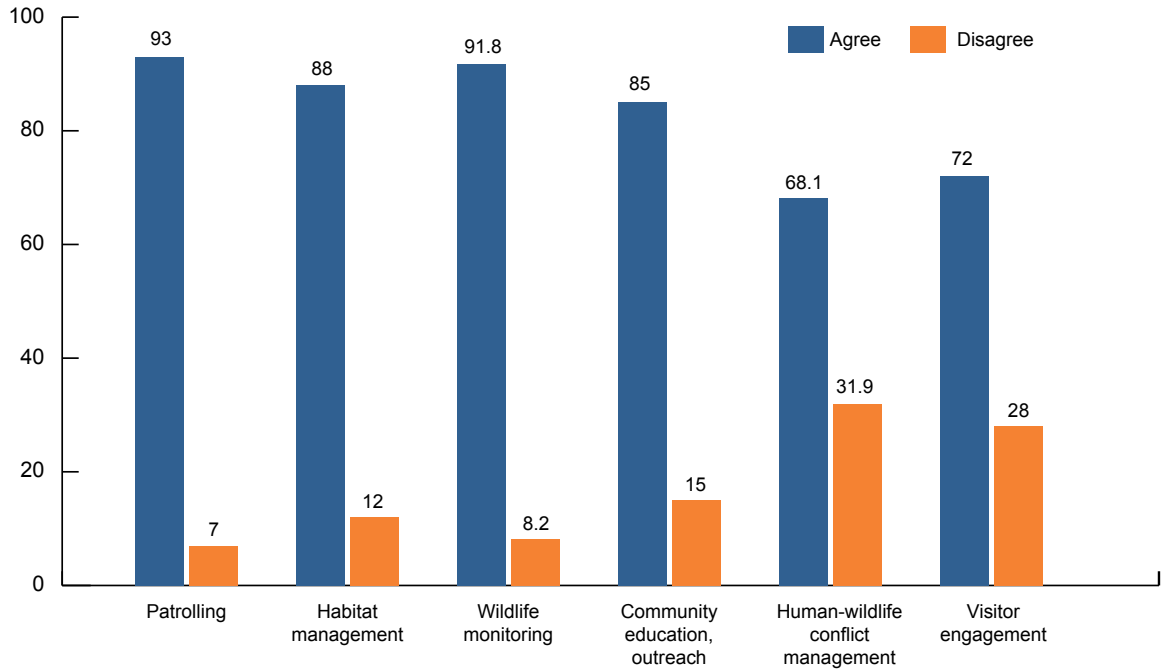

Figure 4. Percentage of rangers who agreed or disagreed that the flood has impacted various aspects of their work including patrolling, habitat management, wildlife monitoring, human–wildlife conflict management, and visitor engagement.

including motorbikes, bicycles, GPS devices, mobile phones, cameras, office furniture and generators. The floods caused physical injuries; 21.6 per cent rangers reported that either they or their colleagues were injured during the floods.

The rangers unanimously agreed that the floods significantly impacted their regular activities, including patrolling (93 per cent), habitat management (88 per cent), wildlife monitoring (91.8 per cent), human–wildlife conflict management (68.1 per cent) and visitor engagement (72 per cent). Limited engagement with visitors was attributed to the decline in visitor numbers post-flood, as access to the sites was very limited due to the floods. Despite this, the rangers highlighted that they made their best efforts to perform their duties (Figure 4).

Impact of floods on rangers: Personal losses and family challenges

At a personal level, the floods inflicted a distinct set of challenges upon the rangers, leaving them vulnerable to the impacts of natural disasters. The responses indicated that 76.8 per cent of rangers reported that floods directly affected their homes, towns and villages. The extent of the floods' impact on various aspects of the rangers' lives was substantial: 65 per cent reported the loss of personal property, 57.7 per cent experienced the loss of agricultural land, and 62.4 per cent endured damage to their homes. Additionally, 42 per cent of rangers experienced damage to their personally owned motorbikes and bicycles, which were essential for daily transportation and mobility within their communities. These personal losses were particularly severe because the vast majority of rangers (99.6 per cent) lived with their families in the same flood-affected areas where they worked, making them directly vulnerable to the disaster's impacts at both the personal and professional level.

Approximately 64.9 per cent of rangers reported that their children were unable to attend school after the flood due to damage to educational facilities. Moreover, 47 per cent had limited or no access to healthcare facilities, while 45.4 per cent of rangers and their families suffered from outbreaks of diseases in the aftermath of the flood event. Although the rangers were government employees, there was no system to compensate them for personal or work-related losses, such as injuries or damaged equipment.

Rangers as first responders

Rangers across all sites were actively working during the floods. A majority, comprising 72.7 per cent of the rangers interviewed, were involved in additional tasks assigned to them by their management. These additional responsibilities included providing emergency relief support, such as food and water, to the flood-affected communities (68 per cent), rescuing livestock and other animals displaced by the floods (25 per cent), and assisting in community evacuation efforts (32.5 per cent). A small proportion of rangers were involved in the distribution of financial support to the flood affected communities (12.4 per cent). Although this kind

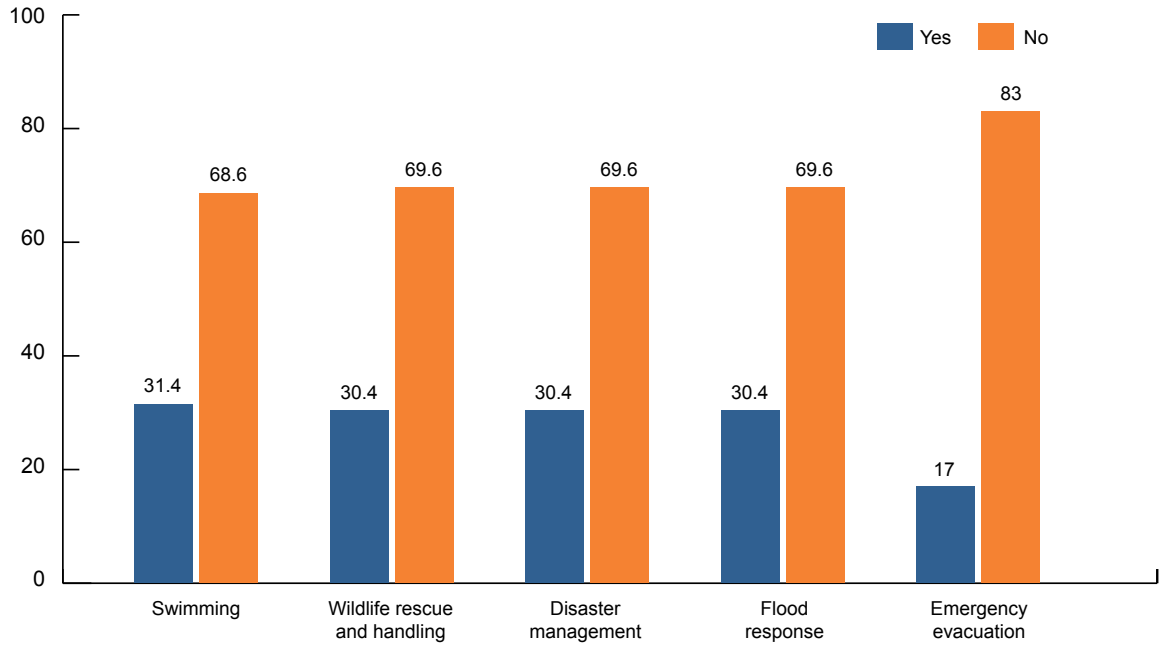

Figure 5. Percentage of rangers who received formal training in key disaster response and management aspects.

of support is not part of their official job descriptions, rangers across all sites were assigned flood response duties and played a vital role in assisting affected communities during the crisis.

Existing adaptive capacity of rangers to respond to floods and natural disasters

A high proportion of rangers, 66.5 per cent, expressed a sense of insecurity while carrying out their duties during floods. When questioned about the existence of disaster management plans within their sites, 68.7 per cent acknowledged the absence of a disaster management and response plan, 18 per cent believed that their site was equipped with such a plan, and 13 per cent were either uncertain or unaware of the concept of a disaster management plan. Additionally, even amidst the challenging flood conditions and restricted mobility due to submerged roads, 68.6 per cent of rangers were not provided with supplementary vehicles or boats to facilitate their operations.

A majority of rangers (73.2 per cent) were without official communication devices like mobile phones or walkie-talkies, which hindered their access to crucial updates on flooding conditions. A substantial 68.6 per cent of surveyed rangers lacked official insurance schemes to cover personal losses and damages incurred during their duties. Moreover, a striking 73.2 per cent of rangers did not have access to essential equipment needed for their duties, such as life-saving kits, appropriate footwear and life jackets.

Destruction to a road caused by the floods in Pakistan
© WWF-Pakistan

In terms of capacity, a significant majority did not receive any formal training in disaster management and response. Specifically, 68.6 per cent reported not having received formal swimming training, while 69.6 per cent did not receive training in wildlife rescue, handling, and disaster management for responding to events like floods. Alarmingly, 83 per cent reported a lack of training in emergency evacuation.

DISCUSSION

This study sheds light on less frequently discussed aspects of the lives of rangers serving as first responders in seven flood-affected districts of Pakistan, highlighting their vulnerability to floods and other climate-induced disasters. Limited access to equipment, resources and training, critical for effective response was a key challenge, especially for rangers operating in flood-affected areas. While we did not include the responses of rangers from sites in non-flood-affected regions, participants described how these challenges were particularly acute during flood response operations. These responses are consistent with the findings of the Global Ranger Perception Survey which reported similar concerns about inadequate training, safety, and resourcing across 25 countries, including Pakistan (Belecky et al., 2019).

The literature on ranger job satisfaction levels and challenges they encounter in the course of their duties has been increasing (e.g. Warchol and & Kapla, 2012; Belecky et al., 2019, 2021; Moreto et al., 2019, 2021; Singh et al., 2020). It shows that rangers are consistently exposed to dangers including wildlife, zoonotic diseases and challenging weather conditions (Belecky et al., 2019; Singh et al., 2020; Singh, Galliers, Appleton, et al., 2021; Singh, Galliers, Moreto, et al., 2021), and affirms that insufficient capacity, inadequate equipment and resources significantly affect ranger responsibilities. Rangers face additional responsibilities in responding to changing environmental conditions and natural disasters. These extra duties exacerbate their already challenging working conditions and which highlights a notable gap in existing research.

Rangers in flood-affected areas of Pakistan lacked access to clean drinking water, antivenom and insect bite treatment kits. One respondent from the Punjab Wildlife and Parks Department, who was part of a rescue operation team in flood-affected communities, contracted malaria, while the rest of his team experienced weakness, frequent nausea, persistent diarrhoea, and severe skin-related diseases.

Achieving a balance between addressing immediate flood-related concerns and maintaining sufficient funding for nature protection and first responders' roles is essential in safeguarding the overall safety and security of communities (Stolton et al., 2023; Werner et al., 2024). However, when a substantial portion of resources is directed towards flood relief, it can lead to a potential shift of funds away from other sectors, including conservation law enforcement. For example, during Hurricane Katrina in 2005, flood emergency support affected government law-enforcement budgets including law enforcement (Tompkins and & Neil Adger, 2005; Prakash et al., 2021).While our research focused on the most flood-impacted sites in southern Pakistan, the economic losses and salary cuts experienced by rangers extended beyond those located in the target affected areas. Daily-wage rangers working in Margalla Hills National Park, Islamabad, Pakistan were laid off because the funds were diverted to provide flood relief support.

Deaths resulting from occupational and work-related accidents are globally recognised as the second leading cause of ranger casualties, accounting for 254 lives lost between 2006 and 2021 (Galliers et al., 2022). In our research, we did not find any documented cases of ranger fatalities attributed to the floods of 2022 in the study areas. However, the escalating frequency and intensity of such extreme weather events may contribute to an increase in ranger casualties and injuries. One ranger from northern Pakistan was severely injured due to rain-induced landslides (Dunya News, 2023) and in 2017, one ranger died and five others injured while attempting to extinguish a forest fire in Gorani area in Khyber Pakhtunkhwa, Pakistan (The Express Tribune, 2017).

Rangers support climate adaptation and biodiversity by managing protected and conservation areas for flood prevention, coastal protection, wildfire response, and carbon sequestration and validating carbon stocks (Stolton et al., 2023). During natural disasters, they are the first responders, leveraging their deep knowledge of local ecosystems and animal behaviour to assess and address impacts on wildlife and their habitats (Carter, 2004). Coming from local communities, rangers carry a strong sense of responsibility, not only towards biodiversity protection but also in serving their communities (Parker et al., 2022). A majority of those surveyed hailed from within a 20 km radius of the site where they were stationed. At Taunsa Barrage Wildlife Sanctuary in Punjab, for instance, rangers were working with police to assist in evacuating communities from villages affected by floods, even though they had limited swimming skills. Despite facing challenges such as inadequate training and resources, they engage in these tasks due to their inherent sense of responsibility to support their fellow community members.

A substantial portion of rangers engaged in this research, expressed concerns about their safety while performing their duties during floods and stressed the pressing need for comprehensive disaster management strategies and strengthened support systems. Initiatives focused on enhancing the capacity of rangers can significantly improve their effectiveness in responding to such crises.

Advocacy is needed to ensure that ranger employers offer sufficient health and life insurance coverage to all rangers. However, this implementation may take some time. In the interim, conservation NGOs have the potential to provide support to rangers (Galliers et al., 2022).

We anticipate that this research will contribute to assessing the vulnerability of rangers to extreme weather events and disasters, such as the catastrophic floods in Pakistan, by establishing a baseline. Future research endeavours should also prioritise evaluating the regional-scale impacts of climate change and the specific vulnerabilities of rangers to extreme weather events. In addition, future studies should document the diverse roles rangers play as first responders to climate-related disasters, in order to strengthen their strategic role within disaster risk reduction and mitigation efforts.

CONCLUSIONS

Our study sheds light on the role and vulnerabilities of rangers as first responders, extending beyond the scope of traditional biodiversity conservation and law enforcement duties. During the 2022 Pakistani floods, rangers engaged in flood response and relief activities, ranging from safely evacuating communities to providing them with clean water and distributing cash grants, all while helping to protect communities' homes, livestock and essential belongings. These efforts were in addition to their core responsibilities of protecting biodiversity and managing protected areas. This multifaceted contribution received limited recognition, not only locally but also on a broader global scale. The lack of recognition can be demoralising for rangers as their roles expand and demands on the workforce increase without corresponding institutional or public support. The study serves as evidence to garner better recognition for the profession and highlight their broader contributions not only to biodiversity conservation and sustainable development, but also in their often-overlooked role as first responders.

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RESUMEN

Los guardabosques desempeñan un papel vital en la conservación de la biodiversidad, pero se ha pasado por alto su contribución fundamental como primeros intervinientes en catástrofes naturales. En este trabajo se evalúa el papel esencial desempeñado por los guardabosques como primeros intervinientes durante las inundaciones extremas de 2022 en Pakistán, así como su vulnerabilidad. Nuestro estudio incluyó entrevistas estructuradas y grupos de discusión con 194 guardabosques de siete distritos afectados por las inundaciones a lo largo del río Indo en Pakistán. Todos los guardabosques encuestados informaron del aumento de la intensidad de los fenómenos meteorológicos extremos y de que las inundaciones les afectaban negativamente. Las inundaciones interrumpieron sus tareas habituales y les causaron pérdidas personales, como daños en viviendas tierras agrícolas y otras posesiones. A pesar de ello, los guardabosques participaron en las labores de ayuda de emergencia, apoyando a las comunidades afectadas, rescatando ganado, ayudando en las evacuaciones y distribuyendo alimentos a las comunidades locales. Nuestro estudio pone de relieve el papel desempeñado por los guardabosques en Pakistán como primeros intervinientes y subraya cómo los guardabosques de todo el mundo, especialmente en entornos con recursos limitados, deben ser reconocidos y apoyados como trabajadores sanitarios planetarios. La investigación futura debe evaluar las funciones de los guardabosques y las vulnerabilidades a otros fenómenos meteorológicos extremos inducidos por el cambio climático en todos los ecosistemas, proporcionando información para informar el desarrollo de políticas, mecanismos de apoyo, y el reconocimiento mundial de la profesión de guardabosques.

RÉSUMÉ

Les gardes forestiers jouent un rôle essentiel dans la conservation de la biodiversité, mais leur contribution critique en tant que premiers intervenants lors de catastrophes naturelles a été négligée. Nous évaluons le rôle essentiel joué par les gardes forestiers en tant que premiers intervenants lors des inondations extrêmes de 2022 au Pakistan, ainsi que leurs vulnérabilités en la matière. Notre étude a consisté en des entretiens structurés et des discussions de groupe avec 194 gardes forestiers dans sept districts touchés par les inondations le long de l'Indus au Pakistan. Tous les gardes interrogés ont fait état d'une augmentation de l'intensité des phénomènes météorologiques extrêmes et ont indiqué qu'ils étaient affectés par les inondations. Les inondations ont perturbé leurs tâches régulières et causé des pertes personnelles, notamment des dommages aux maisons, aux terres agricoles et à d'autres biens, des terres agricoles et d'autres biens. Malgré cela, les gardes forestiers ont participé aux efforts de secours d'urgence, en soutenant les communautés touchées, en sauvant le bétail, en aidant aux évacuations et en distribuant de la nourriture aux communautés locales. Notre étude met en lumière le rôle joué par les gardes forestier au Pakistan en tant que premiers intervenants, et souligne comment les rangers du monde entier, en particulier dans les environnements à ressources limitées, devraient être reconnus et soutenus en tant qu'agents de santé planétaires. Les recherches futures devraient évaluer les rôles et les vulnérabilités des gardes forestiers face à d'autres événements météorologiques extrêmes induits par le changement climatique dans l'ensemble des écosystèmes, afin d'éclairer l'élaboration des politiques, les mécanismes de soutien et la reconnaissance mondiale de la profession de garde forestier.

TOWARDS RESPONSIBLE WASTE MANAGEMENT IN PROTECTED AREAS: AN EVALUATION OF SOUTH AFRICAN NATIONAL PARKS MANAGEMENT PLANS

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ABSTRACT

Waste management in protected areas is crucial to maintain their integrity and protected status, yet there is increasing evidence that the complexity of governance associated with their management can underpin poor waste management practice. In the absence of integrated waste management plans applying specifically to protected areas in South Africa, it falls to the protected area management plans to become the *de facto* waste management plan. An analytical framework comprising six principles for waste management in protected areas is adopted as the basis for evaluation of the management plans, which can also be used in other country settings and future evaluations. Protected area management plans of twenty South African national parks were systematically evaluated against this analytical framework. The evaluation highlighted several weaknesses and several cross-cutting areas for improvement, such as waste-related risks not being addressed in the management plan; important considerations in introductory narratives not finding their way into objectives or actions of management programmes, as well as objectives being stated without measurable criteria or indicators, and actions without sufficient detail for implementation and monitoring. The paper suggests recommendations to enhance the inclusion of principles towards responsible waste management in future protected area management plans.

Keywords: waste management hierarchy, pollution prevention, waste services, principles, developing countries

INTRODUCTION

Waste management in protected areas has increasingly become a concern, and it is recognised that responsible waste management in such areas is crucial to preserving their ecological integrity and ensuring sustainable tourism (Przydatek, 2019; Roos et al., 2022). Internationally, protected areas are responding to waste challenges through various innovative approaches. At Mole National Park in Ghana, reuse, upcycling and plastic-selling initiatives aim to reduce pollution (Nutsugbodo et al., 2024), while Mount Kilimanjaro in Tanzania uses a 'trash-in-trash-out' system to enhance waste collection and promote recycling (Kaseva & Moirana, 2009). Similarly, in the United States, the National Park Service's 'zero landfill' initiative combines waste reduction, recycling and composting to divert waste from landfills and instil sustainable practices among park visitors (Miller et al., 2019). These international examples underscore the importance of clear, coordinated management responses, which is an aspect often complicated by the complex governance structures that shape waste management practices in protected areas (Roos et al., 2023).

In South Africa, the complexity of waste management is heightened by the fragmented division of responsibilities across national, provincial and municipal authorities. National parks and marine protected areas fall under national entities like SANParks and the Department of Forestry, Fisheries, and the Environment (DFFE), while provincial and municipal parks are managed by respective conservation authorities and local governments. Waste management is a constitutional mandate of local government, which is responsible for planning and service delivery, including waste collection, storage and disposal (RSA, 1996). These services

Signage at Mountain Zebra National Park, explaining the importance of responsible waste practices and encouraging visitors to remove their waste © Francois Retief

are coordinated through legislated Integrated Waste Management Plans (IWMPs) at a local municipality level.

The implementation plans incorporated in IWMPs primarily address waste management within the main municipal area and its residential communities, with limited attention given to remote or outlying regions such as national parks[1] (Rodseth et al., 2020). This exclusion is largely due to logistical challenges, including difficult terrain, poor access roads and long transport distances; as well as constrained municipal budgets, inadequate infrastructure and limited personnel (Viljoen et al., 2021). Consequently, national parks often lack the detailed provision for waste management planning, support and infrastructure that IWMPs offer to more urbanised and densely populated regions. These shortcomings are echoed by Du Plessis et al. (2013), who highlight persistent challenges related to ineffective waste handling in South African national parks and argue that urgent interventions are needed to improve waste management and recycling practices in these ecologically sensitive areas.

In South African national parks, the primary sources of waste include tourist accommodation and catering facilities, administrative operations, and staff and visitor lodging (Du Plessis et al., 2013; SANParks, 2018a). The waste generated is predominantly solid in nature and comprises food waste, packaging materials (such as plastics, cardboard and cans), glass, garden waste and household hazardous wastes. In more remote parks, the accumulation of waste is exacerbated by logistical constraints, including infrequent collection and limited on-site processing or recycling capacity. These realities underscore the need for targeted and context-specific waste management interventions.

In the absence of applicable municipal IWMPs, protected area management plans emerge as a pragmatic instrument for managing solid waste in South African national parks. SANParks is also developing an integrated waste management strategy for its parks. This research intends to inform this strategy by critically evaluating existing management plans against waste management principles, establishing a baseline for current performance. This framework will serve as a benchmark for assessing future waste management practices and their evolution under the new strategy.

Accordingly, the aim of this paper is to derive and apply an analytical framework for evaluating the extent to which responsible waste management is provided for in protected area management plans, using South African national parks as a case study. We believe that the derived framework will also be valuable for evaluating programmes and/or plans emanating from future waste management strategies.

1 National Parks (Parks) have been defined by the IUCN as areas to be managed for ecosystem protection and the promotion of education and recreation.

Open waste bins along the coastline at West Coast National Park - posing potential risks of loss of containment, despite efforts to reduce pollution in sensitive marine environments © Claudine Roos

Protected area management plans

Protected area management plans are comprehensive documents developed under the South African National Environmental Management: Protected Areas Act (57 of 2003) (NEM: PAA) to guide the administration and operation of these areas. They outline the goals, strategies and actions necessary to maintain and enhance the ecological, cultural and recreational value of protected areas. According to Goosen and Blackmore (2019), protected area management plans fulfil three primary functions. First, they ensure that protected areas are managed effectively, aligning with the purposes for which they were established. Second, they provide a consistent framework for management actions, ensuring continuity during transitions between different authorities or managers. Third, they serve as a transparent mechanism for the public, demonstrating that protected areas are being managed in their best interests and those of future generations.

SANParks oversees twenty national parks (Figure 1), each guided by a park management plan (PMP), which is revised every ten years. While strategic direction is provided by SANParks' head office, park-specific teams are responsible for drafting and implementing these plans. Each park operates under its own internal management structure, typically led by a Park Manager and supported by functional units like conservation, tourism, and infrastructure. Larger parks may have dedicated staff for roles such as waste management, whereas smaller parks often have limited personnel, impacting their capacity to address operational issues. Although SANParks provides templates for PMPs (Goosen & Blackmore, 2019), there is no national standard mandating the detailed coverage of issues like waste management. As a result, the inclusion of waste-related objectives may vary based on local contexts, staff capacity and available resources.

Despite their critical role in conservation, protected area management plans in South Africa have received limited research attention regarding their implementation and effectiveness (Goosen & Blackmore, 2019). Existing studies tend to focus on biodiversity and cultural heritage management (e.g. Goodman, 2003; Taru et al., 2013), with minimal evaluation of how these plans address other essential areas such as waste management. This gap in research constrains the development of effective, context-specific strategies for managing waste within protected areas.

Methods

In the absence of specific legal requirements, other criteria or established best practice principles for waste management in national parks, the evaluation uses

An open bin with scattered waste in Golden Gate Highlands National Park, likely disturbed by monkeys or baboons - underscoring ongoing human-wildlife waste conflicts in protected areas © Claudine Roos

the principles proposed by Roos et al. (2023) in their paper *'Proposing principles towards responsible waste management in South African protected areas'*. In short, these principles include:

Principle 1. Protection of ecosystems and biodiversity: This principle aims to ensure that waste is managed to avoid damage to unique and endemic species, ecosystems and habitats. To achieve no net loss of biodiversity, waste infrastructure should be located outside sensitive areas while remaining accessible to park users. This aims to ensure that ecological integrity is maintained, as even minor impacts in protected areas can be considered significant.

Principle 2. Prevention and remediation of pollution: Principle 2 advocates for the responsible management and disposal of waste, as well as the prevention of littering and illegal dumping to avoid pollution and contamination as far as possible. It furthermore requires the remediation and rehabilitation of areas that have been contaminated by waste.

Principle 3. Implementation of the waste management hierarchy: The waste management hierarchy aims to avoid, minimise, re-use, recycle and recover waste, with disposal as the last resort. Principle 3 requires that the waste management hierarchy is considered and implemented in protected areas as far as possible.

Principle 4. Provision of effective waste services and infrastructure: This principle emphasises the need for planned, reliable waste services, including collection, transportation and disposal, as well as appropriate infrastructure such as bins, separation and composting facilities, and transfer or treatment stations within protected areas. In the South African context, many protected areas are situated in remote or rural locations where municipal waste services are limited or entirely absent. Logistical challenges, such as long distances and wildlife interference, combined with financial constraints, complicate service provision. Consequently, management authorities are often required to establish and manage these services independently or through private sector partnerships. To ensure environmental compliance and legal alignment, institutional frameworks must allocate dedicated budgets, personnel and capacity.

Principle 5. Promotion of participation and building of partnerships: This principle emphasises the importance of meaningful stakeholder participation and sustainable partnerships in waste management. Engaging interested and affected parties, including local communities and Indigenous groups, ensures that waste

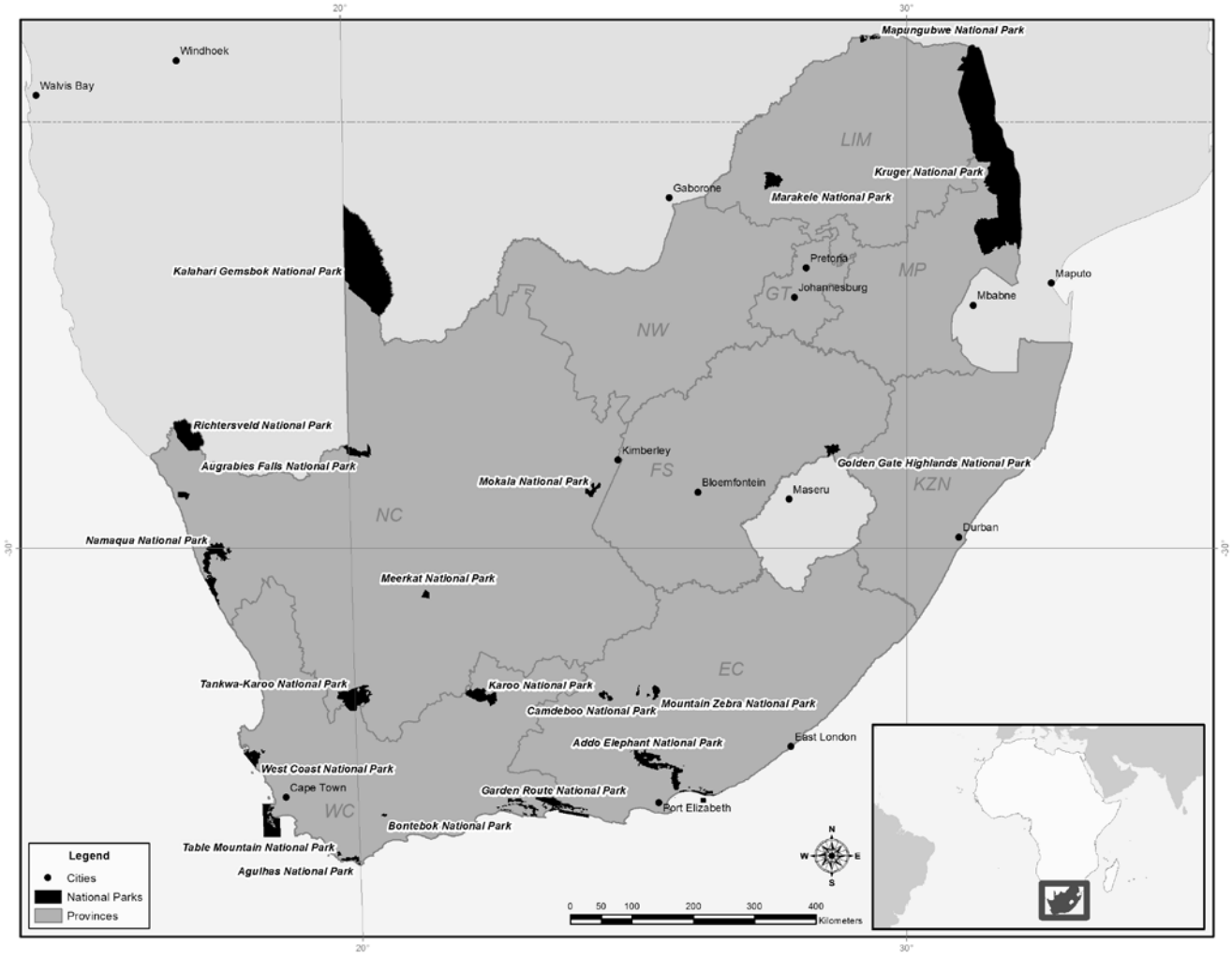

Figure 1. Map of the twenty national parks in South Africa.

practices are appropriate, accepted and informed by local knowledge. Traditional and Indigenous knowledge can support the development of context-sensitive solutions, while inclusive consultation fosters ownership, trust and long-term success.

Principle 6. Contribution to well-being, livelihood and capacity: Waste management in protected areas can support community well-being through job creation, skills development and livelihood opportunities. This includes integrating local communities and the informal waste sector into circular economy initiatives. Building local capacity through education, awareness and training is essential to enable effective waste management and unlock related opportunities.

These principles align with South African environmental and waste legislation and have been contextualised for protected areas based on the objectives of protected area and biodiversity legislation. They also draw on international principles, guidelines, and good or best practices for waste, biodiversity, ecotourism and protected area management (see Roos et al., 2023 for detail). Including these principles in management plans would support compliance with both legal requirements and international best practices.

Although only published in 2023 and not legally required, the principles are valuable as an evaluation tool. Assessing their inclusion in current management plans provides insight into the current state of waste management planning and serves as a baseline for evaluating alignment with best practice. This, in turn, informs recommendations for improving management actions and guiding future plans. The same principles can be used to evaluate future integrated waste management plans or strategies, helping determine whether these contribute to improved waste management in South Africa's national parks.

A case study approach was used, focusing on South Africa's national parks. Final, approved park management plans (PMPs) were obtained for all selected parks. Most PMPs were developed after 2014 (Table 1), although five (Bontebok, Camdeboo, Marakele, Tankwa Karoo, and West Coast) were under revision during the study.

Table 1. National parks included in the evaluation with the date and status of their park management plans (PMPs).

Park and management plan	Province	Management plan date	Status
Addo Elephant National Park (SANParks, 2015a)	Eastern Cape	2015–2025	Approved October 2015
Agulhas National Park (SANParks, 2020a)	Western Cape	2020–2029	Approved December 2020
Augrabies Falls National Park (SANParks, 2024)	Northern Cape	2024–2033	Approved March 2024
Bontebok National Park (SANParks, 2013a)	Western Cape	2013–2023	Approved September 2013, being revised
Camdeboo National Park (SANParks, 2013b)	Eastern Cape	2013–2023	Approved September 2013, being revised
Garden Route National Park (SANParks, 2020b)	Western Cape and Eastern Cape	2020–2029	Approved December 2019
Golden Gate Highlands National Park (SANParks, 2020c)	Free State	2020–2029	Approved December 2020
Karoo National Park (SANParks, 2017a)	Western Cape	2017–2027	Approved September 2017
Kgalagadi Transfrontier Park (SANParks, 2023a)	Northern Cape	2023–2027	Approved August 2023
Kruger National Park (SANParks, 2018a)	Mpumalanga and Limpopo	2018–2028	Approved November 2018
Mapungubwe National Park (SANParks, 2019)	Limpopo	2019–2028	Approved November 2019
Marakele National Park (SANParks, 2014a)	Limpopo	2014–2024	Approved November 2014, being revised
Meerkat National Park (SANParks, 2022)	Northern Cape	2022–2031	Approved September 2022
Mokala National Park (SANParks, 2017b)	Northern Cape	2017–2027	Approved September 2017
Mountain Zebra National Park (SANParks, 2016)	Eastern Cape	2016–2026	Approved May 2016
Namaqua National Park (SANParks, 2023b)	Northern Cape	2024–2033	Approved July 2023
Richtersveld National Park (SANParks, 2018b)	Northern Cape	2018–2028	Approved August 2018
Table Mountain National Park (SANParks, 2015b)	Western Cape	2015–2025	Approved April 2016
Tankwa Karoo National Park (SANParks, 2014b)	Western Cape and Northern Cape	2014–2024	Approved November 2014, being revised
West Coast National Park (SANParks, 2013c)	Western Cape	2013–2023	Approved September 2013, being revised

Each PMP was systematically reviewed to assess its provision for waste management. A data mining approach was used to search for keywords such as *'waste', 'waste management', 'litter', 'littering', 'refuse', 'garbage', 'pollution', 'barrier'*, and *'micro-plastic'* across all sections of each PMP – including introductory text and specific programme content. These programmes are usually presented in tables detailing objectives, sub-objectives, actions, responsibilities and the Portfolio of Evidence (PoE). Each reference was then assessed against the six responsible waste management principles. The level of inclusion was categorised as follows (see Table 2): Addressed (A) indicated in green; Partially addressed (B) indicated in yellow; or Not addressed (C) indicated in orange.

Table 2: Extent to which proposed principles for responsible waste management are provided for in the park management plans (PMPs) of twenty South African national parks, with A = addressed (green), B = partially addressed (yellow), C = not addressed (orange)

Park management plans	**Principle 1:** Protection of ecosystems and biodiversity	**Principle 2:** Prevention and remediation of pollution	**Principle 3:** Implementation of the waste management hierarchy	**Principle 4:** Provision of effective waste services and infrastructure	**Principle 5:** Promotion of participation and building of partnerships	**Principle 6:** Contribution to well-being, livelihoods and capacity
Addo Elephant National Park	C	C	C	B	C	C
Agulhas National Park	C	C	A	B	C	C
Augrabies Falls National Park	C	C	A	A	B	C
Bontebok National Park	C	C	C	C	C	C
Camdeboo National Park	C	C	C	C	C	C
Garden Route National Park	C	A	A	B	C	C
Golden Gate Highlands National Park	C	C	A	A	C	B
Karoo National Park	C	C	C	A	C	C
Kgalagadi Transfrontier Park	C	C	C	B	C	C
Kruger National Park	C	B	A	A	A	A
Mapungubwe National Park	A	C	A	A	C	C
Marakele National Park	C	C	C	C	C	C
Meerkat National Park	C	C	C	C	C	C
Mokala National Park	C	C	C	B	C	C
Mountain Zebra National Park	C	C	C	B	C	C
Namaqua National Park	C	C	A	B	C	C
Richtersveld National Park	C	C	C	B	C	C
Table Mountain National Park	C	C	C	C	C	C
Tankwa Karoo National Park	C	B	C	C	C	C
West Coast National Park	C	B	C	C	C	C

RESULTS AND DISCUSSION

Table 2 provides the results of the evaluation of the twenty national parks' management plans against the six principles proposed for responsible waste management in protected areas.

Extent to which proposed principles for responsible waste management in protected areas are addressed in park management plans

Most park management plans made some reference to waste management, although in a limited way. Five of the twenty plans did not include waste management in any programme but mentioned rules such as 'no littering' and 'disposal of waste in bins' in the appended internal park regulations. Similarly, some plans identified 'littering', 'waste disposal' and 'poor waste management practices' as threats in the narrative sections but failed to translate these into concrete actions within their programme components. The best-performing plan was that of Kruger National Park, which mentioned 'waste' sixteen times, addressed four principles and partially addressed a fifth.

Principle 1: Protection of ecosystems and biodiversity

Principle 1 emphasises the conservation of ecosystems and biodiversity within protected areas to ensure they provide services, value and benefits for current and future generations. This principle underscores the importance of achieving no net loss to biodiversity through effective waste management practices that avoid damage to unique, endemic, threatened or declining species, habitats and ecosystems (Roos et al., 2023).

Of the twenty national parks (Table 2), only Mapungubwe National Park addressed (A) Principle 1 in the context of managing human–wildlife conflicts. This programme

provides for *"monitoring the implementation and effectiveness of an integrated waste management plan to minimise human–wildlife conflict issues"* (SANParks, 2019: 104). At the time of the research, it could not be established whether an IWMP had been developed and implemented.

The fact that only one out of twenty national parks has addressed Principle 1 highlights a significant gap in the consideration of waste management measures towards the protection of ecosystems and biodiversity. To address this gap, national parks should acknowledge the ecological risks of poor waste management, such as pollution, habitat degradation and harm to wildlife. Waste-related risks should be integrated into biodiversity conservation strategies and ecological monitoring. Parks can adopt preventative measures like wildlife-proof bins, anti-littering enforcement and clean-up operations in high-risk areas. Management objectives should link waste reduction to ecosystem protection and include measurable indicators to track progress. Strengthening this principle supports both biodiversity conservation and alignment with broader environmental mandates.

Principle 2: Prevention and remediation of pollution

Four of the twenty park management plans have addressed (A) or partially addressed (B) Principle 2 (Table 2), which aims at the prevention, minimisation, mitigation and remediation of pollution.

The Garden Route National Park management plan identifies *"lack of proper waste management"* and *"litter, illegal dumping and ineffective waste management"* as threats to the park's vital attributes (SANParks, 2020b: 42–43). It includes a sub-objective to ensure responsible waste management, with actions such as reviewing current practices to support pollution prevention. Similarly, the Kruger National Park plan lists *"pollution from refuse"* as a threat (SANParks, 2018a: 43). While the Freshwater Ecosystem Programme notes groundwater monitoring linked to sanitation and waste disposal (SANParks, 2018a: 111), no further waste-related monitoring is outlined in the plan's action programmes. Furthermore, the management plans of Tankwa Karoo and West Coast National Parks address waste management within the Environmental Management Programme, highlighting the need to identify environmental impacts and legal requirements, set objectives and targets, and implement, monitor and review actions for continuous improvement (SANParks, 2013c: 50; SANParks, 2014b: 62). Lastly, the narrative section of the Management Programme for

Waste separation bins at Malelane Camp, Kruger National Park, with an elephant in the background - a visual reminder of the intersection between conservation infrastructure and wildlife presence © Claudine Roos

the Langebaan Ramsar site included in the West Coast National Park management plan (SANParks, 2013c: 96–102) highlights the duty to *"Ensure all waste and sewage discharges within the Lagoon and catchment of the aquifers are appropriately licensed (Lead Agency: Saldanha Bay Municipality, Priority: High)"*.

These provisions partially align with Principle 2, focusing on the minimisation of impacts and the prevention of pollution. No specific mention is, however, made of waste management in the Environmental Management Programme objectives or actions.

Principle 3: Implementation of the waste management hierarchy

Principle 3 considered the extent to which management plans addressed the implementation of the waste management hierarchy, (i.e. the extent to which waste is avoided, minimised, reused, recycled or recovered). Principle 3 was most frequently provided for in the evaluated management programmes, with seven of the twenty management plans addressing (A) the implementation of the waste management hierarchy (Table 2).

Several national park management plans integrate waste management into their Responsible Tourism Programmes, with an emphasis on waste minimisation and recycling. Parks such as Agulhas, Augrabies Falls, Golden Gate Highlands, Kruger, Mapungubwe and Namaqua have sub-objectives to *"use local resources sustainably"* and *"minimise waste and recycle",* in line with Principle 3. However, only the Kruger National Park management plan specifies a measurable target, aiming for a 30 per cent reduction in solid waste over seven years through initiatives such as plastic reduction and partnerships with recycling companies (SANParks, 2018a: 163).

The Climate Change Programmes of these parks highlight increased recycling but do not provide concrete actions. Kruger National Park is also unique in focusing on changing human behaviour towards waste management through education for both staff and tourists (SANParks, 2018a: 179), although research suggests that such efforts alone may not suffice without additional strategies (Strydom, 2018). Augrabies Falls National Park mentions performing a lifecycle assessment of waste for recycling opportunities, but this is not formalised in the action plan. The Garden Route National Park stresses waste reduction and resource-efficient designs for new activities, redesigns and upgrades (SANParks, 2020b: 93), while Namaqua National Park includes waste minimisation in its infrastructure planning but provides no further details in its action plan (SANParks, 2023b). This emphasises the importance of providing for waste management considerations in environmental impact assessment (EIA) processes for developments in protected areas, as highlighted by Claassens et al. (2022).

Despite the frequent inclusion of Principle 3 provisions in the evaluated management plans, many of these provisions lack specific targets or key performance indicators for waste reduction or recycling. Furthermore, many sections of text in the narrative parts of the management plans are not translated into concrete objectives and actions (as part of programmes), risking that these measures will not be effectively addressed.

Principle 4: Provision of effective waste services and infrastructure

Principle 4, which advocates for the provision of effective waste services and infrastructure, was also frequently provided for in the management plans, with five of the management plans addressing (A) and eight of the management plans partially addressing (B) this principle (Table 2).

The Infrastructure Programmes of the park management plans for Augrabies, Golden Gate Highlands, Kruger and Mapungubwe National Parks include a sub-objective to ensure the maintenance and upgrading of solid waste infrastructure. The specific actions for this sub-objective include compiling an inventory of existing infrastructure to assess the required maintenance and implementing an annual maintenance plan. These actions represent an essential first step in providing effective waste services and infrastructure within the parks. The research project *'Perspectives on the Future of Waste Management in South African Protected Areas',* funded by the South African Department of Science and Innovation (DSI) and the Council for Scientific and Industrial Research (CSIR), aims to assess the status of waste management infrastructure in national parks, contributing to the inventory of waste-related infrastructure.

Other national parks, such as Addo Elephant, Agulhas, Garden Route, Karoo, Kgalagadi, Mokala, Mountain Zebra, Namaqua and Richtersveld, partially address Principle 4 in their Infrastructure Programmes, which reference the *'touching the earth lightly'* principle, including waste management infrastructure. However, these plans do not provide detailed specifications for the required infrastructure or integrate waste management into specific management objectives or actions.

The management plans for Karoo and Garden Route National Parks stand out by including more specific provisions related to waste management services and infrastructure. Karoo National Park's Environmental Management Programme includes a sub-objective to *"coordinate and implement effective waste management (solid and fluids)"* (SANParks, 2017a: 97), though it refers to *'Waste Management Policies'* without further details. The Terrestrial Ecosystems Management Programme of Garden Route National Park also addresses *"appropriate infrastructure designs and effective waste disposal"* as part of a sub-objective focused on managing the human–wildlife interface, though no detailed actions or specific infrastructure designs are outlined in the plan (SANParks, 2020b).

More detailed management actions, with allocation of budget, timeframes and responsible persons would be required to ensure that waste management infrastructure and services are effectively implemented in these parks.

Principle 5: Promotion of participation and building of partnerships

Objectives and actions towards the achievement of Principle 5, focusing on the promotion of participation and building of partnerships, were poorly addressed in the park management plans evaluated. Only one management plan (Kruger National Park) addressed this principle (A), while another management plan (Augrabies Falls National Park) partially addressed it (B) (Table 2).

The Integrated Land Use and Regional Planning and Management Programme of the Kruger National Park includes a sub-objective to promote responsible natural resource management and land restoration, with an action to *"develop guidelines, criteria, and programmes for co-operative waste management within adjacent communities"* (SANParks, 2018a: 86). Additionally, the Kruger management plan's Infrastructure Programme outlines an action to develop an MoU with recycling companies to purchase recyclable products (SANParks, 2018a: 163), supporting the park's 30 per cent waste reduction target over the next 7 years. These provisions align with Principle 5, which encourages partnerships to address waste management.

Although not formally integrated into any specific programmes, the Augrabies Falls National Park management plan partially addresses Principle 5. The plan notes that the park collaborates with various organisations, such as the Park Forum, Kakamas Water Users Association and the Kai! Garib Environmental Forum, to share information, support cultural initiatives, and enhance waste and sanitation management in the surrounding municipalities (SANParks, 2024: 71).

While these collaborations align with Principle 5, which emphasises the importance of partnerships and stakeholder engagement in addressing waste management challenges, it is crucial that these efforts are formally recognised and integrated into park management plans. Specifically, incorporating these collaborations into the Stakeholder Engagement or Communications Programmes would ensure that partnerships are strategically managed, clearly defined and effectively coordinated. This formal integration would also enhance transparency and accountability, allowing for better tracking of joint initiatives and their outcomes. Moreover, by institutionalising these partnerships within park management plans, the park can establish clear frameworks for cooperation, allocate appropriate resources, and ensure that stakeholders, including local communities and external partners, are provided for.

A vervet monkey "investigating" waste separation bins at Pretoriuskop Camp, Kruger National Park © Claudine Roos

Principle 6: Contribution to well-being, livelihoods and capacity

Lastly, Principle 6 acknowledges the contribution that responsible waste management could make towards well-being, livelihoods and capacity building. This principle is poorly provided for in the management plans of national parks, with Principle 6 being addressed (A) in only one management plan (Kruger National Park) and partially addressed (B) in another management plan (Golden Gate Highlands National Park) (Table 2).

The Integrated Land Use and Regional Planning Programme of Kruger National Park includes a sub-objective to promote responsible resource management and land restoration. This involves developing guidelines and programmes to support co-operative

Educational signage discouraging littering at Golden Gate Highlands National Park - part of ongoing visitor awareness and environmental stewardship initiatives © Claudine Roos

waste management with adjacent communities, linking to environmental education and socio-economic development (SANParks, 2018a: 86). These initiatives could foster capacity building, skills development, job creation and enhance livelihoods. Similarly, the Golden Gate Highlands National Park management plan's Socio-economic Transformation Programme highlights various community development programmes, including waste management and the Extended Public Works Programme (EPWP), but lacks further details on waste management actions (SANParks, 2020c: 105).

Similar to what was suggested under Principle 5, park management plans could include more specific actions and measurable objectives related to waste management in the context of community development. This could involve incorporating waste management as a key component of local socio-economic programmes, with clear targets for waste reduction, recycling and job creation in the surrounding communities. Additionally, formalising partnerships with local stakeholders (see Principle 5) could enhance collaboration and ensure that waste management initiatives are effectively integrated into broader strategies.

CONCLUSIONS

In the absence of forthcoming integrated waste management strategies and plans, protected area management plans are a potentially valuable instrument for managing waste in national parks. Therefore, this paper aimed to evaluate the extent to which responsible waste management principles are provided for in the management plans of twenty South African national parks to inform future waste management plans and practices, thus leading to improved adoption of the principles. The findings reveal that, apart from two principles *(Principle 3: Implementation of the waste management hierarchy* and *Principle 4: Provision of effective waste services and infrastructure),* most park management plans make insufficient provision for the proposed principles towards responsible waste management.

Beyond the incomplete coverage of the principles, several cross-cutting weaknesses were identified. In several park management plans, waste-related concerns such as littering, pollution and inadequate waste disposal are recognised as environmental risks or threats. However, these are often not translated into actionable objectives or interventions within the structured management programmes. Similarly, waste management is sometimes acknowledged in the narrative introductions of programme sections, but not incorporated into the formal objectives, actions or performance indicators. Where objectives and actions are included, they tend to be generalised and lack the specificity required for effective implementation, monitoring and reporting.

Several contextual and systemic factors may explain why many South African protected areas fail to sufficiently address waste management in their management plans. Many parks are located in remote or rural areas, where access to municipal waste services is limited or entirely absent. This places the full responsibility for planning,

funding and implementing waste services on park management authorities, many of which operate under severe financial and capacity constraints. Furthermore, waste management is often deprioritised in favour of more visible conservation issues such as biodiversity protection or anti-poaching efforts. Limited technical expertise, a lack of dedicated waste management staff, and the absence of clear national guidelines or enforcement mechanisms for waste planning in protected areas further contribute to these shortcomings (Roos et al., 2023).

These systemic challenges are further reflected in the inconsistent provision for waste management across park management plans. Although SANParks is the statutory authority responsible for drafting and implementing park management plans for all national parks in South Africa (Goosen & Blackmore, 2019), there is significant variation in how these plans address waste management. This disparity can be attributed to several factors, one of which is the lack of detailed, national-level guidance or regulation specifically requiring consistent waste management planning within management plans.

Recommendations to address cross-cutting weaknesses and to enhance the inclusion of responsible waste management principles into future protected area management plans include:

- Strengthening strategic planning and implementation: Waste management should be integrated into all stages of park planning, with clear objectives, measurable indicators, budgets and responsible personnel. Objectives should align with biodiversity and habitat protection, addressing pollution and litter risks in sensitive environments.
- Institutionalising governance and accountability: To address fragmented responsibility, governance structures should be formalised within parks and institutions. Multi-stakeholder committees, including park staff, municipalities and community representatives, can improve coordination and accountability. SANParks should assign clear mandates and performance targets for waste management.
- Promoting adaptive and participatory management: Adopt adaptive co-management frameworks that allow for iterative learning, stakeholder input and regular performance reviews. Stakeholder participation may enhance compliance, local ownership and socio-economic opportunities related to waste, including education and job creation.
- Mainstreaming waste management across conservation mandates: Waste management must be integrated into conservation goals, alongside biodiversity protection. Management plans should include waste considerations as part of ecological risk assessments, biodiversity monitoring and habitat protection.
- Enhancing environmental education and information dissemination: Educational efforts should be directed not only at local communities and park staff but also at tourists, who are key actors in waste generation. Visitor-focused interventions, such as interpretive signage, information boards and digital communication platforms, can foster awareness, encourage responsible behaviour and support waste reduction at source.

We recognise that improving the content of protected area management plans does not in itself guarantee the implementation of effective waste management. However, failure to incorporate these responsible waste management principles does reduce the likelihood of effective implementation since actions and budgeting are linked to the plans. This research serves as a first step in improving waste management planning towards more effective waste management in the context of protected areas. The proposed evaluation framework may be useful in evaluating future waste management plans or programmes developed for national parks.

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RESUMEN

La gestión de los residuos en las áreas protegidas es fundamental para mantener su integridad y su condición de protegidas, pero cada vez hay más pruebas de que la complejidad de la gobernanza asociada a su gestión puede dar lugar a prácticas deficientes en este ámbito. A falta de planes integrados de gestión de residuos que se apliquen específicamente a las áreas protegidas de Sudáfrica, corresponde a los planes de gestión de las áreas protegidas convertirse en el plan de gestión de residuos *de facto*. Se ha adoptado un marco analítico que comprende seis principios para la gestión de residuos en las áreas protegidas como base para la evaluación de los planes de gestión, que también puede utilizarse en otros contextos nacionales y en futuras evaluaciones. Se han evaluado sistemáticamente los planes de gestión de veinte parques nacionales sudafricanos con arreglo a este marco analítico. La evaluación puso de relieve varias deficiencias y varios ámbitos transversales que deben mejorarse, como la falta de atención a los riesgos relacionados con los residuos en el plan de gestión; la ausencia de consideraciones importantes en las narrativas introductorias que no se reflejan en los objetivos o las medidas de los programas de gestión, así como la formulación de objetivos sin criterios o indicadores medibles y medidas sin detalles suficientes para su aplicación y seguimiento. El documento formula recomendaciones para mejorar la inclusión de principios para una gestión responsable de los residuos en los futuros planes de gestión de las áreas protegidas.

RÉSUMÉ

La gestion des déchets dans les zones protégées est essentielle pour préserver leur intégrité et leur statut protégé, mais il apparaît de plus en plus clairement que la complexité de la gouvernance associée à leur gestion peut être à l'origine de mauvaises pratiques en matière de gestion des déchets. En l'absence de plans de gestion intégrée des déchets s'appliquant spécifiquement aux zones protégées en Afrique du Sud, il incombe aux plans de gestion des zones protégées de devenir le plan de gestion des déchets *de facto*. Un cadre analytique comprenant six principes pour la gestion des déchets dans les zones protégées est adopté comme base pour l'évaluation des plans de gestion, qui peut également être utilisé dans d'autres contextes nationaux et pour des évaluations futures. Les plans de gestion de vingt parcs nationaux sud-africains ont été systématiquement évalués à l'aide de ce cadre analytique. L'évaluation a mis en évidence plusieurs faiblesses et plusieurs domaines transversaux à améliorer, tels que les risques liés aux déchets qui ne sont pas pris en compte dans le plan de gestion, les considérations importantes dans les descriptions introductives qui ne se retrouvent pas dans les objectifs ou les actions des programmes de gestion, ainsi que les objectifs énoncés sans critères ou indicateurs mesurables et les actions sans détails suffisants pour leur mise en œuvre et leur suivi. Le document formule des recommandations visant à renforcer l'intégration des principes d'une gestion responsable des déchets dans les futurs plans de gestion des zones protégées.

COMMUNITY-LED MARINE OECMS: ASSESSING ENABLING REGULATORY FRAMEWORKS AND POTENTIAL CASES IN INDONESIA

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ABSTRACT

The Convention on Biological Diversity's Kunming-Montreal Global Biodiversity Framework (KM-GBF) calls for conserving at least 30 percent of the planet through protected areas or Other Effective Area-based Conservation Measures (OECMs) by 2030. OECMs can complement Marine Protected Areas by recognising diverse forms of management delivering biodiversity benefits regardless of their objectives. A key barrier to their implementation is a lack of legal clarity on OECM identification, recognition, and monitoring at the national level. To address this, we examine Indonesia's marine and forestry regulations in the context of OECM criteria, identifying opportunities to adapt existing policies to support the recognition of community-led marine areas as OECMs. These regulations generally align well with Criterion A (non-protected area) and Criterion B (active governance), but gaps remain in addressing effectiveness in conserving biodiversity (Criterion C) and associated ecosystem services and socio-cultural values (Criterion D). Building on this analysis, we evaluated three Locally Managed Marine Areas in Indonesia to assess how the OECM framework could support on-ground management practices. These case studies showed conservation effectiveness, with increases in resource availability (e.g. >65% more catch in two sites). Our findings underscore OECMs' potential as inclusive, adaptable models for advancing biodiversity targets in Indonesia and beyond.

Keywords: Enabling policies, Kunming-Montreal Global Biodiversity Framework, 30x30 target, community-led conservation, Marine OECMs

INTRODUCTION

The Kunming-Montreal Global Biodiversity Framework (KM-GBF), adopted in December 2022, is a landmark decision under the Convention on Biological Diversity (CBD) that aims to halt and reverse biodiversity loss by 2030. Target 3 of the KM-GBF, also known as the '30x30' target, seeks to conserve at least 30 percent of the planet's terrestrial, inland water, and coastal and marine areas by 2030 (CBD, 2022). The framework acknowledges the critical role of Indigenous peoples and local communities to conservation, as first introduced in Article 8(j) of the CBD. However, area-based conservation efforts have historically relied on top-down governance, where decision-making authority rests primarily with government agencies (Gurney et al., 2023). These government-led conservation models often restrict local community participation, raising concerns about feasibility (Glaser et al., 2010), equity (Gurney et al., 2021) and ecological effectiveness (Bennett & Dearden, 2014; Sanchirico et al., 2002), especially in Global South countries.

The inclusion of Other Effective Area-Based Conservation Measures (OECMs) in Target 3 of the KM-GBF presents a key opportunity to diversify the area-based conservation toolbox and improve both effectiveness and equity of the conservation system (Gurney et al., 2021; Jonas et al., 2021; Maini et al., 2023). First introduced in the 2010 Aichi Targets, OECMs were formally defined under COP CBD Decision 14/8 as 'geographically defined areas that achieve long-term biodiversity conservation' (CBD, 2018). The key distinction between OECMs and MPAs is that MPAs are generally understood to have a primary objective of biodiversity conservation, whilst the definition of OECMs specifies no restrictions on objectives but specifies that they must be effective in conserving biodiversity (CBD, 2018).

This flexibility of the OECM framework facilitates recognition of a diversity of management areas that contribute to biodiversity conservation regardless of their objectives, and as such, opens the door to recognising and strengthening existing management practices, including those led by communities (Dudley et al., 2018; Maini et al., 2023). Thus, the OECM framework provides a means to potentially strengthen bottom-up approaches, addressing some of the limitations of top-down approaches (Claudet et al., 2022). Community-led governance can enhance the effectiveness of conservation because it is tailored to its context and aligned with local values, governance and traditional knowledge systems. Its recognition through an OECM framework could potentially contribute to fostering equitable governance that contributes to communities' well-being, and through fostering local leadership, support and compliance lead to biodiversity conservation effectiveness (Gray, 2006; Gurney et al., 2021; Halim, 2020).

Despite its potential, the use of the OECM framework remains limited, with OECMs covering less than 1.2 per cent of land and freshwater environments and less than 0.2 per cent of marine areas (UNEP-WCMC & IUCN, 2025). Furthermore, to date, the majority of OECMs that have been reported to the World Database on OECMs are governed by government (although a large proportion are under shared governance) (Jonas, Bingham et al., 2024), raising questions about their promised utility of providing a means to recognise and support community-led governance (Jonas, Bingham et al., 2024). The slow uptake of the OECM framework, particularly for community-led managed areas, stems partly from a lack of legal and regulatory clarity surrounding their establishment and long-term governance (Jonas, Bingham et al., 2024; Paterson, 2023). Indeed, national-level contextualisation of OECMs remains mostly underexplored, leaving a gap in understanding how global frameworks like the KM-GBF can be translated into practical, effective and localised implementation strategies (Estradivari et al., 2022). The success of Target 3 depends on countries adapting their regulatory frameworks to accommodate OECMs, taking into account national legal, bureaucratic and socio-cultural contexts (Jonas, Bingham et al., 2024).

Indonesia exemplifies both the challenges and opportunities for implementing community-led OECMs, particularly in the marine context. Its coral reefs are among the most biodiverse on Earth (Glaser et al., 2010), and small-scale fisheries, which contribute 60 per cent of national fish production and support over 12,000 coastal villages, are critical to food security (MMAF, 2016). The strong cultural and economic reliance of Indonesia's coastal communities on marine resources, combined with supportive marine affairs regulations (Dudayev et al., 2023), has enabled the identification of over 390 potential marine OECM sites (Estradivari et al., 2022). By leveraging community-led management practices, OECMs in Indonesia could complement traditional MPAs by addressing gaps in top-down governance and facilitating the use of local knowledge and institutions in biodiversity conservation (Estradivari et al., 2024).

Despite these opportunities, Indonesia's marine governance remains predominantly top-down (Satria & Matsuda, 2004). Coastal communities often face insecure tenure rights, which undermine their capacity for sustainable resource management (Adhuri et al., 2022). Critics of this command-and-control governance model highlight the lack of adequate fisheries expertise within government agencies, which limits their ability to manage marine resources effectively (Gray, 2006; Kooiman, 1999). Furthermore, while Indonesia has nearly achieved its national target of 10 per cent MPA coverage, none of its MPAs are considered sustainably managed (Meilana et al., 2023). As of 2021, many locally governed LMMAs in Indonesia lacked national recognition and thus were not reported towards the Global Biodiversity Framework, despite having legal status at the provincial level (Handayani et al., 2022). These governance challenges highlight the urgent need to alter regulatory frameworks to better enable and support community-led management and formally recognise their contribution to national conservation strategies.

Table 1. The CBD criteria and sub-criteria for identifying OECMs (CBD 14/8; Jonas, Wood et al., 2024)

CBD criteria for OECMs	CBD sub-criteria for OECMs
Criterion A: Area is not currently recognised as a protected area	● Not a protected area
Criterion B: Area is governed and managed	● Geographically defined space ● Legitimate governance authorities ● Managed
Criterion C: Achieves sustained and effective contribution to in situ conservation of biodiversity	● Effective ● Long-term ● In situ conservation of biological diversity ● Information and monitoring
Criterion D: Associated ecosystem functions and services and cultural, spiritual, socio-economic and other locally relevant values	● Ecosystem functions and services ● Cultural, spiritual, socio-economic and other locally relevant values

In response, national initiatives led by the Ministry of Marine Affairs and Fisheries (MMAF) and a consortium of NGOs are advancing a 30x30 roadmap[1] that positions OECMs as a key mechanism to achieve 10 per cent marine area conservation by 2030 and 30 per cent by 2045. The Indonesian Biodiversity Strategic Action Plan 2025–2045 further includes OECMs in Target 3 (protected area coverage) and Target 17 (community participation), which emphasises inclusive public participation and equitable access to biodiversity planning – commitments which are also embedded in the Medium-Term National Development Plan via Presidential Regulation No. 12/2025. Despite these national efforts, the slow uptake of OECMs in Indonesia and globally highlights two key barriers: (i) a lack of legal and regulatory clarity surrounding their recognition and governance, and (ii) insufficient national contextualisation that translates the OECM framework into an effective, locally relevant conservation tool (Cook, 2024; Paterson, 2023). Addressing these challenges is critical for ensuring that OECM status is not merely a symbolic designation, rather that it represents recognition of managed areas that deliver biodiversity benefits (Gurney et al., 2021; Hoffman, 2022; Ólafsdóttir et al., 2024). To address these gaps, we examine how Indonesia's legal frameworks can better support the implementation of community-led marine OECMs by bridging the gap between regulatory structures and local conservation practices. Through a combined legal analysis and case study approach, we assess how existing policies align with the CBD criteria for OECMs and provide practical insights into how community-led conservation efforts can be formally integrated into national conservation regulations and strategies. Our findings contribute to broader global discussions on OECM governance and offer actionable recommendations for CBD Parties working towards advancing the OECM framework in their own contexts.

1 Derived from the National Workshop on Guidance on Aquatic OECM in Indonesia (Definition of Criteria & Mapping of Potential OECM Sites) for the Conservation of Ecosystems and Aquatic Biota in Indonesia (Lokakarya Nasional Panduan OECM Perairan di Indonesia (Definisi Kriteria & Pemetaan Lokasi Potensi OECM) untuk Konservasi Ekosistem dan Biota Perairan di Indonesia), held on 27 March 2024 by the Ministry of Marine Affairs and Fisheries (MMAF) in collaboration with the OECM Consortium (WWF, CTC, RARE, YPL, KI and Rekam).

METHODS

This paper employs a dual analytical approach to explore the enabling conditions for implementing community-led marine OECMs in Indonesia: a legal review (*de jure*) and a case study evaluation (*de facto*). The legal review assesses how Indonesia's regulatory frameworks align with the CBD criteria for OECMs (Table 1), while the case studies explore real-world applications of these frameworks.

Legal review

We analyse Indonesia's marine and forestry regulatory frameworks against the CBD criteria for OECMs (CBD, 2022). The legal review evaluated eight regulations, ranging from national acts to derivative regulations (Kelsen, 1991) selected based on their relevance to marine and natural resource governance in Indonesia and their potential to facilitate community-led marine OECMs' implementation. We assessed forestry as well as marine regulatory frameworks, as some marine ecosystems are governed under forestry regulations, including mangrove management and social forestry, which can cover mangrove areas. These regulations were analysed using thematic content analysis (Aynalem & Vibhute, 2005) to identify gaps, opportunities and conflicts in applying the OECM criteria as the basis of the analysis.

Figure 1. Location of Ccase Sstudies: Sinaka Village, West Sumatera; Sungai Piyai Village, Riau; and Akoon Village, Maluku (dark circles). Darker grey land area represents the Republic of Indonesia.

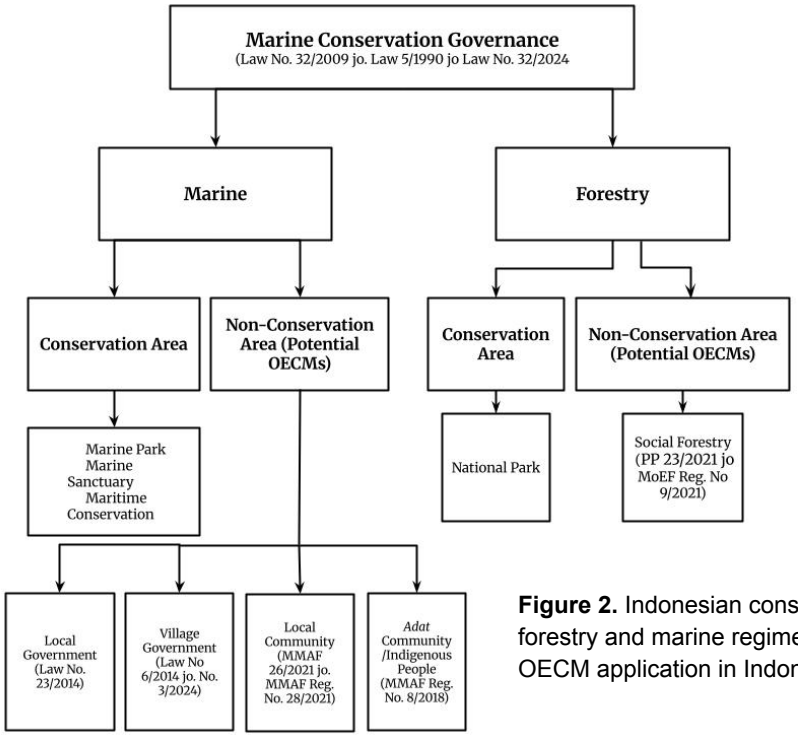


Figure 2. Indonesian conservation governance framework, including forestry and marine regimes potentially enabling community-led marine OECM application in Indonesia (see Supplementary Online Material)

Case study analysis

The case study component of the analysis assessed whether existing community-led marine management practices align with the OECM criteria. Three villages – Sinaka, Sungai Piyai and Akoon Villages – located in West Sumatra, Riau and Maluku Provinces (Figure 1), were selected as case studies based on their distinct local governance models and different regulatory pathways for potential OECM recognition. These case studies were analysed for their adherence to the OECM criteria, focusing on spatial boundaries, biodiversity outcomes, governance structures and socio-economic impacts. Data for the case study analysis were gathered through a literature review of the academic and grey literature, including project reports.

RESULTS

Marine conservation governance in Indonesia

Indonesia's marine conservation is governed under Law 32/2009 jo 5/1990 jo 32/2024, allowing forestry and marine affairs authorities to share responsibility for managing different types of conservation areas (Figure 2). This structure creates two main conservation pathways. Firstly, marine governance, which is overseen by the Ministry of Marine Affairs and Fisheries (MMAF)

Table 2. Existing Indonesian regulations that could potentially support OECM recognition and their degree of alignment with CBD criteria for OECMs

Regulations	Scheme	Criterion A Spatial management but not a protected area	Criterion B Active governance and management	Criterion C Biodiversity conservation effectiveness	Criterion D Socio-economic values
MMAF Reg. 26/2021	Rehabilitation of coastal ecosystems (e.g. mangroves, seagrass) with minimum two-year period	Yes (ecosystem management zone)	Yes (private/local community)	Partially (no guarantee beyond rehabilitation phase)	Partially (does not require the recognition of biodiversity-associated socio-cultural values)
MMAF Reg. 28/2021	PKKPRL[1] Permits for communities using marine space	Yes (utilisation area specifically for tourism)	Partially (governance body not explicitly mentioned and lacking guidelines for enforcement)	Partially (but limited to tourism and artificial reef preservation)	Partially (Unclear scope of permitted conservation activities)
MMAF Reg. 8/2018 jo MoHA Reg. No. 52/2014	Recognition of Indigenous (*adat)* community rights	Yes (utilisation area – *Adat* zone)	Yes (*Adat* community)	Yes (though not explicitly stated)	Yes (explicitly stated)
Law 6 2014 jo 1/2014	Village autonomy to manage natural resources	Yes (utilisation area for ecosystem management, fisheries or tourism)	Yes (village government)	Partially (in ecosystem management, fisheries, or tourism zones).	Yes (explicitly stated)
PP2 23/2021 jo MOEF Reg. No 9/2021	Social forestry	Yes (production forest for non-timber utilisation)	Yes (village government / community)	Yes (increase resource availability with potential biodiversity benefits)	Yes (for community needs, not commercial use)
Law 23/2014	Provincial authority to delegate marine management to communities	Yes (utilisation area for ecosystem management, fisheries or tourism)	Yes (village government / community)	Yes (based on cases from Southeast Sulawesi Province)	

While Indonesia does not yet have a regulatory framework specifically for OECMs, several existing regulations create the enabling conditions for their recognition. These regulations outline governance structures and spatial boundaries – both foundational for OECM designation – but they remain fragmented and insufficient in their current form. Instead, they govern areas designated for non-conservation purposes that nonetheless possess clear governance arrangements and the potential to contribute to in-situ biodiversity outcomes. This creates a legal opening for OECM recognition within Indonesia's current system, even in the absence of formal OECM provisions.

1 Spatial Utilisation Activity Agreement Approval

2 Government Regulation or *Peraturan Pemerinta*h (PP)

and local governments, covers marine parks, coastal sanctuaries and areas managed through *adat* and local community schemes. Secondly, forestry governance, which is managed by the Ministry of Forestry (MoF), includes mangrove conservation, marine zones within national parks, and social forestry programmes.

Indonesia embraces legal pluralism, where informal marine governance systems – such as *sasi* or community-agreed rules – are considered legitimate and coexist with formal structures, playing a vital role in regulating access and use through local norms, customary enforcement and collective decision-making (Dudayev et al., 2023). Beyond these formally recognised areas, both governance mechanisms have local conservation initiatives and community-led management schemes that, while not formal conservation areas, can contribute to biodiversity

conservation. These mechanisms provide important pathways for recognising potential community-led conservation efforts, including OECMs (Figure 2; Table 2). Although potential community-led OECMs are not explicitly recognised in Indonesian law, these existing legal frameworks in both marine and forestry regime provide possible pathways for their recognition, particularly within non-conservation areas that still contribute to biodiversity conservation.

Analysis of regulatory frameworks

Table 2 presents key existing regulations (see Supplementary Online Material) that could potentially enable the management of marine natural resources outside of formal conservation areas in Indonesia. These regulations have been analysed using CBD criteria for OECMs, focusing on their legal provisions for spatial delineation, biodiversity conservation, governance structures and socio-economic benefits.

While Indonesia does not yet have a regulatory framework specifically for OECMs, several existing regulations create the enabling conditions for their recognition. These regulations outline governance structures and spatial boundaries – both foundational for OECM designation – but they remain fragmented and insufficient in their current form. Instead, they govern areas designated for non-conservation purposes that nonetheless possess clear governance arrangements and the potential to contribute to in-situ biodiversity outcomes. This creates a legal opening for OECM recognition within Indonesia's current system, even in the absence of formal OECM provisions.

Several sectoral regulations in Indonesia provide partial enabling conditions for the recognition of community-led OECMs. These include regulations issued by the MMAF, MoF, Ministry of Villages Disadvantaged Regions and Transmigration, Ministry of Home Affairs (MoHA), as well as relevant local and village government frameworks. The regulations span areas such as ecosystem rehabilitation, village autonomy, social forestry, customary law and marine spatial planning. All align with Criterion A. Many also demonstrate alignment with one or more additional OECM criteria, particularly by enabling local governance (Criterion B) and supporting potential biodiversity conservation outcomes (Criterion C) and integrating socio-cultural values (Criterion D) (see Supplementary Online Material for full analysis of regulations).

CASE STUDIES

The analysis of the case studies – Sinaka, Akoon and Sungai Piyai Villages – demonstrates their alignment with the CBD criteria for OECMs. Each case showcases distinct governance models and conservation approaches, illustrating the role of community-led management in biodiversity conservation while supporting local livelihoods. Although formal OECM recognition remains in early stages in Indonesia, these cases show strong commitment to sustainable management practices that align with OECM principles (Table 3).

Sinaka Village

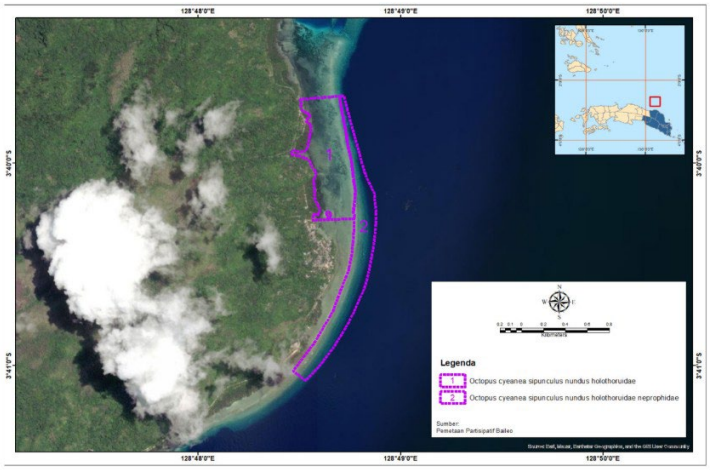
Sinaka Village, located in West Sumatra Province, lies within a utilisation area outside formal protected areas (Criterion A). The village has implemented community-led octopus fisheries management based on local agreements, an approach aligned with Criterion B, as it prevents overharvesting and supports marine biodiversity recovery. Between March 2021 and March 2022,[2] the community, especially women, conducted a data-driven assessment of octopus populations before introducing temporary fishing closures. Catch per unit effort (CPUE) data reflected an increase from 3.5 kg/

2 Data collection was conducted with the assistance and support of Yayasan Citra Mandiri Mentawai, a local civil society organisation (CSO) based in West Sumatra.

Table 3. Community-led marine management case studies' alignment with the CBD criteria for OECMs

Village	Criterion A Spatial management but not a protected area	Criterion B Active governance and management	Criterion C Biodiversity conservation effectiveness	Criterion D Socio-economic values
Sinaka Village	Yes (Utilisation Area Zone)	Yes (local community and village government)	Yes (but requires longer management evaluation)	Yes (but requires further evaluation)
Akoon Village	Yes (*Adat* Zone)	Yes (*adat* community)		Yes (managed for spiritual purposes)
Sungai Piyai Village	Yes (Production Forest Zone)	Yes (forestry community group)		Yes (follows traditional management practices but needs further evaluation)

Fishers and village government discussed locally-managed marine area regulation in Sinaka Village © Rayhan Dudayev



Marine Management Area in Akoon Village © Baileo Foundation

trip to 6.2 kg/trip between March and September 2022, demonstrating the effectiveness of the closures.

Governance in Sinaka is strengthened by Village Regulations based on the Mentawai Islands Regent Regulation No. 51/2019, ensuring clear management structures. The regulation grants local organisations (such as Gaba Ibara, Nulu Takep, and Saksak) the authority to enforce sustainable fishing practices and manage marine resources through temporary closures. By formalising these regulations, the village government has clarified governance structures and strengthened local authority, addressing ambiguities that previously hindered effective policy implementation. This governance structure mirrors the Managed Access with Reserves (MA+R) approach, which enables the effective management of coastal fisheries in an ecosystem context (Domondon et al., 2021). The management system also meets Criterion D, as it integrates traditional ecological knowledge and customary practices, resulting in the provision and protection of ecosystem services and associated socio-cultural values, for example ecosystem services provision ensuring food security. Sinaka exemplifies how small-scale fisheries governance can align with OECM principles, offering a model for community-led fisheries management that has historically[3] been constrained by centralised governmental control.

3 Bailey and Zerner (1992) examined community-led fisheries management in Indonesia and concluded that local management systems often face significant challenges due to centralised control by higher government authorities, which limits their effectiveness. Similarly, Satria and Matsuda (2004) also argue that centralisation, as enforced in Indonesia, has proven ineffective in addressing the complexities of local fisheries management, further underscoring the need for decentralised approaches.

Release of fisheries resource in Akoon Village by Raja (chief of Akoon Village) © Stevi Talahatu

Akoon Village

Located in Maluku Province, Akoon Village lies within a designated utilisation area outside formal protected areas (Criterion A). The village manages a 2.7-hectare area through a traditional management system termed '*Sasi laut*'. The system involves temporarily closing certain fishing areas (Adhuri et al., 2022) to ensure sustainable harvesting of species such as octopus, sea snail (*Trochus niloticus* – locally known as '*Lola*'), sea cucumber, lobster and marine worm (*Sipunculus nudus)* – locally known as '*Sia-Sia*') (Criterion C), all of which are crucial to the community's livelihood (Adhuri et al., 2022). Octopus, a key commodity in Akoon, is often harvested before maturity, threatening its sustainability. Similarly, Endangered, Threatened and Protected species such as *lola*, lobster, sea cucumber, and *sia-sia* have been overexploited, causing population declines and limiting community access to these culturally and economically significant resources (Adhuri et al., 2022).

The *Sasi* system, which enforces temporary closures, has contributed to improved stock availability in Akoon, as reflected in a 2020 monitoring period average CPUE of 2.01 kg/trip, representing a 66 per cent increase over the annual average of 1.21 kg/trip indicating measurable ecological outcomes from customary closures (Criterion C) (Rufiati et al., 2021). The governance structure under *Sasi* (Criterion B) is rooted in the *adat* village structure, with the *Kewang* (traditional environmental guards) overseeing resource use and compliance with sustainable practices. This governance is formalised through village-level regulations and aligns with national policy, particularly MMAF Regulation No. 8/2018, which acknowledges environmental management of *Adat* communities to manage their traditional territories. Akoon also meets Criterion D, as seasonal closures under the *Sasi* system sustain ecosystem functions while preserving cultural practices and livelihoods tied to marine biodiversity, including women's roles in gleaning, trading and data collection.

Symbol of Sasi (Prohibition to use resources) © Dedi Adhuri

Sungai Piyai Village

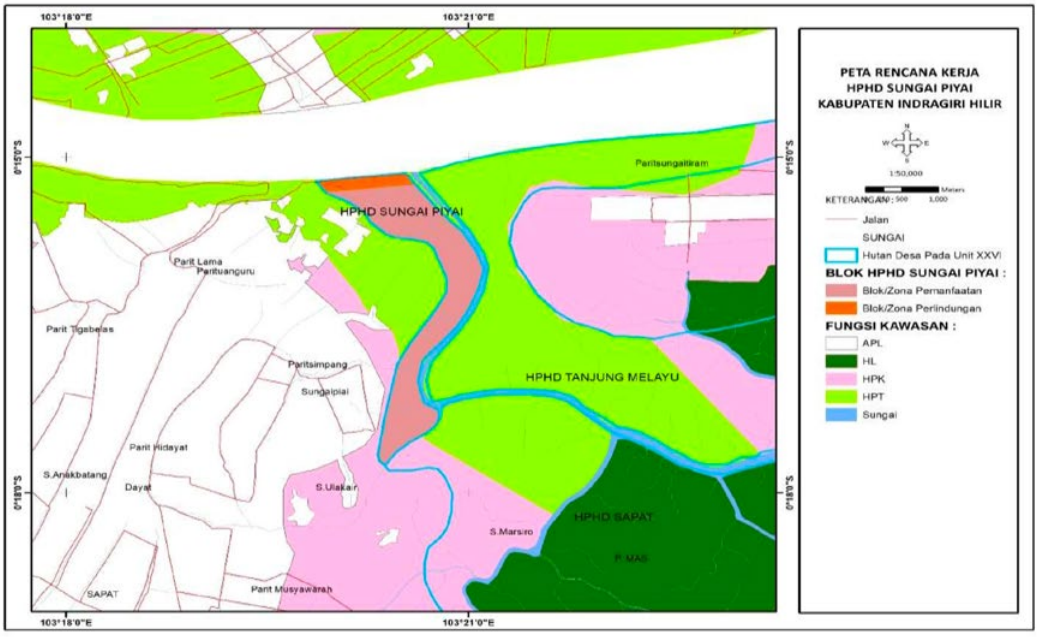
Sungai Piyai Village in Riau Province manages a 299-hectare social forestry area under the Village Forest scheme, designated by the MOF Decree[1]. Governed by the MoEF Regulation No. 9/2021, the scheme is located in a limited production forest (Criterion A), and integrates local community involvement through the Lembaga Pengelola Hutan Desa (LPHD). This community-led organisation enforces sustainable resource practices to prevent overfishing, restore mangroves and maintain ecological protection, aligning with Criterion C. Governance is formalised through LPHD bylaws, granting clear management authority (Criterion B). This governance model integrates traditional and modern conservation practices, ensuring that resource use remains sustainable. The social forestry scheme also delivers socio-economic benefits (Criterion D) by integrating sustainable fisheries, agroforestry and non-timber forest product harvesting, with women actively engaged in harvesting and processing shrimp, while LPHD collaborates with social forestry enterprises to train fishers in stock management and support local businesses. By balancing conservation with economic viability, Sungai Piyai demonstrates how social forestry can align with OECM criteria, though its applicability to marine and coastal OECMs remains underexplored.

1 SK.6730/MENLHK-PSKL/PKPS/PSL.0/12/2017

Sungai Piyai - Sapat Community-based Management Building © Galih Nur Fitriyani

Comparative synthesis

All three case studies demonstrated strong community-led governance (Criterion B), formalised through *adat* institutions, village regulations or social forestry schemes. Each also maintained clearly defined spatial boundaries outside formal protected areas (Criterion A). While environmental monitoring in Sungai Piyai was primarily based on local perceptions, mangrove



Gambar 3.1. Peta Rencana Kerja Wilayah Kelola HD Sungai Piyai.

Management Area and Plans in Sungai Piyai © Yayasan Mitra Insani

restoration efforts have contributed to improved habitat quality and fisheries recovery. In Sinaka, CPUE increased by 77 per cent, from 3.5 to 6.2 kg/trip within three months of implementing collaborative octopus closures, while in Akoon, CPUE rose by 66 per cent during the 2020 monitoring period under the *Sasi* system both demonstrating the ecological benefits of community-enforced seasonal closures (Criterion C) and acting as catalysts for broader management (MA+R) systems that warrant further evaluation (Domondon et al., 2021). Socio-economic benefits (Criterion D) were evident across all sites, where ecosystem services (e.g. sustainable fisheries, mangrove restoration) supported food security, diversified livelihoods, and women's active (though often informal) participation, despite formal state recognition of these contributions remaining limited. Common challenges include insufficient ecological data, unclear national reporting pathways, especially for marine-linked social forestry, and the need for stronger regulatory support. These cases collectively illustrate how community-led models can meaningfully contribute to OECM objectives alongside MPAs, especially in areas where local legitimacy and customary governance are prevalent.

Challenges for community-led OECMs in Indonesia and future directions

OECMs offer a promising approach to biodiversity conservation but face significant challenges in Indonesia. The newly enacted Conservation Law No. 32/2024 expands Indonesia's conservation framework by recognising Preservation Areas that can be considered as OECMs. However, Indigenous groups have challenged the law in the Constitutional Court, citing inadequate participation in its drafting and a lack of recognition for community-led conservation. The court has suspended the law's implementation, emphasising the need for a law that supports community-led conservation based on Free, Prior and Informed Consent (FPIC) (Constitutional Court of Indonesia, 2024).

Another major hurdle is obtaining site recognition, as even when areas meet OECM criteria, legal recognition remains challenging due to competing interests and the need for integration into marine spatial planning (MSP) and high-level political decisions – mirroring the struggles of customary marine areas (Dudayev et al., 2023; Queffelec et al., 2021), which may explain why most reported OECMs are governed by government (Jonas, Bingham et al., 2024). Community areas are often excluded from MSP because the process is typically technocratic, and conducted in provincial capitals, making it difficult for remote communities to participate – particularly when their areas lack formal recognition. Integrating community marine areas into national and provincial MSP through participatory approaches is a crucial enabling condition for community-led OECMs to ease tenure insecurity challenges.

A key challenge remains reconciling diverse conservation perspectives, as the Western-centric OECM framework may conflict with Indigenous and local community knowledge systems (Gurney et al., 2021; Gurney et al., 2023). To support the growing role of OECMs in Indonesia, we recommend three actions for the Government of Indonesia, NGOs and practitioners:

- Establish clear legal pathways to recognise community -led OECMs and secure local governance and tenure by adapting marine and forestry governance frameworks, integrating them into marine spatial planning, and institutionalising traditional knowledge.
- Recognise and support long-term socio-economic and cultural benefits of community-led OECMs and align them with local development goals.
- Enhance biodiversity monitoring in community-led areas to support locally relevant outcomes and national reporting.

CONCLUSION

We assessed the extent to which Indonesia's existing regulatory frameworks enable the recognition of community-led marine OECMs. Our analysis found that the regulatory frameworks, in principle, allow for *adat* and local communities to, in principle, govern OECMs in non-protected areas where governance structures and spatial demarcation already exist. This is particularly evident in ecosystem-based management, tourism, and fisheries zones. However, regulatory refinement is needed to strengthen alignment with OECM Criterion C (long-term biodiversity outcomes) and Criterion D (outcomes for associated ecosystem services and socio-cultural values), while Criteria A and B are generally aligned, with only one regulation requiring adjustment to fulfil Criterion B (active management and governance). In practice, many community-led marine areas already demonstrate positive socio-ecological outcomes. To fully unlock the potential of community-led OECMs, improvements are needed in legal and political recognition, consistent application of FPIC, and institutional support for capacity building and equitable governance and sharing of benefits and costs among diverse actors, including those that are often excluded (e.g. women, youth). Addressing these gaps will require not only regulatory reform but also a stronger empirical foundation to inform policy and implementation. Future research should examine how community-led OECMs perform over time in delivering biodiversity outcomes, and how these areas can be integrated meaningfully into Indonesia's national conservation strategy. Community-led marine OECMs represent a critical opportunity to advance more just, inclusive and sustainable approaches to conservation – both within Indonesia and globally. Ensuring their recognition and support is vital for realising the full ambition of Target 3 of the KM-GBF.

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RESUMEN

El Marco Global de Biodiversidad Kunming-Montreal (KM-GBF) del Convenio sobre la Diversidad Biológica hace un llamamiento a para conservar al menos el 30 por ciento del planeta mediante áreas protegidas u Otras Medidas Eficaces de Conservación Basadas en Áreas (OECMs) para 2030. Las OECM pueden complementar las áreas marinas protegidas al reconocer diversas formas de gestion que aportan beneficios a la biodiversidad independientemente de sus objetivos. Uno de los principales obstáculos para su aplicación es la falta de claridad jurídica sobre la identificación, el reconocimiento y el seguimiento de las OECM a escala nacional, que se puede consultar en. Para abordar esta cuestión, examina la normativa marina y forestal de Indonesia en el contexto de los criterios de las OECM, identificando oportunidades para adaptar las políticas existentes para apoyar el reconocimiento de las áreas marinas dirigidas por las comunidades como OECM. En general, estas normativas se ajustan bien al Criterio A (zona no protegida) y al Criterio B (gobernanza activa), pero siguen existiendo lagunas en que abordan la eficacia en la conservación de la biodiversidad (Criterio C) y los servicios ecosistémicos asociados y los valores socioculturales (Criterio D). Sobre la base de este análisis, evaluamos tres áreas marinas gestionadas localmente en Indonesia para valorar cómo el marco OECM podría apoyar las prácticas de gestión sobre el terreno. Estos estudios de caso mostraron eficacia de la conservación, con aumentos en la disponibilidad de recursos (por ejemplo, >65% más de capturas en dos sitios). Nuestros hallazgos subrayan el potencial de las OECM como modelos inclusivos y adaptables para avanzar en los objetivos de biodiversidad en Indonesia y más allá.

RÉSUMÉ

Le Cadre mondial pour la biodiversité Kunming-Montréal (KM-GBF) de la Convention sur la diversité biologique appelle à conserver au moins 30 % de la planète par le biais de zones protégées ou d'autres mesures efficaces de conservation par zone (OECM) d'ici à 2030. Les OECM peuvent compléter les aires marines protégées en reconnaissant les diverses formes de gestion qui apportent des avantages en termes de biodiversité, quels que soient leurs objectifs. L'un des principaux obstacles à leur mise en œuvre est le manque de clarté juridique OECM en ce qui concerne l'identification, la reconnaissance et le suivi des OECM au niveau national. Pour y remédier, nous examinons sur les réglementations maritimes et forestières indonésiennes dans le contexte des critères OECM, en identifiant les possibilités d'adapter les politiques existantes pour soutenir la reconnaissance des aires marines gérées par les communautés en tant qu'OECM. Ces réglementations s'alignent généralement bien sur le critère A (zone non protégée) et le critère B (gouvernance active), mais des lacunes subsistent sur en ce qui concerne l'efficacité de la conservation de la biodiversité (critère C) et des services écosystémiques associés ainsi que des valeurs socioculturelles (critère D). Sur la base de cette analyse, nous avons évalué trois zones marines gérées localement en Indonésie pour évaluer comment le cadre de l'OECM pourrait soutenir les pratiques de gestion sur le terrain. Ces études de cas ont montré l'efficacité de la conservation, avec des augmentations de la disponibilité des ressources (par exemple, >65% de prises en plus dans deux sites). Nos résultats soulignent le potentiel des OECM en tant que modèles inclusifs et adaptables pour faire progresser les objectifs de biodiversité en Indonésie et au-delà.

BOOK REVIEWS

The culture of conservation

A review of Mark Infield's Beautiful Beasts, Beautiful Lands – The fall and rise of an African national park, Whittles Publishing, Dunbeath (UK), 2024

Reviewed by Grazia Borrini-Feyerabend
Member of the Council of Elders of the ICCA Consortium (www.iccaconsortium.org)
gbf@pkfeyerabend.org

Conservation and human rights: An introduction

by Helen Newing, Amelia Arreguin Prado, Stephanie Brittain, Cathal Doyle, Justin Kenrick, Lassana Koné, Catherine Long, Adam Lunn, Anouska Perram, Lucy Radford, Tom Rowley and Helen Tugendhat, 2024

A review by Cristina Eghenter, WWF International

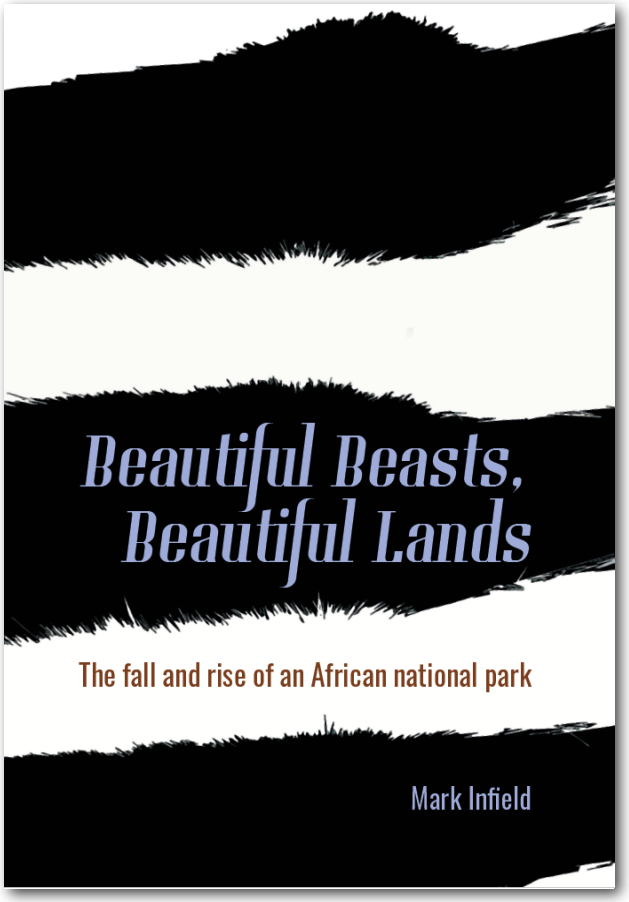
The culture of conservation

Elation, learning and challenging conclusions. You get all three, and more, from *Beautiful Beasts, Beautiful Lands* (BBBL), in which Mark Infield sums up 30 years in conservation.

In 1981, Mark is a volunteer counting wildlife in Uganda. His many hours of flying, blending boredom, excitement at the sight of wildlife and occasional nausea, are surely familiar to many biologists born well before the advent of drones. Flying high above the Rift Valley, Mark observes for the first time an emerald lake surrounded by forests, wetlands, grasslands and rolling hills; a landscape that will soon become Lake Mburo National Park. Seven years later, he will return as project staff to assist his colleague and soon-to-be friend Arthur Mugisha, of the Uganda National Parks. Together, they will work to "save the park".

In the intervening years, the country goes through a turbulent period. While Mark's wildlife data might have testified to the conservation value of the area, the creation of the park during the second presidency of Milton Obote, had serious social consequences. Obote had few supporters among the Bahima pastoralists, the traditional inhabitants of Mburo since the 15th century, and he saw no problem in driving them from their land to establish the park. In fact, he had already 'abolished' their Banyankole kingdom in the late 1960s, when Uganda became a republic under his first presidency.

For the Bahima, the Lake Mburo landscape is nothing less than *Nshara*, the heart of their traditional *Kuna Kurungi* (Beautiful Land) and their 1983 eviction was a disaster of immense proportions. A loss beyond the land, the cattle, or even the human lives taken among the resisters… it was a loss of Bahima cultural identity



and meaning in their lives. But not for long. Three years after the proclamation of the park, Obote's second rule came to a turbulent end when Yoweri Museveni led his guerrilla army to power. Taking advantage of the unrest, Bahima pastoralists, and agriculturalists with traditional claims to the area, reclaimed the land.

Mark details the complex history of wildlife in Mburo. Frankly, a good map and a timeline of the main events would have helped me, but it is still fascinating to read

about the sequence of environmental impacts that followed the first contacts with the British, the sand flea infestations, the colonial hunting regulations (in practice: sport hunting allowed, hunting for food prohibited) and the brutal attempts to regulate tsetse infestations (first by destroying all the vegetation and finally by spraying heavily with DDT). Then, just three years after being proclaimed a national park, and already reduced in size by Museveni, the area of Mburo was settled by farmers and most of its wildlife killed; the park seemed "lost".

Enter Arthur and Mark, and the Uganda National Park's idea to recover the park. Saving a park, in particular one that you might have helped create, is the dream of many conservationists. Arthur and Mark find the task exciting but certainly not easy or immediately rewarding. They have what is needed: a passion for nature, good training, and even an uncommon respect for the local communities. Yet, as they face the dilemmas familiar to all conservationists who try to provide solutions that benefit people while managing those protected areas that, by law, must be 'people-free', their ambitions are soon constrained. The very people removed from the park had shaped it over generations through cattle grazing, and they consider it the heart of their ancestral land. Conditions like these have broken many conservationists, turning some into cynics and a few even into arrogant racists. Not Arthur. Not Mark.

I remember vividly their story of the king of the Bahima, a cultured man who owned many Ankole cattle, the utmost reason for respect among his people. Ankole cattle are a breed selected for their beautiful deep chocolate-brown skin and white oversized horns shaped like lyres. The King said something along the lines of: "Nothing is more splendid than my kingdom when I contemplate it between the horns of my enchanting Ankole cattle". His words remain memorable for me. Why was this so touching? Perhaps the idea of the king who felt satisfied and at one with the wide landscape when meeting the gaze of his precious, dignified 'beast', similarly pleased and dignified? Or is it something Arthur and Mark tell me about the Bahima culture? Its serenity and pride, the silent breeze that I imagine to accompany some pastoralists as they lead their animals through a jade-green sea of tall, moist grasses…

Mark explains in the book how the Bahima understanding of *beauty* is clearly represented by their Ankole cattle and permeates the land they shaped. Mburo is the heart of the Bahima kingdom because its grasses and abundant water are the perfect habitat for the Ankole cattle, which, in turn, maintain it that way. The bond of the Bahima with nature is made up of aesthetics and love, of sustenance and meaning, of duty and detailed local knowledge. For me, this kind of bond as 'custodians' is stronger than if the Bahima owned the land or were legally in charge of managing it. It is a bond every bit as valid as arguments about species richness or the presence of management plans that many of my conservationist colleagues hail at meetings.

Mark recounts that he developed his love for nature and vocation for conservation as a young man in Britain. His appreciation for the diversity and beauty of life grew in delightful solitary exploration of temperate woodlands and ponds, framed by scientific and philosophical concepts and a dash of spirituality. But he didn't stop there. Reading BBBL, I discovered Mark's humility, intellectual dexterity and empathy. Only qualities like these allow us to disentangle ourselves from our own worldview and compare it with that of others. This is what he, honestly and thoughtfully, conveys in the book. And, by comparing his scientific-aesthetic-romantic bond with nature to that of the Bahima pastoralists, Mark manages to convey the moral ambiguities of any one vision prevailing over another. While his achievements bear witness to a genuine vocation and action in favour of nature, BBBL also shows him facing the complexity, uncertainty and abundance of perspectives that unfortunately elude many working in conservation. I will share some examples.

Mark notes that many of the management choices made for conservation are well-intentioned shots in the dark. For example, limiting cattle access to Mburo meant reducing the preferred habitats (short, thin grasses) of some birds, such as lapwings, very much part of desired local biodiversity. Who should decide if Mburo should be managed to optimise the habitat of the lapwings, or of the tourists who don't like to see the cattle?

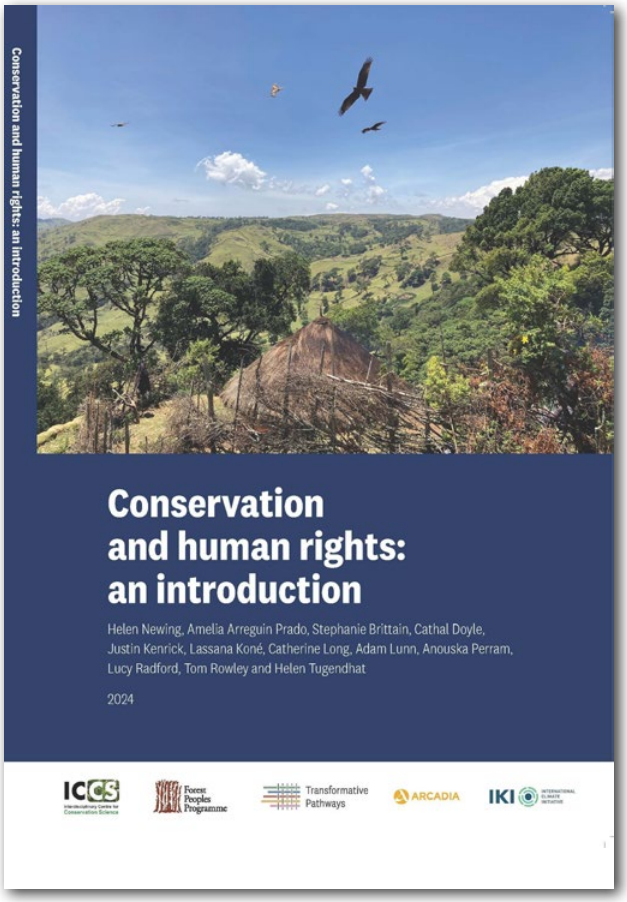
He stresses that the economic arguments for promoting and supporting conservation are often inflated and generally problematic. For example, the economic initiatives proposed to the local residents outside Mburo have never been entirely viable. Some local agreements worked out reasonably well, but revenues remained below the opportunity costs imposed by the park. Mark emphasises that the economic arguments in favour of conservation, so important and omnipresent today, can and do backfire. Fortunately, he also observes that the propensity of communities for economic values above all else is often just a prejudice held by outsiders.

Mark clearly explains that the factual reasons why a species, perhaps once rare and endangered, can be 'saved' in a specific place have much to do with emotions, aesthetics, spirituality, identity, history and culture. This is true even when there are economic values and

significant opportunity costs at stake. Non-economic values are invariably part of the bonds that unite a community and a territory. Such bonds continue to be severed when traditional communities are removed from their land, causing tragedies for people and nature. Mark passionately describes the bonds between the Mburo landscape and the traditional Bahima herders, but he also describes other communities facing a similar fate in Uganda. The traditional 'ridge leaders' who for centuries regulated both access and use in the intensely spiritual Ruwenzori mountains find themselves with no role and no respect when a national park is created there. The Batwa communities of Bwindi National Park, whose knowledge of the forest is unparalleled, cannot freely enter it.

Conservationists are increasingly realising the potential of territories of life conserved by their community custodians, so well embodied by the Bahima pastoralists in Mburo. The Bahima are now organised to interact with modern actors and could easily assume a valuable role as formal custodians of the park. Yet, as we read in the final pages of BBBL, this has not yet happened nor is it likely to happen soon.

As the coverage of protected areas continues to increase, the diversity and beauty of nature continues to decrease. Community support is crucial and remains rare. The obstacles are concrete, concerning the control of land, water and the gifts of nature, but are also cognitive, concerning the cultural hegemony of those who believe that science and economics are all we need. Few books are more useful than BBBL for shaking off this moral arrogance, for making us appreciate the variety of cultures and worldviews that give meaning to life. In my opinion, the challenging conclusion is that we need a new 'culture of conservation', capable of treating many cultures equally and engaging them all with full, and sincere, mutual respect.



Conservation and human rights: An introduction

There is no doubt that the tide has turned on the issue of human rights and conservation. Globally, there is increasing awareness that the pursuit of conservation goals is aligned with respecting, protecting and fulfilling the rights of people to secure their livelihoods, enjoy a healthy environment and live with dignity and free of discrimination. There is positive mutual support between conservation and human rights. While the pursuit of conservation goals can contribute to the realisation of several human rights, these rights can in turn enable more effective conservation outcomes. At the same time, certain efforts to conserve biodiversity and protect ecosystem functions can negatively affect people's rights to access land and use natural resources upon which they rely for economic and cultural needs. The loss of biodiversity and the adverse effects of climate change also undermine the full enjoyment of human rights and reinforce existing patterns of discrimination and inequality.

This is why *Conservation and human rights: An introduction* is an especially appropriate and much needed guide to understanding, respecting and promoting human rights in conservation and for accelerating an effective paradigm shift.

The publication is "*intended as a resource for conservation professionals who are interested to learn more about the relationship between conservation and human rights*". To best serve this purpose, it has been organised into three main parts. Firstly, it highlights the Kunming-Montreal Global Biodiversity Framework (KM-GBF) and gives a brief introduction to human rights and human rights-based approaches (HRBA). In the second part, it presents an overview of international norms and standards on human rights, including voluntary standards. In the third and final part, the guide outlines practical tools and approaches to apply human rights in conservation.

The topic of rights and conservation is not new as the authors readily acknowledge. Through the years, various publications and reports have looked at conservation and human rights through case studies and more explicit efforts to promote and standardise the issue, and encouraged the enforcement of policy and legal instruments, especially through the influential work of the Special Rapporteurs on Human Rights and the Environment. Early initiatives like the Conservation Initiative on Human Rights (2009) and momentous events like the World Parks Congress in Durban 2003, the World Parks Congress in Sydney 2014, and more recently the adoption of the CBD KM-GBF in December 2022, further contributed to mainstreaming human rights in the lexicon of conservation for transformative change and a new conservation ethic. This was enhanced by the adoption of the UN resolution on the human right to a clean, healthy and sustainable environment in 2022 and the resolution of the Human Rights Council on biodiversity and human rights in 2024. This added to an increasingly powerful narrative that conservation is legitimate and effective only if it is more equitable, inclusive and rights-based.

However, the authors note that many of the publications have been "*at the level of broad principles rather than their application in practice*"; they offer this guide to help fill this gap and address the still uneven awareness of human rights amongst conservationists. This is the greatest value of the guidance. Moreover, the publication responds to the commitment in the Human Rights Council resolution (57/28) to "*increase its support, technical assistance and capacity-building for States, with their consent, to implement approaches that integrate the promotion and protection of human rights in the context of conservation of biological diversity*".

The argument in favour of human rights in conservation is based on legal and ethical grounds. Equally, the argument is rooted in strong, empirical evidence that better ecological outcomes can be achieved and sustained when conservation actions respect, protect and fulfil human rights. Conservation actions need to uphold a minimal standard of 'do no harm', but also demonstrate the fundamental benefits of a human rights perspective. The guide clearly elucidates these various dimensions.

The section on 'The Nature of Human Rights' poses a highly debated question of whether rights may be restricted in the name of conservation. The authors make it very clear that rights cannot be treated as discretionary considerations, or restricted, unless in exceptional circumstances, and such restrictions are subject to conditions. The section 'What is a Human Rights-Based Approach' focuses on the responsibilities of non-state actors including conservation organisations as secondary duty-bearers. Core to HRBA in conservation is identifying and supporting rights-holders and working to strengthen measures to hold duty-bearers accountable for meeting their obligations towards rights-holders. Rights-holders in conservation include Indigenous Peoples, people of African descent, peasants, rural and local communities, women, environmental human rights defenders, youth and children, persons with disabilities and other groups in vulnerable situations. The conservation discourse is rapidly moving from a perspective founded on 'needs' to one framed in terms of 'rights'. Being in a position where we can fulfil our needs and be in control over decisions that affect our lives and sense of security about the future is something that conservation and conservationists can contribute to through the realisation of procedural and substantive rights.HRBA can provide us with instruments to address where injustice and biodiversity loss are pervasive and interlinked.

Fundamental human rights are enshrined in a range of human rights instruments, from voluntary standards to legally binding and ratified global conventions, policies and laws. PART 2 describes in comprehensive and compelling ways the spectrum of instruments available, including the emergence of the Rio Conventions. The interface of international law, national policies and jurisprudence, customary law and legal systems is at the core of HRBA. Conservationists might face challenges with inconsistencies of international vs national law, but the general rule in these cases is that they should apply all applicable legal standards, including customary law, especially when it comes to rights of Indigenous Peoples and local communities to land, territories, and natural resources. Conservationists should uphold the higher standards with a clear red line on human rights violations. An important discussion in PART 2 focuses on voluntary standards including certification schemes and

High Conservation Value (HCV) tools, and the overview of rights that are particularly relevant for conservation. The recent UNEP Core Human Rights Principles for Private Conservation Organizations and Funders are one additional example of voluntary standards for conservation (2024).

Notwithstanding the strong evidence and moral obligation for human rights in conservation, political will and capacity can lag and hamper the effective implementation of human rights-based conservation. A rights-based perspective radically changes the way we analyse a situation and engage with stakeholders and rights-holders. A problem is looked at from the point of view of a 'denial of right' and the solution proposed is one that facilitates the empowerment of rights-holders and improves their position in society. HRBA requires that we analyse and transform power structures, efface and redress the power gap. Fulfilling rights is fundamentally about transforming power relationships and enabling rights-holders to be aware, claim, exert and enjoy their rights. The authors are to be especially praised for attempting to lay out practical tools and approaches that can support primary and secondary duty-bearers in respecting, protecting and fulfilling rights in conservation in PART 3. The tools include (although not an exhaustive list) social and environmental safeguards, grievance mechanisms, FPIC, participatory mapping, participatory biodiversity monitoring, supporting community livelihoods and human–wildlife conflict. As the authors state, the tools are relevant for both the 'do no harm' and the 'promote rights' dimensions. Implementing HRBA is not limited to measures that help prevent violations of human rights but needs to be extended to efforts of embedding principles and social justice in conservation practices and programming.

This publication provides greatly needed and timely guidance, prodding us to move from a deeper understanding of legal and policy frameworks to a thoughtful and practical application of human rights in conservation. It is hoped that more guidelines, teachings and experiences will help further define the pathways to enabling a full paradigm shift in conservation.