ARTICLE TYPE: PERSPECTIVES

The rapid expansion of Madagascar's protected area system

Charlie J. Gardner[a*], *Martin E. Nicoll*[b], *Christopher Birkinshaw*[c], *Alasdair Harris*[d], *Richard E. Lewis*[e], *Domoina Rakotomalala*[b], *and Anitry N. Ratsifandrihamanana*[b]

[a] Durrell Institute of Conservation and Ecology (DICE), School of Anthropology and Conservation, University of Kent, Canterbury, Kent, CT2 7NR, UK

[b] WWF Madagascar, BP 738, Antananarivo 101, Madagascar

[c] Missouri Botanical Garden, Madagascar Research and Conservation Program, Lot VP 31, Anjohy Ankadibevava, BP 3391, Antananarivo 101, Madagascar

[d] Blue Ventures Conservation, Level 2 Annex, Omnibus Business Centre, 39-41 North Road, London, N7 9DP, UK.

[e] Durrell Wildlife Conservation Trust, Lot II Y 49 J Ampasanimalo, BP 8511, Antanananarivo 101, Madagascar

* Corresponding author, email: C.Gardner-399@kent.ac.uk. Tel: (+44) 7831 959073

Running head: Protected area evolution in Madagascar

Word count: 7198 (of which abstract 224, references 2062)

No. Figures: 2

No. Tables: 1

Abstract

Protected areas (PAs) are our principal conservation strategy and are evolving rapidly, but we know little about the real-world management and governance of new forms. We review the evolution of Madagascar's PA system from 2003-2016 based on our experience as practitioners involved. During this period PA coverage quadrupled and the network of strict, centrally-governed protected areas expanded to include sites characterized by: i) multiple-use management models in which sustainable extractive natural resource uses are permitted, ii) shared governance arrangements involving non-governmental organizations (NGOs) and local community associations, and iii) a management emphasis on livelihood-based approaches and social safeguards. We discuss the principal challenges for the effectiveness of the expanded system and detail management/policy responses. These include i) enhancing stakeholder participation, ii) ensuring financial sustainability, iii) enforcing rules, iv) ensuring the ecological sustainability of PAs faced with permitted resource extraction, v) reducing the natural resource dependence of local communities through transformative livelihood change, and vi) developing long-term visions to reconcile the differing objectives of conservation NGOs and other stakeholders. In general PAs have had limited effectiveness in reducing deforestation and other threats, which may be related to their rapid establishment processes and the complexity of management towards multiple objectives, coupled with insufficient resources. While Madagascar's achievements provide a basis for conserving the country's biodiversity, the challenge faced by its protected areas will continue to grow.

Keywords: community-based conservation; conservation finance; governance; Madagascar; poverty alleviation; sustainable natural resource use;

1. Introduction

Covering 15% of the Earth's land surface and 7% of the oceans, protected areas are our principal tool for the conservation of biodiversity (WDPA 2017). However, while much conservation research is carried out within PAs and the study of where to establish them – systematic conservation planning – has become one of the most sophisticated and productive fields of conservation science, we know little about the realities of PA governance and management on the ground. This knowledge gap is a particular concern given that recent decades have seen the rapid evolution of both protected area theory and practice (Dudley et al. 2014; Watson et al. 2014), and a progressive global transition from centrally-governed, strict PAs managed for conservation, research and recreation to more complex institutions managed for multiple conservation and human development objectives through shared-governance structures. For example, almost 40% of the global PA estate is now managed in multiple-use categories (i.e. IUCN category V and VI, UNEP-WCMC & IUCN 2016), and 25% of sampled PAs in sub-Saharan Africa are administered by institutions other than State agencies (Belle et al. 2015).

An improved understanding of contemporary PA management is critical to inform policy, orient research agendas and generate best practice, and thus ensure that PAs are effectively managed in line with requirements of the Convention on Biological Diversity (CBD; Watson et al. 2016). This is particularly pressing as CBD signatories are expected to extend their PA portfolios to cover 17% of terrestrial and inland water areas and 10% of coastal and marine areas by 2020 (CBD 2010). Meeting this target will require the most rapid expansion of PAs in history (Venter et al. 2014), and will largely be achieved through the establishment of multiple-use PAs (McDonald & Boucher 2011): however, recent experiences with the implementation of such PAs have been poorly documented. Here we review Madagascar's efforts to expand its protected area system in the period 2003-2016, based on our experience

in policy development and the establishment and management of a range of PAs throughout this period. Specifically, we highlight three major changes in PA policy and practice, and discuss six principal challenges for current and future management.

2. Madagascar context

Madagascar is a top global conservation priority with unparalleled endemism rates at species and higher taxonomic levels (Brooks et al. 2006). However the country is extremely poor, and its predominantly rural population is characterized by low education levels, rapid population growth and high dependence on small-scale agriculture and natural resources for food, fuel and income (Fritz-Vietta et al. 2011). As a result remaining forests are highly threatened by shifting cultivation, charcoal production, artisanal (and industrial) mining, bushmeat consumption and overharvesting of varied resources (Cook & Healy 2012; Fritz-Vietta et al. 2011; Razafimanahaka et al. 2012; Urech et al. 2015); wetlands are threatened by overfishing and riziculture (Bamford et al. 2017); and coastal areas suffer from overfishing, destructive fishing and environmental change (sedimentation, bleaching) (Harris 2011). Additionally, certain high-value resources (e.g. rosewood, tortoises, sea cucumber, shark fin) are increasingly threatened by intensive illegal collection fuelled by foreign (particularly Chinese) demand (e.g. Barrett et al. 2010; Cripps & Gardner 2016; Randriamalala & Liu 2010).

3. The 'Durban Vision'

Madagascar's first PAs were created in 1927 and the network had grown to 36 sites by the mid-1980s when a domestic environmental agenda began to emerge (Kull 2014). In 1991 the country launched Africa's first National Environmental Action Plan, created the para-statal ANGAP to oversee management of PAs, and began the promotion of community-based natural resource management (CBNRM, hereafter management transfers) through the transfer

of limited management rights from the State to local community user associations (Ferguson et al. 2014; Pollini et al. 2014). The policy focus shifted back to protected areas in 2003 when, at the Vth World Parks Congress in Durban, South Africa, the Malagasy government committed to tripling the coverage of the protected area network (the 'Durban Vision', Norris 2006).

At this time the PA network managed by ANGAP (subsequently renamed Madagascar National Parks (MNP)) consisted of 47 sites covering almost 1.7 million ha, and comprising 'strict' PAs in IUCN categories Ia (Strict Nature Reserve), II (National Park) and IV (Special Reserve) (Randrianandianina et al. 2003). Following the Durban declaration, five working groups consisting of government officials, foreign donors, NGOs and conservation scientists were established to advise on implementing the vision, specifically focusing on management and categorization, biodiversity prioritization, communication, legal frameworks, and funding (Corson 2014). Systematic conservation planning and gap analyses were carried out to prioritize where new PAs should be created (Kremen et al. 2008; Rasoavahiny et al. 2008), and a number of policy changes were implemented in line with IUCN recommendations. This resulted in the revision of the Protected Area Code (COAP) in 2008, although this legislation wasn't ratified until 2015 due to a political crisis in 2009 (see 6. Discussion).

New PAs are established in a two-step process. First, the organization leading the initiative (henceforth 'promoter') applies for temporary protection which grants sites a two-year moratorium on mining under the terms of an inter-ministerial decree negotiated between the Ministry of Environment, Ecology and Forests (MEEF) and the mining ministry. Promoters must then complete all consultative, administrative and planning procedures to gain definitive protection within this two-year window, or request an extension.

By 2016 the PA system had grown to 122 sites covering 7.1 million hectares, a growth of 416% in area (Fig. 1; Table 1). Five new PAs were established by MNP (which also expanded nine existing national parks), and the remaining new PAs are largely promoted by NGOs and managed in shared governance arrangements with local communities. Together these two sub-networks (henceforth MNP and non-MNP) form the Madagascar Protected Area System (SAPM), administered by the Biodiversity Conservation/Protected Area System Directorate (DBC/SAP) within MEEF, although marine PAs are administered under the Ministry of Fisheries.

[Figure 1]

[Table 1]

4. Evolving protected area policy and practice

4.1 Expanded objectives and categories

While the pre-2003 PAs were managed for conservation, research and (in category II sites) recreation (Randrianandianina et al. 2003), the objectives of SAPM were expanded to include the conservation of cultural heritage and the promotion of sustainable natural resource use for poverty alleviation and development, in addition to biodiversity conservation. This parallels global trends in PA policy (Dudley et al. 2014), and reflects the realization that most priority sites were home to significant populations of rural people that depended to varying extents on natural resources for their subsistence and income (e.g. Brown et al. 2011; Urech et al. 2015). Thus the establishment of strict PAs was seen as inappropriate for many sites, and the Protected Area Code was revised to permit the establishment of IUCN category III, V and VI

protected areas – multiple-use sites in which extractive resource use is permitted (Dudley 2008; Gardner 2011). Almost half of Madagascar's PAs are now proposed as IUCN category V[1] or VI (Table 1) and permit sustainable extractive use of natural resources, such as livestock grazing, fuelwood collection, charcoal production, commercial fishing and the harvest of wood, non-timber and marine products, according to a zoning plan.

4.2 Novel governance arrangements

Prior to 2003 all PAs in Madagascar were governed by the State through the parastatal ANGAP/MNP (though in some cases management was delegated to NGOs), but the Durban Vision saw the rewriting of the Protected Area Code to permit actors other than MNP to manage PAs within SAPM. All non-MNP PAs have a legally-recognized promoter, typically international or Malagasy NGOs (although also universities, mining companies and private individuals), but are generally governed in shared governance arrangements incorporating regional authorities and local communities (Alvarado et al. 2015; Virah-Sawmy et al. 2014). These governance structures have evolved iteratively: initial management plans of many sites proposed community management with promoter NGOs limited to a supporting role (e.g. Gardner et al. 2008), however this concealed the reality of promoters as de facto (co)managers, providing funds, technical capacity, direction and drive (Franks & Booker 2015). In response, promoters must now be named as delegated managers of new PAs with responsibility for management to the State.

Most non-MNP PAs have multi-tiered governance structures incorporating i) an executive body/platform comprising the promoter and a community-based management committee, and

[1] Category V PAs as implemented in Madagascar differ conceptually from the model envisaged in the IUCN definition, see Gardner (2011).

ii) an orientation committee grouping regional authorities, relevant ministries and private sector representatives (e.g. tourism operators) (Franks & Booker 2015; Virah-Sawmy et al. 2014). Depending on their size, the community-based management committees may be based around spatially-nested hierarchies with two or three tiers: local management units (LMUs) are responsible for their own territories but elect representatives to sit on a federation of LMUs covering a larger area, and this in turn may elect representatives to a central committee responsible for the whole protected area (Andriamalala & Gardner 2010; Virah-Sawmy et al. 2014) (Fig. 2). In some PAs the LMUs are composed of management transfers enacted under CBNRM legislation and thus have a legal standing beyond that of the PA. In all cases these structures remain 'works in progress', and will require years of further experimentation and evolution before they are optimized.

[Figure 2]

Beyond new protected areas, the MNP sub-network is also transitioning from State governance to shared governance between MNP and representatives of local communities (although some protected areas, such as Bezà Mahafaly, have been under shared governance since their establishment; Richard & Ratsirarson 2013). Typically, adjacent communities are integrated into two forms of structure, Local Park Committees (CLP) and a Protected Area Orientation and Support Committee (COSAP). CLPs are established for each community around a PA and are responsible for surveillance (and sometimes monitoring) of the neighboring park sector. They also participate in the prioritization of development interventions and submit project proposals to the COSAP for approval and funding. The COSAP, of which MNP is not a member, lobbies for the interests of local communities and other stakeholders around a PA: it is principally composed of CLP members, as well as

traditional leaders, civil society groups, municipal authorities, regional ministerial representatives (e.g. Environment, Health, Education), and private sector operators (Franks & Booker 2015; MNP 2014).

4.3 Management emphasis on livelihoods and social safeguards

The evolution of Madagascar's PAs epitomizes global trends of increasing integration of social and development objectives into PA management. Like mines and infrastructure projects, all PAs must carry out an environmental and social impact assessment for submission to the National Environment Office (ONE), and subsequently develop and implement a social safeguards plan (PSSE). The PSSE requires promoters to identify all parties likely to be affected by PA establishment, evaluate opportunity costs arising from access restrictions, and implement mitigation or livelihood improvement initiatives as compensation. However, the full implementation of these plans is a major challenge for promoters given the resources required (Virah-Sawmy et al. 2014).

Many non-MNP PAs go beyond ensuring safeguards to explicitly seek poverty alleviation as a core objective, and thus focus on livelihood-based interventions rather than 'traditional' habitat management and threat abatement activities (Gardner et al. 2013). For example, many new wetland and marine PAs ally conservation with community-based fisheries management, targeting the recovery of fast-growing species to help fishing-dependent communities derive meaningful livelihood benefits from resource management (Oliver et al. 2015), complemented with livelihood-based initiatives such as aquaculture development. In terrestrial sites, promoters have focused largely on tourism development and agricultural improvement (e.g. infrastructure rehabilitation, market development, enhanced production methods), in some cases involving development NGOs or private sector partnerships: for example the Malagasy

NGO Fanamby has created a company to broker markets and offer technical support to local cooperatives producing ginger, rice, vanilla, cashew nuts and essential oils around the Loky-Manambato and Anjozorobe-Angavo NPAs (Gardner et al. 2013). In other instances, promoter investments in local communities are channeled through innovative mechanisms such as community-based payments for ecosystem services (PES) schemes involving conservation agreements and inter-village competitions (Brimont & Bidaud 2014; Sommerville et al. 2010). In addition, Madagascar is a global leader in the expansion of 'population-health-environment' (PHE) initiatives associated with PAs, helping meet demand for healthcare services that is unmet by the State (Robson & Rakotozafy 2015). However while many PAs have made notable investments, the challenge of scaling up these interventions across the expanded network remains formidable.

5. Principal challenges

5.1 Enhancing participation

Despite the transition to shared governance of all Madagascar's PAs, the effective level of local community participation in decision-making may vary between sites. Negotiation processes during the establishment of new PAs may be skewed by power imbalances resulting from the strong mandate of MNP and NGO promoters to establish new PAs (Ferguson et al. 2014; Freudenberger 2010): as a result, field agents tasked with leading participatory planning exercises may in some cases have been incentivized to persuade rural communities to agree to pre-established plans rather than encourage participatory planning (Corson 2014; Marie et al. 2009). However, in other cases ongoing negotiations with communities have led to PA limits and zoning being considerably altered between the temporary and definitive protection stages, highlighting the effectiveness of consultation processes. Furthermore, village-level consultations take the traditional form and are dominated by older men, marginalizing groups

such as women, young people and migrants (Virah-Sawmy et al. 2014), while participation in PA governance may become a tool in intra-community struggles for power and access to resources. For example educated community members, often newcomers, may be better placed to participate and thus empower themselves at the expense of traditional leaders and other interest groups (Pollini et al. 2014). Beyond participation in governance, local communities are expected to play an active management role in many PAs, for example in surveillance and monitoring: however, the incentive for them to do so is not always apparent.

5.2 Ensuring financial sustainability

Of PAs with definitive protection, 13 currently lack active management and can be considered 'paper parks', while a further 29 'orphan' sites were adopted by NGO promoters but – for various reasons including rural insecurity, international donor withdrawal during the 2009-2014 political crisis (see 6. Discussion) and changing strategic priorities – never received PA status. This is a concern because the launch of a PA establishment process may encourage some people to claim land through deforestation, while abandonment partway through establishment may preclude future conservation initiatives due to diminished trust with local communities and authorities.

The future of established PAs depends on their financial sustainability, since PA effectiveness is dependent on investment in management (Geldmann et al. 2015; Gill et al. 2017). However traditional funding sources (multi- and bilateral donors, NGOs and private foundations) are unreliable due to changing donor priorities and periodic political crises resulting in international sanctions and major donor withdrawal (Nicoll & Ratsifandrihamanana 2014). In addition the unpredictable nature and short timescales (3-5 years) of grant-based funding are inappropriate and unrealistic for addressing the scale and complexity of contemporary PA

management challenges, while frequent changes in donor fashions can cut off support to established programs and thus encourage risk-averse management. Recognizing the need for financial stability and sustainability, a trust fund – the Madagascar Biodiversity and Protected Areas Foundation – was established in 2005 by the government, MNP and several NGOs to cover recurrent protected area management costs (MNP 2014). In 2014 capitalization of the fund reached US$52 million, generating revenues of US$2.16 million, used to fund the management of 27 PAs of which 70% managed by MNP. Nevertheless, the projected annual funding deficit of MNP protected areas for 2011–2015 was estimated at 7–8 million US dollars, while the cumulative funding deficit for a sample of 70 non-MNP sites was estimated to reach 25 million USD by 2015 (AGRECO 2012). Available funding has not kept pace with PA expansion, thus reducing per-unit resource availability: hence, the development and implementation of a sustainable financing strategy for SAPM remains a critical priority.

In recognition of this shortfall PA managers are adopting an entrepreneurial approach to diversify revenue streams. For example, many non-MNP sites are developing private sector partnerships and market-based mechanisms including PES, to support both livelihood interventions and management costs (Brimont & Bidaud 2014; Gardner et al 2013), while MNP is targeting strategic markets such as corporate social responsibility, mining offsets, ecotourism and tourism concessions, film and photography, research and carbon markets (MNP 2014). However, while funders increasingly demand the development of market-based approaches to promote financial sustainability, conservationists cannot always be reprogrammed successfully as entrepreneurs and there are no examples in Madagascar of PAs able to support themselves fully through such mechanisms. Since it remains highly unlikely that even the most well visited or entrepreneurial PAs will achieve full financial independence in the near future, the network's reliance on donor funding will probably grow further.

297

298 *5.3 Applying rules*

299 Law enforcement is a major challenge for PAs worldwide, particularly in developing
300 countries with limited resources for surveillance and enforcement and widely-dispersed,
301 resource-dependent rural populations and/or organized criminals seeking to illicitly extract
302 natural resources (Nolte 2016). The problem is exacerbated in Madagascar because neither
303 MNP nor new PA promoters have authority to apply the law: instead serious infractions
304 require managers to organize and fund field missions by a 'mixed brigade', comprising
305 members of the gendarmerie, MEEF agents, local and municipal authorities and members of
306 the PA management committee. The system is slow, costly and inefficient, and hampered by a
307 lack of capacity since PA expansion has not been accompanied by growth in the human
308 resources of the ministries responsible. Enforcement is further hampered by poor knowledge
309 of PA-related legislation, a lack of political will, and an ineffective judiciary that rarely
310 enforces penalties.

311

312 Partly in order to overcome this enforcement vacuum, protected areas legislation permits a
313 second form of regulation – *dina* – to be developed and applied by local community
314 managers. Traditionally referring to social norms that exist outside the formal legal system
315 (Henkels 1999), *dina* have been used to govern management transfers since the 1990s and
316 comprise locally-developed and applicable laws regulating resource use within any designated
317 area. Enforceable at the local level without recourse to any higher authority, *dina* may also be
318 ratified by a regional court to become legally-recognized by-laws, allowing recourse to the
319 judicial system when infractions cannot be resolved (Andriamalala & Gardner 2010). Despite
320 the nominally community-based development of *dina*, however, the articles often reflect the
321 interests of PA promoters rather than the communities: accordingly, community members

may be reluctant to apply rules against members of their own community, as well as powerless to do so against outsiders (Brimont & Bidaud 2014; Rabesahala Horning 2003). In response, *dina* application committees are now widely integrated into local governance structures.

5.4 Achieving ecological sustainability

The authorization of extractive resource uses within PA sustainable use zones means that new PAs will undergo continued ecosystem change and biodiversity loss (Gardner et al. 2016a; Nicoll & Ratsifandrihamanana 2014), even if managers are successful in preventing illicit threats[2]. This is a particular concern in terrestrial sites as most endemic vertebrates are obligate forest dwellers (Goodman & Benstead 2005) and forest degradation triggers community turnover from endemic to non-endemic species (Gardner 2009; Gardner et al. 2016a; Irwin et al. 2010).

In addition to reducing the natural resource dependence of local communities through livelihood-based interventions, minimizing the impacts of permitted activities will require the spatial configuration of sustainable use zones to ensure metapopulation persistence (Carroll et al. 2004), and applied ecological research into harvested species/systems to inform the development of low-impact extraction methods and quota setting. However few, if any, PAs are currently enabling science-based sustainable resource use. Participatory research into resource stocks and monitoring of their dynamics would help to overcome the low research capacity of many PAs, and provide a means to engage resource users in discussions over future use: however, appropriate resources to guide managers are not available. The absence

[2] Beyond permitted and illicit threats, many forest protected areas are extremely small and therefore also threatened in the long term by their small size and isolation.

of an evidence base increases the importance of effective monitoring programs, carried out as part of an adaptive management cycle, so that negative impacts can be identified and management adjusted accordingly. Given that ecological sustainability will not be the only management objective, particularly for resource users whose short-term interests may be best served by overharvesting, mechanisms for stakeholders to negotiate trade-offs will also need to be developed (McShane et al. 2010; Sayer et al. 2017).

5.5 Achieving transformative livelihood change

The objectives of SAPM state that PAs should support poverty alleviation and development through the sustainable use of natural resources. However, while such resources provide a valuable safety net for rural communities, dependence on them may form a poverty trap (Barrett et al. 2011). The management of new PAs tends to be landscape focused, but depends on the types of resource underpinning local livelihoods: wetland and coastal PAs focus on improving the productivity and sustainability of existing natural resource use (e.g. Oliver et al. 2015) since fisheries respond rapidly to management, while forest PAs seek to reduce natural resource use through interventions based on agriculture and tourism (Gardner et al. 2013; Pollini et al. 2014). There is no one-size-fits-all approach, and the participatory design of productive landscapes that meet the needs of all stakeholders should be considered a critical step in management planning, as well as fertile ground for research. Mobilizing sufficient resources to achieve transformative change at the necessary scale will be an enormous challenge for promoters, particularly in isolated landscapes comprising tens of thousands of households. Moreover, economic development around PAs may lead to increased demand for natural resources (e.g. Scales et al. 2017): in response, some NGO promoters are experimenting with conservation contracts whereby investments are conditional on behavior change or threat reduction.

370

371 *5.6 Stakeholder motivations and long-term vision*

372 While most new PAs involve local community structures, regional/municipal authorities and
373 in some cases the private sector in their governance, it would be naive to assume that all
374 stakeholders retain similar motivations for PA management: while promoters may champion
375 biodiversity conservation, other stakeholders (e.g. local communities) may prioritize revenue
376 generation and retain little interest in the PA other than for the opportunities they perceive
377 may arise from it. This raises concerns for the long-term governance of these sites given the
378 uncertain ability of NGOs to continue providing leadership, drive and resources indefinitely.
379 The long-term vision for non-MNP sites has not been clearly articulated in policy, but some
380 NGO promoters talk of exit strategies once co-managers have the necessary capacity.
381 However capacity does not equal motivation, so the transition from NGO-driven to truly
382 locally-managed PAs will require careful planning and implementation. One option may be to
383 convert the site-based teams of international NGOs into autonomous Malagasy NGOs.

384

385 **6. Discussion**

386 In 2003 the government of Madagascar made a major commitment to global biodiversity
387 conservation through the expansion of its PA system. The intervening period has seen rapid
388 change in the country's conception of PAs and the development of new protected area policy
389 and practice. The PA system has quadrupled in size, and the country's new PAs have led the
390 development of new management approaches and governance systems. These achievements
391 provide a model for other tropical developing countries seeking to expand their protected area
392 coverage to meet CBD goals.

393

394 The country's success in so rapidly quadrupling its protected area coverage is particularly
395 notable given the general lack of State capacity in rural areas, widespread corruption, the
396 absence of adequate land tenure systems (Ferguson et al. 2014), the extreme isolation of many
397 sites and the impacts of the 2009-2014 political crisis, amongst other factors. This period saw
398 central government functioning come to a virtual standstill, the suspension of funding from
399 numerous multilateral and bilateral donors, the decreasing rule of law, and consequent
400 increases in deforestation and other illegal activities both within and outside protected areas
401 (Barrett et al. 2010; Nicoll & Ratsifandrihamanana 2014; Schwitzer et al. 2014; Waeber et al.
402 2016). Nevertheless, NGO promoters were largely able to maintain funding and continued
403 their efforts in the field (where security permitted), the cohort of technicians within DSAP and
404 relevant ministries remained stable, and the Durban Vision continued to be implemented
405 despite a loss of momentum and the absence of governmental leadership.
406
407 While national progress towards CBD targets is measured by PA coverage, the convention
408 also stipulates that PAs should be effectively managed, and in this regard the performance of
409 SAPM remains a serious concern. While PAs have reduced deforestation at a system-wide
410 level (Eklund et al. 2016, though see Waeber et al. 2016), the effects are small and uneven,
411 and some regions and sites show no significant decline in deforestation rates despite PA
412 establishment. Forest clearance continues in both MNP and non-MNP sites (Allnutt et al.
413 2013; Grinand et al. 2013), while activities such as illegal logging (Randriamamala & Liu
414 2010), artisanal mining (Cook & Healy 2012) and bushmeat hunting (Razafimanahaka et al.
415 2012) remain widespread. Similarly, marine PAs have had limited effectiveness in reducing
416 overfishing, curbing the use of destructive fishing methods, deterring illegal foreign fleets, or
417 controlling the trade in threatened species (Cripps & Gardner 2016; Le Manach et al. 2012).
418 Across all biomes, evidence for the stabilization or recovery of key ecological or biodiversity

indicators within the new generation of PAs remains scarce. This reflects a growing body of recent research which finds little evidence for the effectiveness of community-based, extractive resource management in conserving biodiversity in terrestrial, developing world contexts, primarily due to the differences in objectives between local resource users and conservationists, and the inability of resource users to satisfy their needs through permitted sustainable uses (Rao et al. 2016; Sayer et al. 2017; Terborgh & Peres 2017). Likewise, there is mixed evidence for the effectiveness of multiple use (category V) protected areas in conserving biodiversity (Dudley et al. 2016).

While the limited effectiveness of PAs to date may not be surprising given the challenging social-ecological contexts in which they have been established, it may also have been influenced by the rapidity with which the system has been expanded. The time-bound nature of the Durban Vision (a "conservation emergency", Marie et al. 2009) meant that many PA establishment projects were launched without sufficient understanding of the socio-ecological contexts in which they are embedded, and have continued to be managed without an evidence base or adequate monitoring systems to ensure that implemented actions are effective. Indeed we often don't even know which species occur in newly established sites, and very little of the research conducted on Madagascar is relevant to management decision-making (Gardner 2012). The rush to establish new PAs also stretched the resources of promoter NGOs, undoubtedly compromising the rigor of participatory planning processes and potentially undermining the robustness and legitimacy of new institutions, which depend on the establishment of trustful and cooperative relationships between partners. While the Durban Vision provided an unprecedented opportunity to create new PAs, it may inadvertently have incentivized quantity over quality in PA establishment processes.

Alternatively, the limited success of many PAs may be the result of them attempting to do too much with insufficient expertise and resources, and thus spreading their efforts too thinly. Protected area promoters now seek not only to prevent environmental change but also reverse the socio-economic trajectories of impoverished communities living over vast, isolated landscapes. To do so successfully requires substantial resources, but promoters instead compete for donor funds in a scramble that may see the same site simultaneously characterized as a climate adaptation, food security, poverty alleviation, sustainable livelihoods, gender empowerment, carbon sequestration or biodiversity conservation initiative. While financially expedient, rebranding PAs in this way has brought new challenges for the sector, not least in meeting expectations of a new generation of donors for development outcomes which PA managers have little experience of delivering or measuring.

The establishment of protected areas is a complex and lengthy process, and it is still early to be judging the success of the Durban Vision in terms of its conservation and development objectives. What is clear is that the challenge continues to grow, as Madagascar has changed greatly since the Vision was launched – the economy has weakened further, the rule of law has decreased, the human population has grown by a third, and climate change continues to undermine rural livelihoods and increase dependence on the safety net provided by natural resources (Gardner et al. 2016b; Harvey et al. 2014). As land and resources continue to be set aside within PAs and degradation outside them continues, physical and political pressure on the country's PAs is likely to grow, so the challenge faced by the government, NGOs and their rural community partners is greater than ever. However the conservation sector's achievements since 2003 provide a robust platform from which to build.

In conclusion, Madagascar's experiences show that tropical developing countries can rapidly expand their protected area networks to meet CBD targets, and that this can be achieved primarily by non-State actors. Multiple-use PA categories and shared governance arrangements have an important role to play in such expansion because they help minimise conflict with other stakeholders and reduce the management burden on the State. However, such institutions are necessarily complex, and the simultaneous pursuit of development and conservation goals is an enormous (and ambitious) challenge if promoters lack sufficient resources to adequately address the root causes of biodiversity loss. Given this, it is important that equal attention is paid to PA effectiveness as it is to PA coverage, in post-2020 CBD targets and more generally.

Acknowledgements

We are thankful to the Editor and three anonymous reviewers for thoughtful comments which helped us strengthen the manuscript.

Conflicts of interest

All authors currently or previously worked with organisations involved in the expansion and management of Madagascar's protected areas, and these experiences provide the bulk of the data on which the paper is built. However there are no conflicts of interest influencing the paper.

Role of the funding source

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

493 **References**

494 AGRECO. 2012. Analyse des coûts et sources de financement du système des aires protégées
495 de Madagascar (Octobre 2010 – Janvier 2012). AGRECO, Antananarivo.
496
497 Allnutt TF, Asner GP, Golden CD, Powell GVN. 2013. Mapping recent deforestation and
498 forest disturbance in northeastern Madagascar. Tropical Conservation Science 6: 1–15.
499
500 Alvarado ST, Buisson E, Carrière SM, Rabarison H, Rajeriarison C, Andrianjafy M,
501 Randriatsivery FM, Rasoafaranaivo MH, Raharimampionona J, Lowry II PP, et al. 2015.
502 Achieving sustainable conservation in Madagascar: the case of the newly established Ibity
503 Mountain protected area. Tropical Conservation Science 8: 367–395.
504
505 Andriamalala G, Gardner CJ. 2010. L'utilisation du dina comme outil de gouvernance des
506 ressources naturelles: leçons tirés de Velondriake, sud-ouest de Madagascar. Tropical
507 Conservation Science 3:447–472.
508
509 Bamford AJ, Razafindrajao F, Young RP, Hilton GM 2017. Profound and pervasive
510 degradation of Madagascar's freshwater wetlands and links with biodiversity. PLoS One 12:
511 e0182673.
512
513 Barrett MA, Brown JL, Morikawa MK, Labat JN, Yoder AD. 2010. CITES designation for
514 endangered rosewood in Madagascar. Science 328: 1109–1110.
515
516 Barrett CB, Travis AJ, Dasgupta P. 2011. On biodiversity conservation and poverty traps.
517 Proceedings of the National Academy of Sciences, USA 108: 13907–13912.

518

519 Belle E, Wicander S, Bingham H, Shi Y. 2015. Governance of protected areas in Africa: a
520 global review. UNEP-WCMC, Cambridge.

521

522 Brimont L, Bidaud C. 2014. Incentivising forest conservation: payments for ecosystem
523 services and reducing carbon emissions from deforestation. Pages 299–319 in Scales IR,
524 editor. Conservation and environmental management in Madagascar. Routledge, Abingdon.

525

526 Brooks TM, Mittermeier RA, da Fonseca GAB, Gerlach J, Hoffmann M, Lamoreux JF,
527 Mittermeier CG, Pilgrim JD, Rodrigues ASL. 2006. Global biodiversity conservation
528 priorities. Science 313: 58–61.

529

530 Brown KA, Flynn DFB, Abram NK, Ingram JC, Johnson SE, Wright P. 2011. Assessing
531 natural resource use by forest-reliant communities in Madagascar using functional diversity
532 and functional redundancy metrics. PLoS ONE 6: e24107. DOI:
533 10.1371/journal.pone.0024107.

534

535 Carroll C, Noss RF, Paquet PC, Schumaker NH. 2004. Extinction debt of protected areas in
536 developing landscapes. Conservation Biology 18: 1110–1120.

537

538 CBD. 2010. Decision adopted by the Conference of the Parties to the Convention on
539 Biological Diversity at its tenth meeting [Decision X/2] Nagoya, Aichi Prefecture, Japan, 18–
540 29 October 2010. CBD Secretariat, Montreal.

541

542 Cook R, Healy T. 2012. Artisanal and small-scale mining in and around protected areas and
543 critical ecosystems project (ASM-PACE). Madagascar case study: artisanal mining rushes in
544 protected areas and a response toolkit. WWF and Estelle Levin, Ltd., Gland.
545
546 Corson C. 2014. Conservation politics in Madagascar: the expansion of protected areas. Pages
547 193–215 in Scales IR, editor. Conservation and environmental management in Madagascar.
548 Routledge, Abingdon.
549
550 Cripps G, Gardner CJ. 2016. Human migration and marine protected areas: insights from
551 Vezo fishers in Madagascar. Geoforum 74: 49–62.
552
553 Dudley N. 2008. Guidelines for applying protected area management categories. IUCN,
554 Gland.
555
556 Dudley N, Groves C, Redford KH, Stolton S. 2014. Where now for protected areas? Setting
557 the stage for the 2014 World Parks Congress. Oryx 48: 496–503.
558
559 Dudley N, Phillips A, Amend T, Brown J, Stolton S. 2016. Evidence for biodiversity
560 conservation in protected landscapes. Land 5: 38.
561
562 Eklund J, Blanchet FG, Nyman J, Rocha R, Virtanen T, Cabeza M. 2016. Contrasting spatial
563 and temporal trends of protected area effectiveness in mitigating deforestation in Madagascar.
564 Biological Conservation 203: 290–297.
565

566 Ferguson B, Gardner CJ, Andriamarovololona MM, Healy T, Muttenzer F, Smith S, Hockley
567 N, Gingembre M. 2014. Governing ancestral land in Madagascar: have policy reforms
568 contributed to social justice? Pages 63–93 in Sowman M, Wynberg R, editors. Governance
569 for justice and environmental sustainability: lessons across natural resource sectors in Sub-
570 Saharan Africa. Routledge, London.
571
572 Franks P, Booker F. 2015. Shared governance of protected areas in Africa: case studies,
573 lessons learnt and conditions of success. IIED, London.
574
575 Freudenberger KS. 2010. Paradise Lost? Lessons from 25 Years of USAID Environment
576 Programs in Madagascar. International Resources Group, Washington DC.
577
578 Fritz-Vietta NVM, Ferguson HB, Stoll-Kleemann S, Ganzhorn JU. 2011. Conservation in a
579 biodiversity hotspot: insights from cultural and community perspectives in Madagascar. Pages
580 209–233 in Zachos FE, Habel JC, editors. Biodiversity hotspots: distribution and protection of
581 conservation priority areas. Springer, Berlin.
582
583 Gardner CJ. 2009. A review of the impacts of anthropogenic habitat change on terrestrial
584 biodiversity in Madagascar: Implications for the design and management of new protected
585 areas. Malagasy Nature 2: 2–29.
586
587 Gardner CJ. 2011. IUCN management categories fail to represent new, multiple-use
588 protected areas in Madagascar. Oryx 45: 336–346.
589
590 Gardner CJ. 2012. Social learning and the researcher-practitioner divide. Oryx 46: 313–314.

Gardner CJ, Ferguson B, Rebara F, Ratsifandrihamanana AN. 2008. Integrating traditional values and management regimes into Madagascar's expanded protected area system: the case of Ankodida. Pages 92–103 in Mallarach JM, editor. Protected landscapes and cultural and spiritual values. Kasparek-Verlag, Heidelberg.

Gardner CJ, Nicoll ME, Mbohoahy T, Oleson KLL, Ratsifandrihamanana AN, Ratsirarson J, René de Roland LA, Virah-Sawmy M, Zafindrasilivonona B, Davies ZG 2013. Protected areas for conservation and poverty alleviation: experiences from Madagascar. Journal of Applied Ecology 50: 1289–1294.

Gardner CJ, Jasper LD, Eonintsoa C, Duchene JJ, Davies ZG. 2016a. The impact of natural resource use on bird and reptile communities within multiple-use protected areas: evidence from Madagascar. Biodiversity and Conservation 25: 1773–1793.

Gardner CJ, Gabriel FUL, St John FAV, Davies ZG. 2016b. Changing livelihoods and protected area management: a case study of charcoal production in south-west Madagascar. Oryx 50: 495–505.

Geldmann J, Coad L, Barnes M, Craigie ID, Hockings M, Knights K, Leverington F, Cuadros IC, Zamora C, Woodley S et al. 2015. Changes in protected area management effectiveness over time: a global analysis. Biological Conservation 191: 692–699.

614 Gill DA, Mascia MB, Ahmadia GN, Glew L, Lester SE, Barnes M, Craigie I, Darling ES,
615 Free CM, Geldmann J, et al. 2017. Capacity shortfalls hinder the performance of marine
616 protected areas globally. Nature 543: 665–669.
617
618 Goodman SM, Benstead JP. 2005. Updated estimates of biotic diversity and endemism for
619 Madagascar. Oryx 39: 73–77.
620
621 Grinand C, Rakotomalala F, Gond V, Vaudry R, Bernoux M, Vielledent G. 2013. Estimating
622 deforestation in tropical humid and dry forests in Madagascar from 2000 to 2010 using multi-
623 date Landsat satellite images and the random forests classifier. Remote Sensing of
624 Environment 139: 68–80.
625
626 Harris A. 2011. Out of sight but no longer out of mind: a climate of change for marine
627 conservation in Madagascar. Madagascar Conservation & Development 6: 7–14.
628
629 Harvey C, Rakotobe ZL, Rao NS, Dave R, Razafimahatratra H, Rabarijohn RH, Rafaora H,
630 MacKinnon JL. 2014. Extreme vulnerability of smallholder farmers to agricultural risks and
631 climate change in Madagascar. Philosophical Transactions of the Royal Society B 369:
632 20130089. DOI: 10.1098/rstb.2013.0089.
633
634 Henkels DM. 1999. Une vue de près du droit de l'environnement malgache. African Studies
635 Quarterly 3: 39–59.
636

637 Irwin MT, Wright PC, Birkinshaw C, Fisher BL, Gardner CJ, Glos J, Goodman SM, Loiselle
638 P, Rabeson P, Raharison JL, et al. 2010. Patterns of species change in anthropogenically
639 disturbed habitats of Madagascar. Biological Conservation 142: 2351–2362.
640
641 Kremen C, Cameron A, Moilanen A, Phillips SJ, Thomas CD, Beentje H, Dransfield J, Fisher
642 BL, Glaw F, Good TC, et al. 2008. Aligning conservation priorities across taxa in Madagascar
643 with high-resolution planning tools. Science 320: 222–226.
644
645 Kull CA. 2014. The roots, persistence, and character of Madagascar's conservation boom.
646 Pages 146–171 in Scales IR, editor. Conservation and environmental management in
647 Madagascar. Routledge, Abingdon.
648
649 Le Manach F, Gough C, Harris A, Humber F, Harper S, Zeller D. 2012. Unreported fishing,
650 hungry people and political turmoil: the recipe for a food crisis in Madagascar? Marine Policy
651 36: 218–225.
652
653 Marie CN, Sibelet N, Dulcire M, Rafalimaro M, Danthu P, Carrière SM. 2009. Taking into
654 account local practices and indigenous knowledge in an emergency conservation context in
655 Madagascar. Biodiversity and Conservation 18: 2759–2777.
656
657 McDonald RI, Boucher TM. 2011. Global development and the future of the protected area
658 strategy. Biological Conservation 144: 383–392.
659
660 McShane TO, Hirsch PD, Trung TC, Songorwa AN, Kinzig A, Monteferri B, Mutekanga D,
661 Thang HV, Dammert JL, Pulger-Vidal M, et al. 2010. Hard choices: making trade-offs

662 between biodiversity conservation and human well-being. Biological Conservation 144: 966–
663 972.
664
665 MNP. 2014. Madagascar National Parks protected areas network strategic management plan
666 2014-2024. MNP, Antananarivo
667
668 Moat J, Smith P. 2007. *Atlas of the Vegetation of Madagascar*. Kew Publishing, Kew.
669
670 Nicoll M, Ratsifandrihamanana N. 2014. The growth of Madagascar's protected areas system
671 and its implications for tenrecs (Afrosoricida, Tenrecidae). Afrotherian Conservation 10: 4–8.
672
673 Nolte C. 2016. Identifying challenges to enforcement in protected areas: empirical insights
674 from 15 Colombian parks. Oryx 50: 317–322.
675
676 Norris S. 2006. Madagascar defiant. BioScience 52: 960–965.
677
678 Oliver TA, Olesen KLL, Ratsimbazafy H, Raberinary D, Benbow S, Harris A. 2015. Positive
679 catch and economic benefits of periodic octopus fishery closures: do effective, narrowly
680 targeted actions 'catalyze' broader management? PLoS One 10: e0129075.
681
682 Pollini J, Hockley N, Muttenzer FD, Ramamonjisoa BS. 2014. The transfer of natural
683 resource management rights to local communities. Pages 172–192 in Scales IR, editor.
684 Conservation and environmental management in Madagascar. Routledge, London.
685

686 Rabesahala Horning N. 2003. How rules affect conservation outcomes. Pages 146–153. In
687 Goodman SM, Benstead JP, editors. The natural history of Madagascar. University of
688 Chicago Press, Chicago.
689
690 Randriamalala H, Liu Z. 2010. Rosewood of Madagascar: between democracy and
691 conservation. Madagascar Conservation & Development 5: 11–22.
692
693 Randrianandianina BN, Andriamahaly LR, Harisoa FM, Nicoll ME. 2003. The role of
694 protected areas in the management of the island's biodiversity. Pages 1423–1432 in
695 Goodman SM, Benstead JP editors. The natural history of Madagascar. University of Chicago
696 Press, Chicago.
697
698 Rao M, Nagendra H, Shahabuddin G, Carrasco LR. 2016. Integrating community-managed
699 areas into protected area systems: the promise of synergies and the reality of trade-offs. Pages
700 169–189 in Joppa LN, Baillie JEM, Robinso JG, editors. Protected areas: are they
701 safeguarding biodiversity? Wiley Blackwell, Chichester.
702
703 Rasoavahiny L, Andrianarisata M, Razafimpahanana A, Ratsifandrihamanana AN. 2008.
704 Conducting an ecological gap analysis for the new Madagascar protected area system. Parks
705 17: 12–21.
706
707 Razafimanahaka JH, Jenkins RKB, Andriafidison D, Randrianandrianina F,
708 Rakotomboavonjy V, Keane A, Jones JPG. 2012. Novel approach for quantifying illegal
709 bushmeat consumption reveals high consumption of protected species in Madagascar. Oryx
710 46: 584–592.

Richard AF, Ratsirarson J. 2013. Partnership in practice: making conservation work at Bezà Mahafaly, southwest Madagascar. Madagascar Conservation & Development 8:12–20.

Robson L, Rakotozafy F. 2015. The freedom to choose: integrating community-based reproductive health services with locally led marine conservation initiatives in southwest Madagascar. Madagascar Conservation & Development 10: 6–12.

Sayer J, Margules C, Boedhihertono AK. 2017. Will biodiversity be conserved in locally-managed forests? Land 6: 6.

Scales I, Friess D, Glass L, Ravaoarinorotsihoarana L. 2017. Rural livelihoods and mangrove degradation in southwestern Madagascar: lime production as an emerging threat. Oryx: DOI: https://doi.org/10.1017/S0030605316001630.

Schwitzer C, Mittermeier RA, Johnson SE, Donati G, Irwin M, Peacock H, Ratsimbazafy J, Razafindramanana J, Louis Jr. EE, Chikhi L, et al. 2014. Averting lemur extinctions amid Madagascar's political crisis. Science 343: 842–843.

Sommerville M, Milner-Gulland EJ, Rahajaharison M, Jones JPG. 2010. Impact of a community-based payment for environmental services intervention on forest use in Menabe, Madagascar. Conservation Biology 24: 1488–1498.

Terborgh J, Peres CA. 2017. Do community-managed forests work? A biodiversity perspective. Land 6: 22.

Urech ZL, Zaehringer JG, Rickenbach O, Sorg JP, Felber HR. 2015. Understanding deforestation and forest fragmentation from a livelihood perspective. Madagascar Conservation & Development 10: 67–76.

Venter O, Fuller RA, Segan DB, Cawardine J, Brooks T, Butchart SHM, Di Marco M, Iwamura T, Joseph L, O'Grady D, et al. 2014. Targeting global protected area expansion for imperiled biodiversity. PLoS Biol 12: e1001891. DOI: 10.1371/journal.pbio.1001891.

Virah-Sawmy M, Gardner CJ, Ratsifandrihamanana AN. 2014. The Durban Vision in practice: experiences in the participatory governance of Madagascar's new protected areas. Pages 216–251 in Scales IR, editor. Conservation and environmental management in Madagascar. Routledge, Abingdon.

Waeber PO, Wilmé L, Mercier JR, Camara C, Lowry II PP. 2016. How effective have thirty years of internationally driven conservation and development efforts been in Madagascar. PLoS ONE 11: e0161115. DOI: 10.1371/journal.pone.0161115.

Watson JEM, Dudley N, Segan DB, Hockings M. 2014 The performance and potential of protected areas. Nature 515: 67–73.

Watson JEM, Darling ES, Venter O, Maron M, Walston J, Possingham HP, Dudley N, Hockings M, Barnes M, Brooks TM. 2016. Bolder science needed now for protected areas. Conservation Biology 30: 243–248.

761 WDPA (World Database on Protected Areas). 2017. Increased growth of protected areas in
762 2017. https://www.protectedplanet.net/c/increased-growth-of-protected-areas-in-2017.
763 Accessed 22nd December 2017.

Tables

Table 1. Number and area of protected areas in Madagascar in March 2017, by IUCN category. The Madagascar Protected Area System (SAPM) comprises sites managed by Madagascar National Parks (MNP) and the non-MNP network of new protected areas. Numbers in brackets refer to protected areas that currently lack active management and are considered 'paper parks'.

	All SAPM		**MNP network**		**Non-MNP network**	
	No. Sites	**Area (ha)**	**No. Sites**	**Area (ha)**	**No. Sites**	**Area (ha)**
Cat I	1	2228	1	2228		
Cat II	28	2,617,847	27	2,245,377	1	372,470
Cat III	2	4807			2	4807
Cat IV	23(3)	408,231.9 (53,470)	22 (3)	407,461.9 (53,470)	1	770
Cat V	39	2,617,638.4			39	2,617,638.4
Cat VI	17	865,549.5			17	865,549.5
No category	12 (10)	566, 224 (484,517)			12 (10)	566, 224 (484,517)
Total	**122 (13)**	**7,082,525.8 (537,987)**	**50 (3)**	**2,655,066.9 (53,470)**	**72 (10)**	**4,427,458.9 (484,517)**

774 **Figure legends**

775

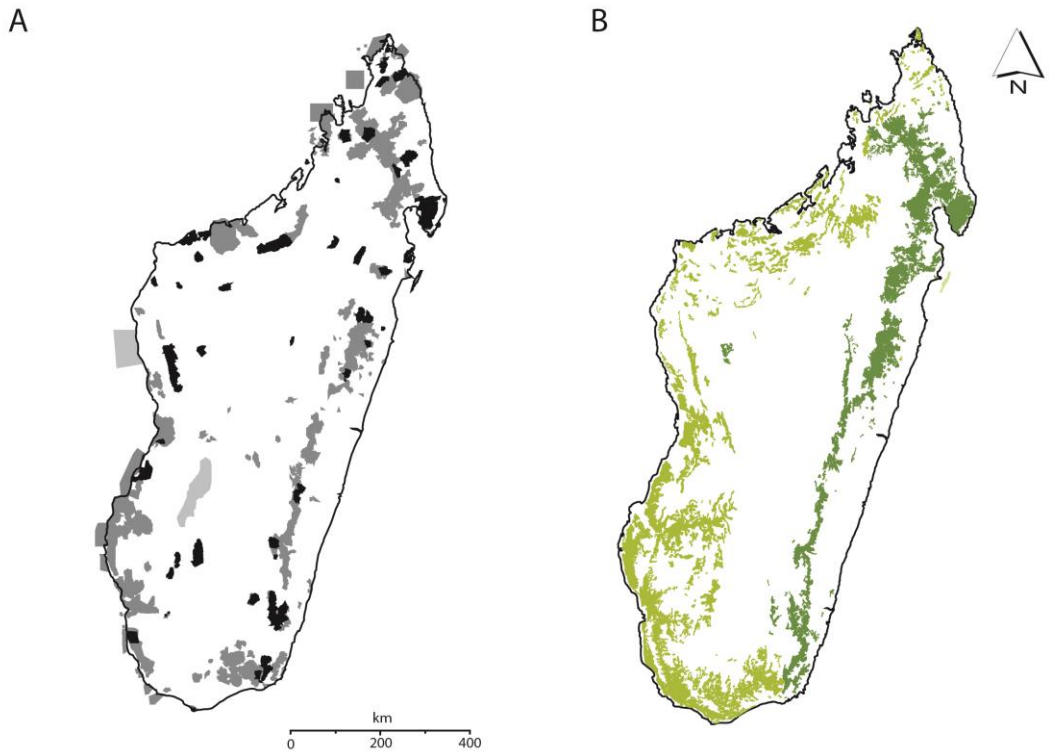
776 Figure 1. Maps of Madagascar showing A) the protected area network, with the pre-2003
777 network in black, new protected areas established since 2003 in dark grey, and protected areas
778 partway through establishment in light grey (Source: REBIOMA, March 2016); B) forest
779 cover, with humid forests in dark green and dry and spiny forests in olive green (Source: Moat
780 and Smith 2007).

781

782 Figure 2. Model shared governance schematic for new, non-MNP protected areas in the
783 Madagascar Protected Area System.

784

785



786

787 Figure 1. Maps of Madagascar showing A) the protected area network, with the pre-2003
788 network in black, new protected areas established since 2003 in dark grey, and protected areas
789 partway through establishment in light grey (Source: REBIOMA, March 2016); B) forest
790 cover, with humid forests in dark green and dry and spiny forests in olive green (Source: Moat
791 and Smith 2007).

792

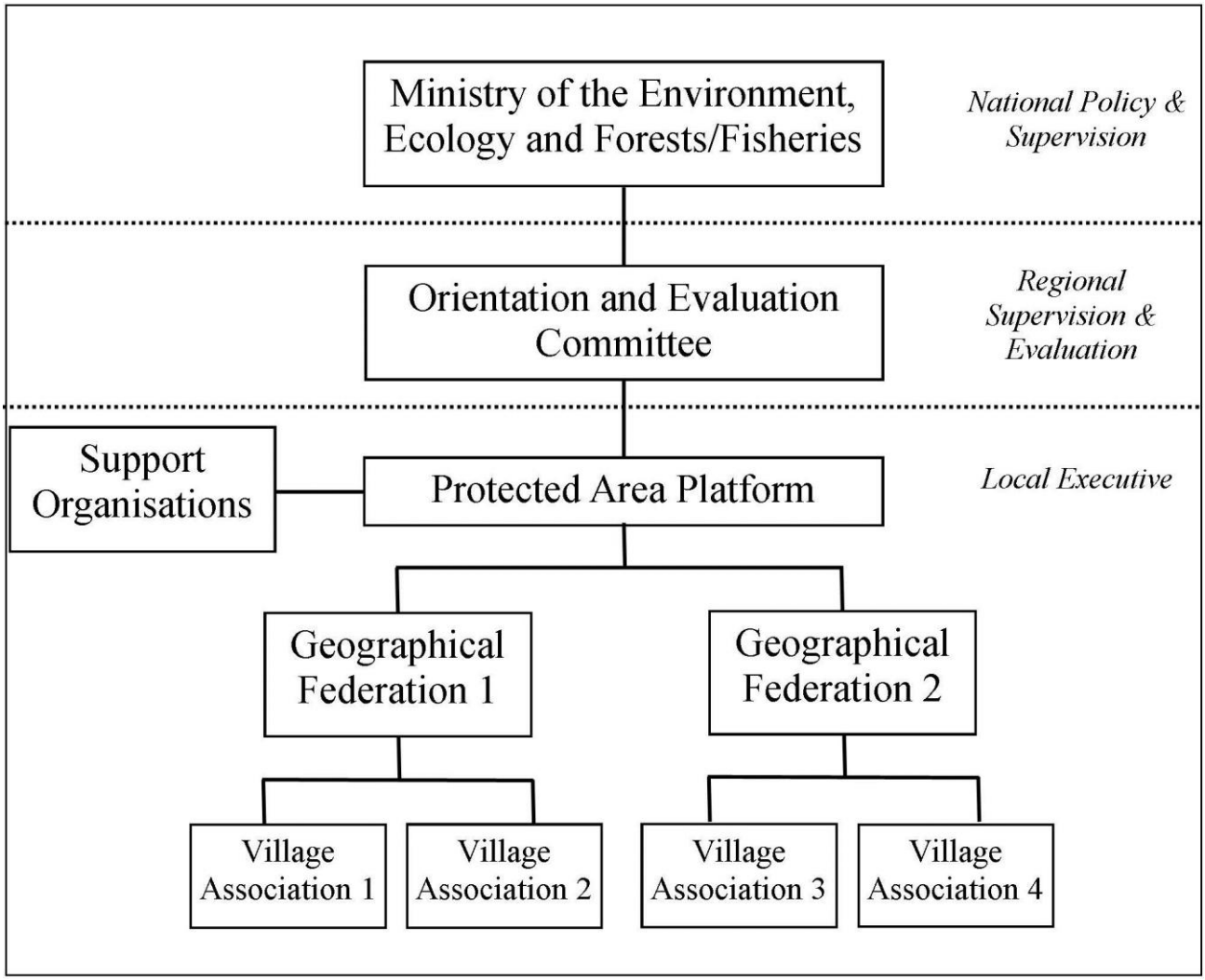


Figure 2. Model shared governance schematic for new, non-MNP protected areas in the Madagascar Protected Area System.