



PATTERNS OF FOREST LOSS IN ONE OF AFRICA'S LAST REMAINING WILDERNESS AREAS: NIASSA NATIONAL RESERVE (NORTHERN MOZAMBIQUE)

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ABSTRACT

Niassa National Reserve (NNR) supports Mozambique's largest populations of endangered fauna and sustains the livelihoods of > 40,000 people who utilise its natural resources. Accurately monitoring fine-scale spatial and temporal trends in land-use and tree-cover is increasingly used for monitoring the ecological state of conservation areas. Here we provide essential information on land-use changes in NNR to support ongoing conservation efforts in the region. We examined patterns of forest and woodland loss in NNR between 2001 and 2014 using high resolution maps of global tree-cover change, and compared this with changes in the wider region. We found that NNR lost 108 km² of forest (0.9 per cent of its 11,970 km² aggregated forest extent), with the majority (89 km²) of forest loss occurring due to expanding agriculture around settlements and along main roads. Although this loss was substantial, it was lower than changes in the surrounding region, with the adjacent districts and Provinces losing 200 km² (3.2 per cent) and 6,594 km² (5.7 per cent) of their respective forest extents. We found NNR's diverse Miombo ecosystems are still intact and could support large mega-faunal assemblages, investment in ensuring the long-term success of NNR is an obvious global conservation priority.

Key words: Forest loss, Habitat loss, conservation planning, monitoring, protected areas, biodiversity conservation, African conservation

INTRODUCTION

Niassa National Reserve (NNR) is Mozambique's largest protected area, spanning 42,300 km², and is one of Africa's most iconic wilderness areas (Mittermeier et al., 2003). It is situated in far northern Mozambique, which is one of the least biologically explored places in Africa (Ryan et al., 2010). NNR is connected to the Selous Game Reserve in Tanzania to its north, via the Selous-Niassa corridor, which permits wildlife to move between the two Reserves (Mpanduji & Ngomello, 2007; Mpanduji et al., 2002). Together, the NNR and the Selous Game Reserve form a massive ~150,000 km² trans-frontier conservation area (Noe, 2015). The region is renowned for having the largest and best preserved tracts of Miombo woodland left in Africa (Maquia et al., 2013; Ribeiro et al., 2008a; Soto, 2009; Mayaux et al., 2004),

which are globally important for carbon storage and sequestration (Ribeiro et al., 2013; Lupala et al., 2014). These woodlands also provide critical habitat for many of Africa's wide ranging species and threatened mega-fauna (Mpanduji et al., 2002; Bauer et al., 2015; Riggio et al., 2013), supporting Mozambique's largest populations of savannah elephants (*Loxodonta africana*), lions (*Panthera leo*), critically endangered wild dogs (*Lycan pictus*) and a broad assemblage of Miombo species (Booth & Dunham, 2014; Begg & Begg, 2012; Begg & Begg, 2007; Grossmann et al., 2014).

NNR also supports a growing population of approximately 40,000 people who live within the Reserve boundaries in two towns, Mecula and Mavago, and ~40 smaller scattered villages. These people

experience very high levels of poverty and their access to infrastructure and social services is limited (Cunliffe et al., 2009; Jorge et al., 2013). They therefore depend heavily on NNR's biodiversity and resources for their livelihood and subsistence needs (Campbell et al., 1996; Cunliffe et al., 2009). The principle livelihood activity has been shifting slash-and-burn agriculture (Cunliffe et al., 2009), which is legal under certain conditions in National Reserves under Mozambican law. However, this agriculture is both expanding and becoming more static as settlements become more established, and the resulting land conversion is in opposition to NNR's conservation objectives (SDGRN, 2006; Cunliffe et al., 2009). Other examples of legal livelihood activities in NNR include fishing and honey gathering, whilst many households also rely on illegal subsistence bush-meat hunting, and some earn cash from artisanal mining and other illegal activities (e.g. ivory poaching, logging). The Reserve management authority allocates a yearly wildlife quota for communities to hunt, and also share 16 per cent of the total revenue generated through commercial photographic and hunting tourism directly with communities through Community-based Natural Resource Management Committees (Jorge et al., 2013). This community engagement is based on growing evidence that well managed protected areas can reduce poverty, improve rural livelihoods and promote peace and stability (Naughton-Treves et al., 2011; Ferraro et al., 2011; Maekawa et al., 2013).

Since the end of the Mozambican civil war in 1992, there has been a dramatic increase in land conversion for agriculture across northern Mozambique, as people returned to rural lands that they had previously abandoned (Temudo & Silva, 2012; Temundo, 2004). This is a well-established post conflict pattern and the consequences for biodiversity can be devastating (McNeely, 2003; Negret et al., 2017). Mozambique's human population is also growing rapidly at a rate of ~3 per cent per year, putting increasing pressure on the country's natural resources (Crist et al., 2017; Temudo & Silva, 2012). Likewise, the human population within NNR has grown at a similar rate (INE, 2008b; INE, 2008a), compounded by immigration from outsiders attracted by NNR's biodiversity, other resources and space for agricultural expansion (Grossmann et al., 2014; Niassa Carnivore Project, 2015). There are concerns that populations of many wildlife species in NNR, which had been steadily increasing since the end of the civil war, are being impacted by increasing human pressure (Grossmann et al., 2014). Anthropogenic conversion of intact vegetation, or habitat loss, is one of the major drivers of species extinctions globally (Maxwell et al., 2016; Fischer & Lindenmayer, 2007), followed closely by overhunting (Maxwell et al., 2016; Tranquilli et al., 2014), both of which pose an immediate threat to NNR's biodiversity and are a major challenge for NNR's management.

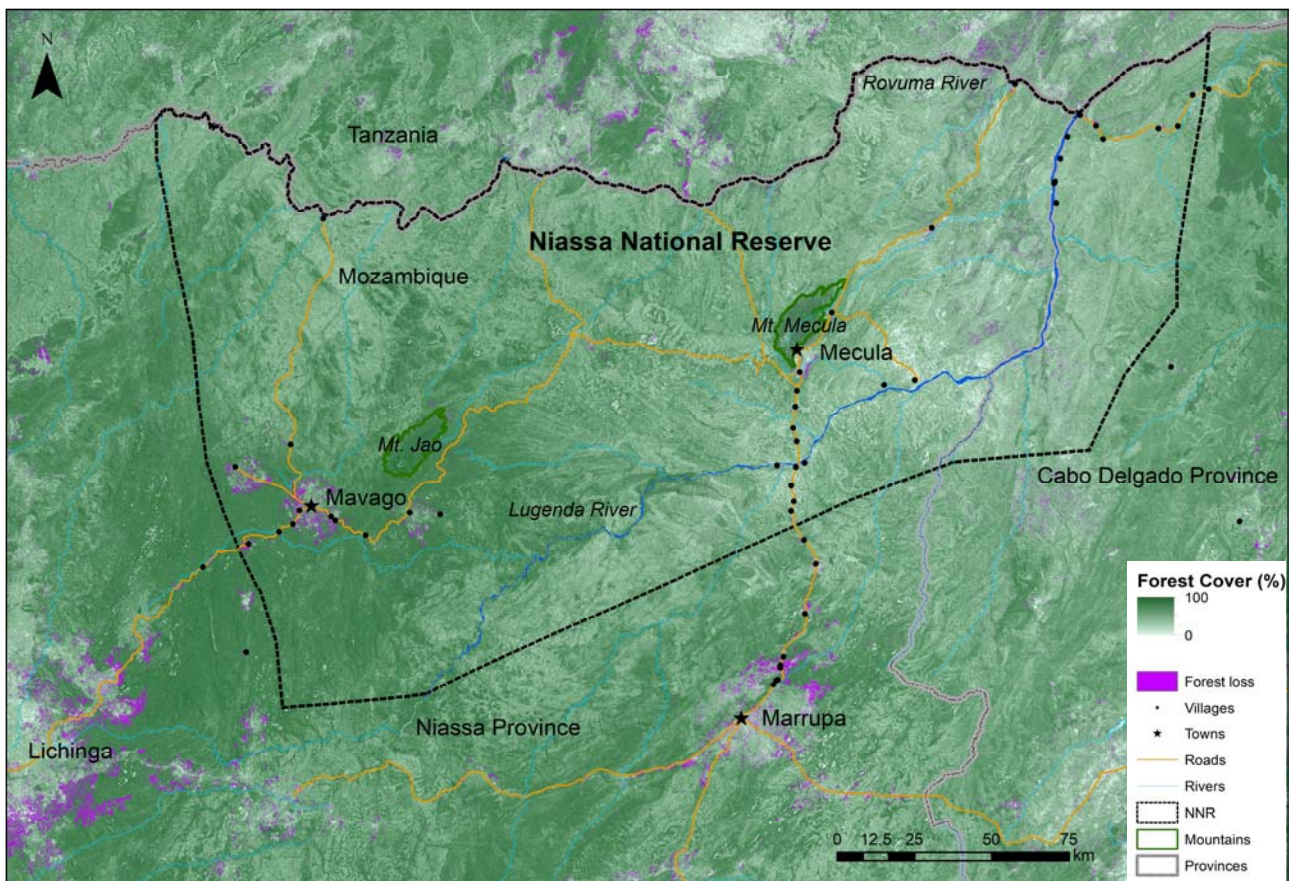


Figure 1. The extent of forest loss in Niassa National Reserve

Accurately monitoring fine scale spatial and temporal trends in land-use and tree-cover is increasingly used for monitoring the ecological state of important conservation areas (Tracewski et al., 2016; Nagendra et al., 2013; Allan et al., 2017). This provides crucial information for conservation planning since it identifies where biodiversity is likely to be threatened and where management actions should be targeted (Tracewski et al., 2016; Turner et al., 2003). However, northern Mozambique is particularly data-poor. Previous efforts to map land-use changes and tree-cover in and around the NNR are outdated (Desmet, 2004; Games, 2004), temporally static (Ganzin et al., 2010; Prin et al., 2014), or have focused on carbon and fire dynamics (Ribeiro et al., 2013; Ribeiro et al., 2008b). There is a clear need for more up-to-date information to support conservation decision making.

We aim to address this gap by analysing patterns of forest and woodland loss (hereafter forest loss) in NNR between the years 2001 and 2014 using high resolution maps of global tree-cover (Hansen et al., 2013). We identify which areas in NNR have suffered the greatest forest loss, and which areas are faring well with limited negative changes to this key component of their ecological integrity. We also compare our findings for NNR with patterns of forest loss across all of northern Mozambique to provide regional context. Key findings from this study can be used by the Reserve management to inform conservation decision making. We also hope to draw more research attention to an understudied region that is globally important for biodiversity conservation.

STUDY SITE

NNR is a socio-economically sensitive and politically complex region; it is in northernmost Mozambique bordering Tanzania, and extends across two provinces: Cabo Delgado and Niassa, and eight administrative districts (Figure 1). NNR was officially proclaimed in 1954, but then abandoned between 1975 and 1992 during Mozambique's civil conflict. Once a peace accord was signed, the Mozambican government made a series of agreements with private companies and non-governmental organisations (NGOs) to manage NNR (SDGRN, 2006). Since October 2012, The Wildlife Conservation Society has been co-managing NNR with the National Administration for Conservation Areas in Mozambique to secure the long-term future of NNR. The Reserve is divided into 18 management blocks of which 16 can be leased as concessions by private concessionaires. Sustainable use of wildlife is permitted within NNR, and eight concessions are currently leased for hunting tourism and two are vacant. One concession is informally designated for community use, four are leased for photo tourism and one is vacant. Two blocks are strictly protected for biodiversity conservation.

NNR has a tropical sub-humid climate, with mean monthly temperatures between 20 and 30 degrees Celsius. The wet season runs from November to April and the mean annual rainfall is 900 mm. Rainfall increases from east to west (800 mm – 1,200 mm) across NNR, as does the altitude (200 m – 1,400 m above sea level). The highlands in the west are well forested and continue beyond NNR's boundaries forming the watershed for its two major rivers: the Rovuma and the Lugenda. Both rivers have strong perennial flows that are key for supporting NNR's biodiversity and people. There are two major peaks in the Reserve, Mount Jao (1,200 m) and Mt Mecula (2,000 m), which contain important protected montane forests in Mozambique and are centres of high diversity in the Miombo belt. The habitat in the rest of NNR (72 per cent) is predominantly Miombo woodland dominated by *Brachystegia* and *Julbernardia* tree species (Ribeiro et al., 2008a; Mayaux et al., 2004). Vegetation dynamics are largely driven by the rainfall gradient across NNR, and a complex interaction between fire (mainly anthropogenic) and elephants, whose destructive herbivory can increase fuel loads and fire intensity (Ribeiro et al., 2013; Ribeiro et al., 2008a).



Lions during the wet season. © Jean-Baptiste Deffontaines

METHODS

We examined patterns of forest loss and gain in NNR and northern Mozambique between 2001 and 2014 using high spatial resolution maps of global tree-cover (Hansen et al., 2013). The Global Forest Change dataset is the most accurate representation of temporal forest loss available (McRoberts et al., 2016). We defined forest cover as vegetation taller than 5m, and forest loss as the complete removal of canopy cover at a 30 m resolution. Data was extracted and processed in the Google Earth Engine (<http://earthengine.google.org/>), a cloud platform for Earth-observation data analysis. We summed the extent of year by year forest loss between 2001 and 2014 to calculate the total extent of forest loss in NNR during this time period, and present this as a percentage of the total forest extent in 2000. We also analysed the total gain in forest cover extent between the years 2001 and 2012. The forest cover gain data is not available in year by year time series, and cannot be compared directly with the forest loss data since they were developed using different methodologies (Hansen et al., 2013). We adapted JavaScript code developed by Tracewski et al. (2016) for analysing forest cover data within specified spatial zones, which is freely available online (<https://github.com/RSPB/IBA>). Forest loss indices were aggregated to the district and provincial scales as they provide useful units representing political

organisational entities and hence management levels. To provide context we compare trends in forest cover in NNR to trends in the surrounding landscapes, which we defined as 1) the 26 districts directly adjacent to NNR, and more broadly as 2) the four northern provinces of Mozambique (Niassa, Cabo Delgado, Nampula and Zambezia). We did not control for landscape or ecological characteristics in our analyses.

RESULTS

We found that the total area of forest lost inside NNR between 2001 and 2014 was 108 km², amounting to 0.9 per cent of the 11,971 km² of NNR's aggregated forest extent in the year 2000. The majority of forest was lost around the towns of Mecula and Mavago where 41.4 km² (0.9 per cent) and 47.5 km² (4 per cent) of forest cover was cleared respectively, primarily for agricultural purposes (Figures 2 and 3). Forest cover was also lost along the main Marrupa-Mecula road leading into the centre of NNR, where communities practise shifting agriculture, and in the northeastern corner of the Reserve near Negomano. The direction of the shifting agriculture was predominantly from NNR's boundaries toward its centre along main roads (Figure 1). The overall annual average of forest loss in NNR remained fairly consistent across the 12 years studied, with peaks occurring in 2008–2009 and 2013 (Figure 4).



Shifting agriculture along the main road near Mecula town in Niassa National Reserve. © James Allan



Figure 2. The extent of forest loss around Mecula town and on the Mecula-Marrupa road

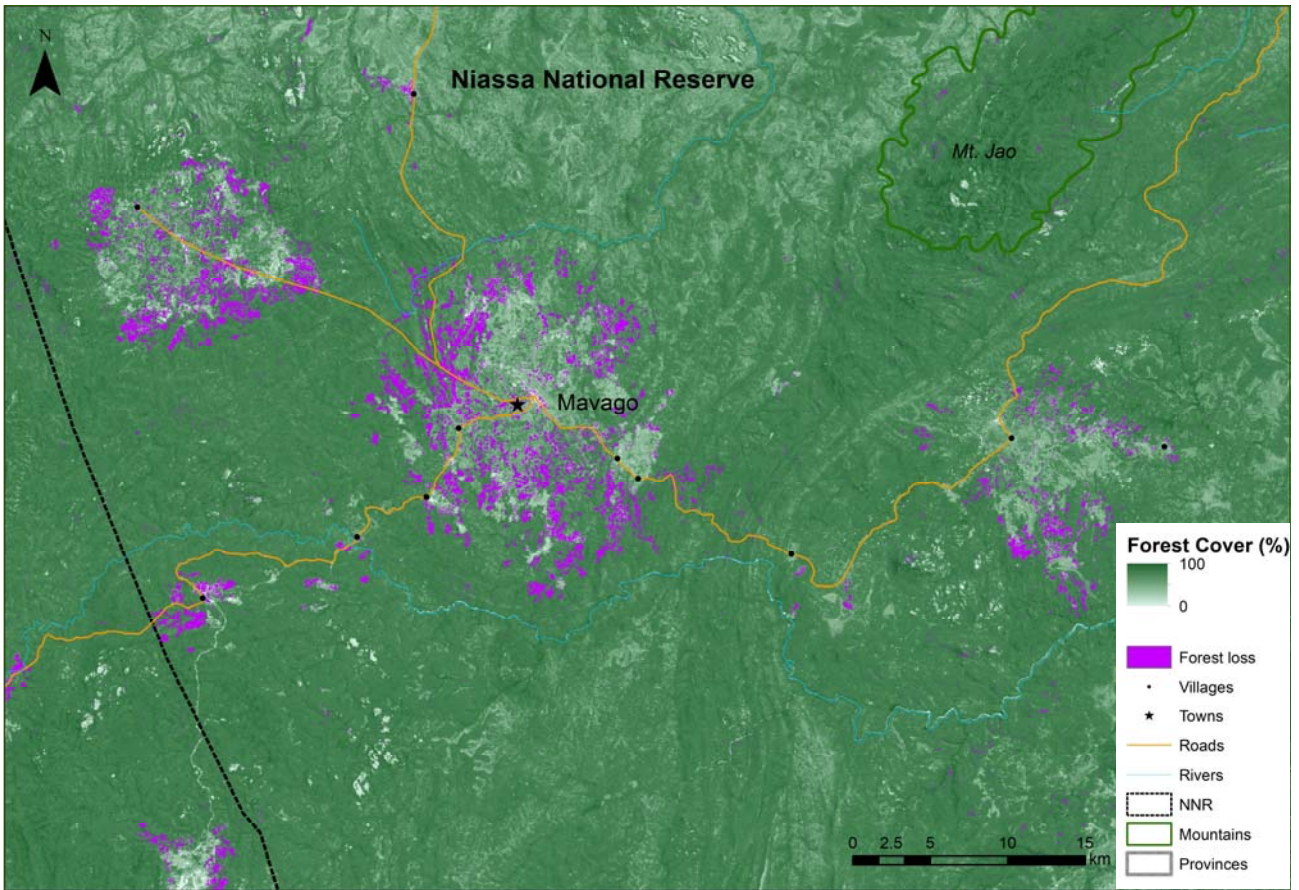


Figure 3. The extent of forest loss around Mavago Town

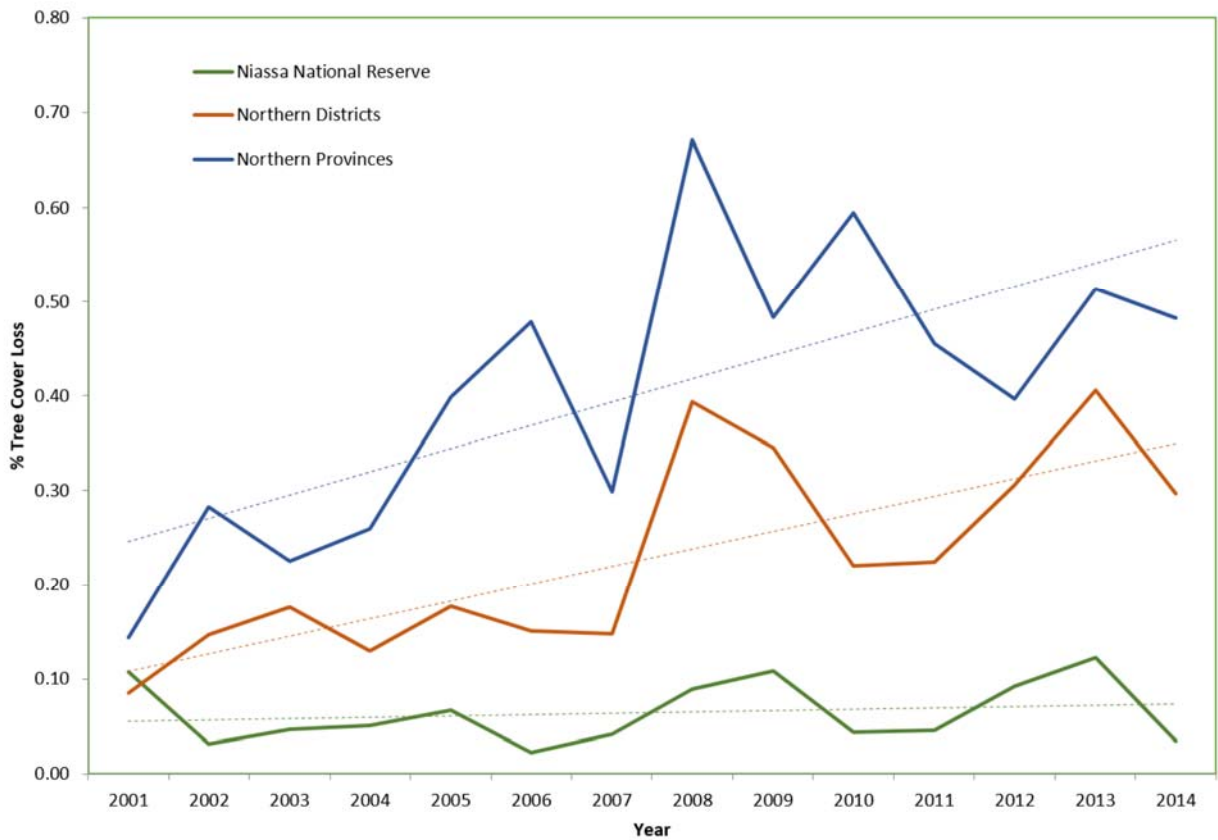


Figure 4. The yearly percentage forest loss between 2001 and 2015 for Niassa National Reserve, and Northern Mozambican provinces and districts

Table 1. The total aggregated forest extent (km²), total amount of forest loss and gain (km²) between 2001 and 2014, and the percentage of forest loss and gain in Niassa National Reserve, and the districts and provinces of Northern Mozambique

	Tree extent (km ²)	Tree-loss (km ²)	per cent Tree loss	Tree-gain (km ²)	Tree gain as per cent of loss
Niassa National Reserve	11970.9	108.1	0.9	1.1	1.0
Districts					
Ancuabe	1823.6	96.3	5.3	6.3	6.6
Balama	1466.7	18.0	1.2	0.2	1.2
Chiure	1190.5	55.4	4.7	1.6	3.0
Lago	2456.0	48.6	2.0	0.9	1.9
Lichinga	1979.5	187.0	9.4	0.9	0.5
Macomia	1419.5	111.0	7.8	26.7	24.1
Majune	4348.5	39.2	0.9	0.6	1.6
Mandimba	950.1	38.7	4.1	0.1	0.3
Marrupa	5175.3	82.0	1.6	0.8	1.0
Maua	2452.0	39.1	1.6	0.4	0.9
Mavago*	3300.7	47.5	1.4	0.4	0.8
Mecanhelas	323.1	22.5	7.0	0.0	0.2
Mecula*	4471.3	41.4	0.9	0.5	1.1
Meluco	2381.8	66.8	2.8	10.4	15.6
Metarica	1506.6	22.7	1.5	0.3	1.3
Mocimboa da Praia	517.8	49.0	9.5	9.4	19.3
Montepuez	4729.5	64.1	1.4	0.8	1.3
Mueda	4075.0	169.9	4.2	39.1	23.0
Muembe	2640.5	66.4	2.5	0.5	0.7
Muidumbe	1051.0	70.6	6.7	19.2	27.3
Namuno	1556.7	66.8	4.3	1.2	1.8
Nangade	1322.9	133.6	10.1	22.3	16.7
N'gauma	1027.1	79.9	7.8	0.2	0.3
Nipepe	1399.4	20.6	1.5	0.2	0.9
Palma	341.9	17.6	5.2	3.1	17.4
Quisanga	331.2	16.7	5.0	7.6	45.7
Sanga	4270.7	43.0	1.0	0.7	1.7
Provinces					
Nampula	21231.7	1705.8	8.0	148.8	8.7
Zambezi	40741.3	2758.4	6.8	175	6.3
Niassa**	28060.7	759	2.7	5.9	0.8
Cabo Delgado**	25977.1	1371.5	5.3	243	17.7

* Districts entirely in the Reserve **Provinces overlapping the Reserve



Niassa National Reserve from the air: The Lugenda River in the dry season. © Jean-Baptiste Deffontaines

Forest loss in NNR was much lower than in the surrounding landscape. The 26 districts directly adjacent to NNR (in the provinces of Niassa and Cabo Delgado) lost an average of 4.4 per cent of their forest cover between 2001 and 2014. The districts of Lichinga, Mueda and Nangade suffered the most, losing 187 km² (9.5 per cent), 170 km² (4 per cent) and 134 km² (10.1 per cent) of their forest cover respectively during the study period (Table 1). Likewise, the northern Mozambican provinces of Niassa, Cabo Delgado, Nampula and Zambezia (excluding NNR) lost a total of 6,594 km² of forest cover amounting to 5.7 per cent of the 116,010 km² of forest cover in the region in the year 2000. The overall rate of forest loss in the provinces and districts of northern Mozambique increased over the study period, with peaks in 2008 and 2013 (Figure 4).

We found that the total area of forest gain within NNR between 2001 and 2014 was negligible, amounting to 1.1 km², which equates to 0.01 per cent of NNR's total aggregated forest extent and 1 per cent of the forest lost during the time period. Forest gain in NNR was also low compared to gain in the districts surrounding NNR which amounted to a more substantial 154 km² (0.3 per cent of forest extent, 9 per cent of the forest extent lost), and in the northern provinces of Mozambique which amounted to 573 km² (0.5 per cent of forest extent, 8.7 per cent of the forest extent lost).

DISCUSSION

Our analysis provides an up-to-date assessment of changes in forest cover in NNR and northern Mozambique between 2001 and 2014 and important baseline information for future conservation planning efforts. We found that NNR lost > 100 km² of forest cover amounting to ~ 1 per cent of its aggregated forest extent. This may appear substantial, but is much lower than the 3 per cent of forest cover lost in protected areas globally during the same time period (Heino et al., 2015; Morales-Hidalgo et al., 2015). Our findings are also particularly encouraging in the African context, given deforestation rates on the continent are five times higher than the global average (Tranquilli et al., 2014), and there are many examples of protected areas in Africa losing much

more forest cover within their boundaries (Bowker et al., 2017; Allan et al., 2017; Sassen et al., 2013).

We found that forest loss was higher in the landscapes surrounding NNR, with some adjacent districts losing up to 10 per cent of their forest extent. This suggests that NNR is performing relatively well at limiting forest loss within its boundaries given external pressure (Bruner, 2001), and supports assessments suggesting protected areas are effectively conserving habitat and biodiversity (Geldmann et al., 2013; Barnes et al., 2016). However, because we did not control for landscape characteristics ("matching") there is a possibility we are overestimating the effect of protection (Joppa & Pfaff, 2010; Joppa & Pfaff, 2011; Geldmann et al., 2013). Although our results do confirm a well-known pattern that protected areas on the African continent and globally are becoming increasingly isolated by land clearing beyond their boundaries (DeFries et al., 2005; Bailey et al., 2016; Newmark, 2008). This is concerning since degradation around a protected area strongly predisposes it to future degradation within its borders (Laurance et al., 2012).

We found that the majority of forest loss in NNR occurred around the two largest towns of Mecula and Mavago, where the majority of NNR's human population resides. Since forest loss is locally restricted, NNR's management can target actions to these high risk areas and engage with the local communities. The communities have the right to continue residing within NNR in accordance with Mozambican law, and NNR's management team and concession holders are already working closely with many of them to build connections and interdependencies. For example, the Reserve Management Authority employs between 75–80 per cent of its 150 staff from local villages in NNR, and Mariri concession block employs 80 per cent of its team from local villages in NNR.

Local communities were also engaged during the development of an updated management plan for NNR, and helped define NNR's vision for the next decade. NNR's new management plan, which will run from 2017 to 2027, is the first to explicitly acknowledge local community members as key stakeholders and partners in NNR's future, and to zone sections of the Reserve for community use and development. There are also micro-zoning initiatives planned and underway in imminently threatened areas to try to control agricultural sprawl as human pressure increases. These actions alone will not protect NNR's biodiversity, but are a major step towards repairing the historically fractured relationship between NNR's communities and management. Through stronger collaborations with public-health professionals and social scientists, NNR's management can also help ensure that human-development goals and the communities' socio-economic aspirations are met. This could help decrease the anthropogenic pressure being

placed on NNR's wildlife and habitats, which in turn should translate into increased revenue to communities, since higher commercial and community hunting quotas will be possible.

Our analysis has several caveats worthy of discussion. There are limitations to satellite derived estimates of tree cover, such as lower accuracy in more arid places, and an inability to distinguish between ecologically valuable forest compositions and commercially valuable forest stands, all of which have been well discussed (Achard et al., 2014; Tropek et al., 2014; Hansen et al., 2013). Despite its limitations, the Global Forest Change dataset is still considered the most accurate global representation of temporal forest loss available (McRoberts et al., 2016; Gross et al., 2017). We recommend particular caution when interpreting the forest gain data, since we cannot be certain that it is the natural regrowth of ecologically valuable vegetation. For example, in Lichinga district there are forestry plantations, and in the districts along the coast there are coconut plantations which could be responsible for some of the gains we recorded outside of NNR (Table 1). We were surprised to find negligible gain in forest extent within NNR but suspect that fields are not being vacated for the 20–30 years required for Miombo woodland to mature (Jew et al., 2016). No commercial forestry is known to occur within NNR.

A second caveat is that we cannot infer the exact causes of forest loss from the data. The patterns of forest loss we identified within NNR – along roads and around villages – strongly suggest that this is the result of anthropogenic clearing to meet local subsistence needs, which has been confirmed by NNR's management, who have already surveyed many of the areas where large extents of forest cover were lost. An important extension of this work would be to model and explore the drivers of forest loss in NNR and northern Mozambique. There are also many anthropogenic threats and disturbances beyond habitat loss which are affecting NNR's ecological state and biodiversity, such as commercial poaching, overhunting, wildfires, climate change, artisanal mining and selective logging, which our analysis does not capture (Barlow et al., 2016; Maxwell et al., 2016). Bush-meat hunting using snares, which kill indiscriminately, is occurring in NNR, as is the poisoning of large carnivores such as lions and leopards for their body parts (Niassa Carnivore Project, 2015). The lion population in NNR is estimated at 800 individuals but is decreasing in localised areas, with some places now completely devoid of carnivores, which could have serious cascading ecological effects (Ripple et al., 2014). Similarly, between 2011 and 2014 NNR's elephant population declined by 63 per cent to an estimated 4,440 individuals in 2014, driven by illegal ivory poaching (Grossmann et al., 2014; Booth & Dunham, 2014). This equates to an estimated loss of just over 7,500 animals – one of the most catastrophic



Land cleared by "Slash and burn" techniques in Niassa National Reserve. © James Allan

declines on the continent (Chase et al., 2016). Other emerging threats to NNR's wildlife, which could also have negative impacts on forest cover, include artisanal mining and charcoal production (Papworth et al., 2017). The Global Forest Change dataset is updated regularly so continued monitoring can ensure emerging threats are identified and managed as early as possible, but there also needs to be additional monitoring efforts and action to secure NNR's species in the long term.

NNR's wildlife is clearly in danger, but it is encouraging that the majority of NNR's Miombo woodland habitat is intact and could support large populations of mega-fauna. There have been recent calls for increased investment in upgrading protected areas that have high but currently unrealised potential both for conservation and communities (Pringle, 2017). By upgrading protected areas we mean increasing their management effectiveness, while harmonising them with the needs and aspirations of their constituencies (Pringle, 2017). Through increased community engagement, and stronger management action against key threats to biodiversity, we suggest NNR could become a flagship for such efforts. NNR has already been identified as a critical protected area for continent-wide lion recovery efforts because it could support well over 1,000 individuals (Lindsey et al., 2017). NNR also has the potential to support approximately 50,000 elephants, which is more than ten times its current population (Robson et al., 2017). Residual wildlife populations are still large enough that they could recover naturally assuming levels of persecution decrease and threats are managed. Given the potentially substantial benefits to biodiversity conservation and broader societal goals, investing in the effective management of NNR is an obvious global conservation priority.

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RESUMEN

La Reserva Nacional de Niassa (NNR, por sus siglas en inglés) apoya las poblaciones más grandes de fauna en peligro de Mozambique y los medios de subsistencia de más de 40,000 personas que dependen de sus recursos naturales. El seguimiento preciso de las tendencias espaciales y temporales a escala fina en el uso de la tierra y la cubierta forestal se utiliza cada vez más para monitorear el estado ecológico de las áreas de conservación. Aquí proporcionamos información esencial sobre los cambios en el uso de la tierra en la NNR para apoyar los esfuerzos en curso para la conservación en la región. Examinamos los patrones de pérdida de bosques y tierras arboladas en la NNR entre 2001 y 2014 empleando mapas de alta resolución del cambio global de la cubierta forestal, y los comparamos con los cambios en la región más amplia. Descubrimos que la Reserva Nacional de Niassa perdió 108 km² de bosque (0,9 por ciento de su extensión forestal agregada de 11.970 km²), debiéndose la mayoría (89 km²) a la pérdida de bosques por la expansión de la agricultura alrededor de los asentamientos y a lo largo de las carreteras principales. Aunque sustancial, dicha pérdida fue menor que los cambios en la región circundante, donde los distritos y provincias adyacentes perdieron 200 km² (3,2 por ciento) y 6.594 km² (5,7 por ciento) de sus respectivas extensiones de bosque. Descubrimos que los diversos ecosistemas de miombo de la NNR todavía están intactos y podrían soportar conjuntos de grandes animales; la inversión para garantizar el éxito a largo plazo de la NNR es una prioridad obvia de conservación a nivel global.

RÉSUMÉ

La Réserve Nationale de Niassa (RNN) abrite les plus grandes populations de faune menacées du Mozambique et assure la subsistance de plus de 40.000 personnes qui utilisent ses ressources naturelles. Une surveillance précise à l'échelle spatiale et temporelle de l'utilisation des terres et de la couverture arborée est de plus en plus utilisée pour examiner l'état écologique des aires de conservation. Le présent document fournit des informations probantes concernant les changements d'affectation des terres dans la RNN afin de contribuer aux efforts de conservation en cours dans la région. Nous avons étudié des modèles de perte de terrain arboré et boisé dans la RNN entre 2001 et 2014 à l'aide de cartes à haute résolution montrant les changements de couverture forestière, et les avons comparées aux changements intervenus au niveau régional. Nous avons constaté que la RNN a perdu 108 km² de forêt (soit 0,9% de l'étendue de ses ressources forestières totalisant 11.970 km²), la plus grande partie (89 km²) de déforestation étant due à l'expansion de l'agriculture autour des villages et le long des routes principales. Bien que cette perte soit substantielle, elle est inférieure aux changements dans la région environnante, les districts et les provinces adjacents perdant 200 km² (3,2%) et 6 594 km² (5,7%) de leurs étendues forestières respectives. Nous avons constaté que les divers écosystèmes Miombo de la RNN sont encore intacts et à même de soutenir de grands assemblages de mégafaune. L'investissement pour assurer le succès à long terme de la RNN est donc une priorité de conservation globale évidente.