PARKS

The International Journal of Protected Areas and Conservation

Developing capacity for a protected planet

Issue 23.2 NOVEMBER 2017

IUCN WCPA

Convention on Biological Diversity

protected planet

PARKS is published electronically twice a year by IUCN's World Commission on Protected Areas. For more information see: parksjournal.com

PARKS is published to strengthen international collaboration in protected area 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 areas;
- promoting understanding of the values and benefits derived from protected areas to communities, visitors, business etc;
- ensuring that protected areas fulfill 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 area support and behaviour through use of information provided in the journal; and
- promoting IUCN's work on protected areas.

Thanks to: Miller Design for layout advice and front cover picture production. Patricia Odio Yglesias and Sarah LaBrasca for abstract translations. Caroline Snow for proofreading. And to all the reviewers who so diligently helped in the production of this issue.

Published by: IUCN, Gland, Switzerland

Citation: IUCN WCPA (2017). *PARKS. The International Journal of Protected Areas and Conservation,* Volume 23.2, Gland, Switzerland: IUCN.

ISSN: ISSN 2411-2119 (Online), ISSN 0960-233X (Print)

DOI: 10.2305/IUCN.CH.2017.PARKS-23-2.en

Cover photo: Adoption of the Strategic Plan for Biodiversity, Photo by Franz Dejon, IISD/ENB (enb.iisd.org/biodiv/cop10/)

Editing: Marc Hockings, Sarah Casson, Helen Newing , Bas Verschuuren, John Waithaka, Olivier Chassot

Layout by: Marc Hockings, IUCN WCPA

Available from: IUCN (International Union for Conservation of Nature)
Global Programme on Protected Areas
Rue Mauverney 28
1196 Gland
Switzerland
Tel +41 22 999 0000
Fax +41 22 999 0002
parksjournal.com
iucn.org/theme/protected-areas/publications/parks-journal

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

IUCN WCPA'S BEST PRACTICE PROTECTED AREA GUIDELINES SERIES

IUCN-WCPA's Best Practice Protected Area Guidelines are the world's authoritative resource for protected area managers. Involving collaboration among specialist practitioners dedicated to supporting better implementation in the field, they distil learning and advice drawn from across IUCN. Applied in the field, they are building institutional and individual capacity to manage protected area systems effectively, equitably and sustainably, and to cope with the myriad of challenges faced in practice. They also assist national governments, protected area agencies, nongovernmental organisations, communities and private sector partners to meet their commitments and goals, and especially the Convention on Biological Diversity's Programme of Work on Protected Areas.

A full set of guidelines is available at: www.iucn.org/pa_guidelines
Complementary resources are available at: www.cbd.int/protected/tools/
Contribute to developing capacity for a Protected Planet at: www.protectedplanet.net/

PARKS: THE INTERNATIONAL JOURNAL OF PROTECTED AREAS AND CONSERVATION

Edited by Marc Hockings, Emeritus Professor, University of Queensland; IUCN WCPA Vice-Chair for Science and Management of Protected Areas; Senior Fellow, UNEP-World Conservation Monitoring Centre

editor@parksjournal.com
School of Earth and Environmental Sciences, University of Queensland, St Lucia, Queensland 4072, Australia

EDITORIAL

Marc Hockings, Managing Editor

Issue 23.2 brings the good news that PARKS is now being indexed in Scopus, the world's largest bibliographic database of peer-reviewed scientific literature. The review process for acceptance into Scopus is rigorous and time consuming and we received news of the acceptance of the journal for inclusion in Scopus in May 2017 after nearly 18 months. In advising us of this acceptance, the Scopus Evaluation Team noted their reviewer's comments that the journal editorial policy and content fully meet all the standards and expectations set out by Scopus, that articles published in the journal are already very well cited by Scopus indexed journals and that the Editors/members of the Editorial Board have a solid recognition in their field of expertise. So, I would like to again thank Sue Stolton and Nigel Dudley for setting up such a solid grounding for the journal. Articles from Issue 23.1 in March 2017 are already indexed in Scopus and new articles will be added as each issue is published. This will ensure even greater exposure for the work of our authors. We have also uploaded all of the available pre-2012 issues of PARKS on the journal website parksjournal.com where you will find them under the Back Issues tab.

This issue also includes book reviews for the first time. Three of the books reviewed in this issue provide essentially historical views on conservation battles under three vastly different circumstances and across three continents; Angola, the Daintree Region in North Queensland and the Nahanni in northern Canada. As Stephen Woodley points out in his review of Gordon Nelson's book on the Nahanni, "those working to conserve nature often forget they are also making history." These books remind us that dedicated individuals are central to conservation efforts around the world and we are privileged to work in an area where so many thousands of individuals around the world devote their passion and energy to conserving our natural world.

Sadly, this issue also includes an obituary. Wayne Lotter, who was a member of the Editorial Board, was killed in Dar es Salaam, Tanzania on 16th August in an apparently targeted killing of this tireless worker against wildlife crime. Rohit Singh from the WWF-Wildlife Crime Initiative, who worked with Wayne in establishing the Ranger Federation of Asia reflects on his life and legacy.

We will continue to commission editorial essays on matters of topical interest. In this issue, Nigel Dudley and his co-authors examine how protected areas can contribute to global efforts to meet the Sustainable Development Goals.

Wayne Lotter
© Krissie Clark

OBITUARY

WAYNE LOTTER

5 DECEMBER 1965—16 AUGUST 2017

Member of PARKS Editorial Board (2012-2017)

On 16 August 2017, 51-year-old Wayne Lotter was gunned down in a taxi while travelling through the city of Dar es Salaam, Tanzania, in an attack that rocked the conservation world and resulted in the loss of one of the most influential characters in the global fight against elephant poaching, and a kind, passionate individual. It was a significant blow to conservation and those that had the pleasure to know and work with Wayne.

Wayne was at the forefront of what many consider to be a war on the natural world, but he did not let this change his kind-hearted personality, nor diminish his well-known sense of humour. Those that were lucky enough to spend time with Wayne know that he was a man capable of immediately putting a stranger at ease through his humour and engaging personality. My first interaction with Wayne was from my WWF office in Malaysia, and whilst this was just a simple call, I could tell that I would enjoy working with him, for what I had hoped would be many years. After this I met Wayne in Pretoria to discuss ranger training and I would see him again on his venture eastwards to Kathmandu to spread his knowledge and passion to Asia, speaking at the symposium, "Towards Zero Poaching in Asia". Wayne inspired me, personally, through his passion for wildlife conservation and for those that work tirelessly to defend the world's natural resources. Perhaps the most impactful experience from my meetings with Wayne was the way in which he managed to embrace and enjoy life.

Having grown up in South Africa, Wayne developed a love for the natural world from an early age. He was born on 5 December 1965, on a continent which, at the time, was home to great numbers of awe-inspiring wildlife, which have since declined rapidly due largely to rampant poaching. Inspired by his love for wildlife and shocked by the rise in wildlife poaching, Wayne decided to dedicate his life to the world of conservation. At the age of 25 Wayne obtained his Master's degree in Nature Conservation and went on to become one of the most influential players in the fight against wildlife crime in Africa. Wayne was most highly regarded for his achievements in wildlife crime prevention. From his early experience as a ranger in South Africa, Wayne went on to support conservation efforts in Tanzania, a region which at the time was suffering from extremely high levels of poaching. Unfazed by the criminal activity, he became a co-founder and chairman of the Protected Area Management Solutions (PAMS) Foundation which was set up in 2006. PAMS Foundation has worked to involve and train thousands of young Africans in conservation.

Wayne's anti-poaching work has led to the arrest of thousands of poachers and traffickers over his career, preventing countless losses and causing a significant blow to global wildlife traffickers. His service to the wildlife and people of Tanzania has been recognised by many, including the Duke of Cambridge, Prince William, who condemned the 'targeted murder' of Wayne shortly after his passing. Despite his long career and dedication, Wayne spoke of how each elephant carcass he saw continued to cause him great distress. Whilst the elephant poaching crisis is far from over, one can only imagine how much worse the situation could be today if it wasn't for the dedication and passion of people like Wayne, and Wayne himself.

Wayne's consideration and love for wildlife was also extended to the people and communities with whom he worked. He recognised early on (perhaps before many others) that successful conservation relied on successful cooperation with the communities that live side-by-side with wildlife.

Importantly, Wayne understood the sacrifices and dedication of rangers. It was during his time as vice president of the International Ranger Federation that the Ranger Federation of Asia (RFA) was set up. Wayne recognised the importance of Asian rangers and worked with myself, the RFA and many other critical partners in Asia to improve the capacity and welfare of rangers. The RFA continues to benefit from the support of PAMS Foundation, amongst many other critical partners.

Wayne, and the PAMS Foundation, have helped to reduce the impact of poaching on Tanzania's wild elephant populations, through ensuring effective conservation management, and critically, the fight against illegal wildlife trafficking, a venture which eventually led to his murder. While this tragic loss has greatly impacted the fight against poaching, the elephants of Tanzania, the global ranger force and the wildlife conservation community, we can only imagine how the loss of this kind man has affected his family. My greatest sympathies go out to wife, Inge, daughters Cara Jayne and Tasmin, and parents Vera and Charles.

By Rohit Singh, WWF-Wildlife Crime Initiative & President of the Ranger Federation of Asia

EDITORIAL ESSAY: PROTECTED AREAS AND THE SUSTAINABLE DEVELOPMENT GOALS

Nigel Dudley[1,2,*], Natasha Ali[3], Marianne Kettunen[4] and Kathy MacKinnon[5]

*Corresponding author: nigel@equilibriumresearch.com
[1] Equilibrium Research, 47 The Quays, Cumberland Road, Bristol BS1 6UQ, UK.
[2] School of Earth and Environmental Sciences, University of Queensland, St Lucia, Brisbane 4072, Australia.
[3] IUCN, The David Attenborough Building, Pembroke Street, Cambridge, CB2 3QZ, UK.
[4] Institute for European Environmental Policy, 11 Belgrave Road, London, SW1V 1RB, UK.
[5] IUCN World Commission on Protected Areas, 28 rue Mauverney, CH-1196, Gland, Switzerland.

Next year IUCN will celebrate its 70th anniversary and the World Commission on Protected Areas will celebrate its 60th birthday. During this long history there have been many conservation initiatives and creation of new conventions designed to address biodiversity loss and promote more sustainable development. Most recently countries agreed the Sustainable Development Goals (SDGs). The *2030 Agenda for Sustainable Development* will be the driving force behind much of the global work on sustainable development and conservation over the next decade (United Nations, 2015). The Goals are universally applicable, but will be led through governmental commitments to the sustainable development agenda. Although the content of the SDGs has been the subject of considerable debate (e.g., *The Economist*, 2015), they are now fixed, and it is important to align protected area policies and the work of the IUCN World Commission on Protected Areas (WCPA) as far as possible within their framework. Failure to do so will leave protected areas increasingly marginalised, as governments, donors and members of civil society scramble to fulfil the SDGs and conservation priorities get pushed to one side.

SDG targets 14 and 15 are consciously modelled on the Convention on Biological Diversity's (CBD) Aichi Biodiversity Targets (www.cbd.int/sp/targets/) and the timeline for delivery of these two targets is clearly linked to attainment of the Aichi Targets. Yet, the relationship between the SDGs and protected areas is not always clear cut.

SDG 14, focused on the future of the ocean, provides the clearest message, in that it consciously repeats the Aichi Biodiversity Target 11 call for the conservation of costal and marine areas and efforts to expand the global marine protected areas (MPA) network.

SDG 14.5 states: "By 2020, conserve at least 10 per cent of coastal and marine areas, consistent with national and international law and based on the best available scientific information". However, many marine ecologists believe that the eventual MPA coverage will need to be much larger, with 30 per cent of the global ocean protected and another 50 per cent under sustainable management. Other targets of SDG 14 are aimed at increasing the resilience of marine ecosystems, reducing the impacts of ocean acidification, addressing over-fishing and implementing international law to protect oceans, all of which directly relate to MPAs and their various benefits. Indeed, SDG 14 probably has the strongest direct fit with existing protected area strategies.

SDG 15, which focuses on protecting, restoring and promoting sustainable use of terrestrial ecosystems to halt biodiversity loss, is less directly linked to the protected area agenda. Target 15.1 states: "By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements". This does not repeat Aichi 11's call for at least 17 per cent of terrestrial ecosystems to be in protected areas; indeed, the term "protected area" does not appear at all in the SDGs. Furthermore, the critical detail in Aichi Target 11 that protected areas should be "effectively and equitably managed, ecologically representative and well-connected…" is absent. Nevertheless SDG 15.1 notes that conservation should be "in line with obligations under international agreements", which is frequently interpreted as support for the existing terrestrial component of Aichi 11. Arguably it also refers to other existing agreements including the CBD's Programme of Work on Protected Areas, contracting Parties' commitments to the Convention on Wetlands (Ramsar Convention) and obligations for sites listed for their natural values under the UNESCO World Heritage Convention and UNESCO Biosphere Reserves.

Given the tacit understanding that the "environmental" SDGs will be revised in line with whatever supersedes the Aichi targets after 2020, the time is right for the protected areas community to communicate the value of protected areas and the contribution that they can make to the sustainable development agenda.

The role of protected areas is by no means confined to just a few targets within SDGs 14 and 15. Well-managed, properly valued protected areas contribute in concrete ways to many of the Sustainable Development Goals (Kettunen and ten Brink, 2013; ten Brink et al., 2016). Moreover other SDGs may have important implications for the ways in which protected areas are selected, managed and relate to surrounding communities and wider society.

In line with other SDG targets protected areas can contribute to human welfare and wellbeing including poverty alleviation, food and water security, health, disaster risk reduction, sustainable cities and climate change strategies. Building on this, they can even play a role in sustaining peaceful societies and mitigating the risks for conflicts. Some of the clearest opportunities are outlined in Table 1; a more complete listing is available in Dudley et al. (2017). The challenge for the protected area community is to ensure that these contributions are fully recognised and reflected in government planning, policies and reporting.

Table 1. Key links between SDGs and protected areas

SDG Targets relevant to protected areas	Potential responses from the protected area community
1.5: By 2030, build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters.	Highlighting the role of protected areas as tools for adaptation to climate change (Dudley et al., 2009).
2.4: By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality.	Protected areas enhancing food security through: 1. Basic supporting services such as soil production and stabilisation of water supplies 2. Buffering against climate-related shocks 3. Promoting sustainable agriculture such as organic production within Category V protected landscapes (Phillips, 2002) 4. Securing fish stocks in marine protected areas.
2.5: By 2020, maintain the genetic diversity of seeds, cultivated plants and farmed and domesticated animals and their related wild species, including through soundly managed and diversified seed and plant banks at the national, regional and international levels, and promote access to and fair and equitable sharing of benefits arising from the utilisation of genetic resources and associated traditional knowledge, as internationally agreed.	Using protected areas to conserve crop wild relatives, land races and livestock wild relatives to help build agricultural resilience (Meilleur & Hodgkin, 2004; Stolton et al., 2006).
3.4: By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being.	Developing the Healthy Parks Healthy People concept in promoting the role of protected areas as green gyms and places for treatment of mental health and addiction issues (Stolton & Dudley, 2010).

SDG Targets relevant to protected areas	Potential responses from the protected
4.7 By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture's contribution to sustainable development.	Using protected areas near urban centres (Trzyna, 2014), to provide basic knowledge of ecosystem functioning, and to address nature-deficit problems in people of all ages.
6.3: By 2030, improve water quality by reducing pollution, eliminating dumping and minimising release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally.	Promoting protected areas as water towers (Dudley & Stolton, 2003) in collaboration with major suppliers of municipal drinking water, by promoting these links particularly.
6.6: By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes.	Expanding protected areas as a key tool for conservation of inland waters, some of the least protected habitats on Earth.
8.9 By 2030, devise and implement policies to promote sustainable tourism that creates jobs and promotes local culture and products.	Providing important opportunities for nature tourism, the quickest growing tourism sector, in well-managed protected areas.
11.5 By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations.	Recognising and planning the role of protected areas as buffers for cities, both as important urban and peri-urban green space and for wetlands, coastal vegetation and mountain forests to provide an important disaster risk reduction function.
11.7: By 2030, provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities.	Arguing for more urban protected areas, particularly in rapidly growing cities (Trzyna, 2014).
11.b: By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels.	Using natural ecosystems in protected areas to provide mitigation of and adaptation to climate change, including urban nature reserves to provide cooling and absorption for flood water.
12.b Develop and implement tools to monitor sustainable development impacts for sustainable tourism that creates jobs and promotes local culture and products.	Providing a monitoring framework in collaboration with relevant UN agencies and as a contribution to the SDGs.
13.1: Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries.	Using natural ecosystems in protected areas to provide mitigation of and adaptation to climate change (Gross et al., 2016).

Krka National Park in Croatia supplies Šibenik-Knin County with water and is home to the first commercial hydropower plant in Europe © Equilibrium Research

The SDGs also highlight some additional obligations for protected areas. Site managers are invited to make provisions for human livelihoods through protected area establishment and management, to help meet gender targets, increase participatory approaches, reduce waste and engage fully with a wider range of stakeholders within sustainable approaches to rural development. All of these things are already actively being addressed within protected areas, although many still struggle to meet social expectations with little knowledge about where to access support and tools to deliver towards the sustainable development agenda.

For 60 years WCPA has been a leader in promoting the establishment and effective management of protected areas to conserve biodiversity and ecosystem services. Given the critical importance of the SDGs in development planning, now is the time for WCPA to communicate the importance, value and potential of the world's protected area network in helping governments to meet their global commitments for both conservation and development and a sustainable planet.

REFERENCES

Dudley, N., Ali, N. and MacKinnon, K. 2017. *Natural Solutions: Protected areas helping to meet the Sustainable Development Goals*. Briefing, Gland, Switzerland, IUCN World Commission on Protected Areas.

Dudley, N. and Stolton, S. (eds.) 2003. *Running Pure: The importance of forest protected areas to drinking water*. Gland, Switzerland and Washington DC, WWF and the World Bank.

Dudley, N., Stolton, S., Belokurov, A., Krueger, L., Lopoukhine, N., MacKinnon, K., Sandwith, T. and Sekhran, N. (eds.) 2009. *Natural Solutions: Protected areas helping people cope with climate change.* Gland, Switzerland, Washington DC and New York, IUCN-WCPA, TNC, UNDP, WCS, The World Bank and WWF.

The Economist. 2015. "Unsustainable Goals". 26 March 2015.

Gross, J.E., Woodley, S., Welling, L.A. and Watson, J.E.M. (eds.) 2016. *Adapting to Climate Change: Guidance for protected area managers and planners*. Best Practice Protected Area Guidelines Series No. 24. Gland, Switzerland, IUCN.

Kettunen, M. and ten Brink, P. (eds.) 2013. *Social and economic benefits of protected areas – An assessment guide*. London, EarthScan/Routledge.

Meilleur, B.A. and Hodgkin, T. 2004. *In situ* conservation of crop wild relatives: status and trends, *Biodiversity and Conservation* 13: 663–684.

Phillips, A. 2002. *Management Guidelines for IUCN Category V Protected Areas: Protected Landscapes/Seascapes.* Gland, Switzerland and Cambridge, UK, IUCN.

Stolton, S. and Dudley, N. 2010. *Vital Sites: The contribution of protected areas to human health*. Gland, Switzerland, WWF.

Stolton, S., Maxted, N., Ford-Lloyd, B, Kell, S. and Dudley, N. 2006. *Food Stores: Using protected areas to secure crop genetic diversity*. Gland, Switzerland and Birmingham, UK, WWF and University of Birmingham.

ten Brink, P., Mutafoglu, K., Schweitzer, J.P., Kettunen, M., Twigger-Ross, C., Kuipers, Y., Emonts, M., Tyrväinen, L., Hujala, T. and Ojala, A. 2016. *The Health and Social Benefits of Nature and Biodiversity Protection – Executive summary*. A report for the European Commission (ENV.B.3/ETU/2014/0039), London / Brussels, Institute for European Environmental Policy.

Trzyna, T. 2014. *Urban Protected Areas: Profiles and best practice guidelines.* Best Practice Protected Area Guidelines Series No. 22. Gland, Switzerland, IUCN.

United Nations. 2015. *Transforming our World: The 2030 Agenda for Sustainable Development*. New York, United Nations.

STATUS AND PROSPECTS FOR ACHIEVING AICHI BIODIVERSITY TARGET 11: IMPLICATIONS OF NATIONAL COMMITMENTS AND PRIORITY ACTIONS

Patrick Gannon[1], Edjigayehu Seyoum-Edjigu[1], David Cooper[1], Trevor Sandwith[2], Braulio Ferreira de Souza Dias[3], Cristiana Paşca Palmer[1], Barbara Lang[4], Jamison Ervin[5], and Sarat Gidda[1]*

* Corresponding author: sarat.gidda@cbd.int
[1]Secretariat of the Convention on Biological Diversity (SCBD), Montreal, Canada
[2] IUCN (International Union for Conservation of Nature), Gland, Switzerland
[3]Department of Ecology, University of Brasilia, Brasilia, DF, Brazil
[4]Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, Eschborn, Germany
[5]United Nations Development Programme, New York, USA

ABSTRACT
This paper reviews the current status of Aichi Biodiversity Target 11 at the global level. Although there remain gaps in the coverage of ecological regions and areas important for biodiversity and ecosystem services, 10 per cent coverage of coastal and marine areas under national jurisdiction has already been surpassed. The full implementation of agreed national priority actions and other commitments, including those in National Biodiversity Strategies and Action Plans, will expand coverage of the global ocean beyond 10 per cent, and result in more than 17 per cent coverage of terrestrial and inland waters. These commitments will also lead to substantial progress in other elements of the Target. Appropriate recognition of other effective area-based conservation measures and governance types, inter alia, privately protected areas and territories and areas conserved by indigenous peoples and local communities, currently under-reported in global assessments, would further improve the prospects for the achievement of Target 11. This will generate not only multiple benefits for the well-being of society by contributing solutions to the most important global challenges, but will also contribute to other Aichi Targets and globally agreed goals. Hence, concerted efforts by all stakeholders to facilitate the implementation of commitments towards achieving Target 11 will be a wise investment.

Key words: Protected Areas, Other Effective Area-Based Conservation Measures (OECMs), Aichi Biodiversity Target 11, Convention on Biological Diversity (CBD), National Priority Actions, National Biodiversity Strategies and Action Plans (NBSAPs)

INTRODUCTION

The Strategic Plan for Biodiversity 2011–2020 and the 20 Aichi Biodiversity Targets were adopted in 2010 at the tenth meeting of the Conference of the Parties (COP) to the Convention on Biological Diversity (CBD, 2010a) and subsequently endorsed by all other global biodiversity-related conventions and by the United Nations General Assembly (Resolution 65/161). Target 11 calls for:

> By 2020, at least 17 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes (CBD, 2010a).

Furthermore, in October 2012, at its eleventh meeting, the COP invited Parties to undertake major efforts to achieve all elements of Target 11 (CBD, 2012). Two years later, the midterm assessment presented in the fourth Global Biodiversity Outlook (GBO-4) indicated that Target 11 showed some progress, suggesting that more focused and systematic efforts would be required for achieving all elements of the Target by 2020 (SCBD, 2014). Based on the available data, projections showed that, if current trends continued, at least 17 per cent coverage for terrestrial and inland waters would be achieved by 2020 but all other elements would not be met (SCBD, 2014).

Therefore, to facilitate the full achievement of Aichi Biodiversity Target 11, the Secretariat of the Convention on Biological Diversity, in collaboration with partners,

developed a two-phase strategy, to be carried out over the 2015 to 2020 period.

The first phase (2015–2016) included, inter alia, the development of baseline data/information dossiers on Target 11 for each country. It also entailed facilitating capacity development to Parties through regional workshops, for securing the submission of:

- information on the actual status of various elements of the Target, gaps and opportunities for improvement,
- priority actions in the form of roadmaps[1], to advance progress in achieving the Target by 2020, and
- responses to a detailed questionnaire.

Following completion of the six regional workshops, 108 Parties submitted information on status, gaps and opportunities, 101 submitted their national priority actions, while 64 submitted responses to the questionnaire. The second phase (2017–2020) involves facilitating implementation of these priority actions, along with other national commitments, and will be discussed further in the last section.

The objective of this paper is to evaluate information on the current status of the elements of Target 11 at the global level. We wished to highlight the nature of potential progress to be made through, inter alia, fulfilling commitments made by the Parties in their National Biodiversity Strategies and Action Plans (NBSAPs) and national priority actions, the Promise of Sydney of the IUCN World Parks Congress 2014, and the 2016 IUCN World Conservation Congress, including their contribution to meet other Aichi Targets and globally agreed goals and challenges.

STATUS AND PROSPECTS FOR ELEMENTS OF AICHI BIODIVERSITY TARGET 11

The indivisible nature of Target 11 means that for successful achievement, all elements of the Target need to be met. The elements of Target 11 refer to the individual clauses in the language of the target, with separate indicators used to assess progress for each element, and include: at least 17 per cent coverage of terrestrial and inland waters and 10 per cent coverage of coastal and marine areas, ecological representation, coverage of areas important for biodiversity and ecosystem services, connectivity, integration into the wider landscapes and seascapes, and effective and equitable management.

At least 17 per cent of terrestrial and inland water and 10 per cent of coastal and marine areas

As of June 2017, global protected area coverage for terrestrial and inland waters had reached 14.8 per cent, excluding Antarctica; while in the marine realm, 14.4 per cent coverage had been achieved for areas within national jurisdiction, with 5.7 per cent coverage for the entire ocean (UNEP-WCMC, 2017a). In August 2017, following implementation of marine commitments in Cook Islands and Gabon, among others, marine coverage in national jurisdiction had reached 15.9 per cent, with 6.3 per cent coverage for the entire ocean (UNEP-WCMC & IUCN, 2017a).

National commitments have been communicated by Parties through several different fora (Table 1). If these commitments are implemented by 2020, it should be possible to achieve the minimum coverage for terrestrial and inland waters and at least 10 per cent coverage for the global ocean (Figure 1; see supplementary Tables 1 and 2 for the net commitments of each country, after removing redundancy and double counting). Coverage of areas beyond national jurisdiction would still lag, with approximately 1.8 per cent protected, almost all in Antarctic seas. Ongoing progress in work towards an international legally binding instrument under the UN Convention on the Law of the Sea, focusing on conservation and sustainable use of high seas biodiversity, may begin to address greater representation for areas beyond national jurisdiction, among other aims.

Table 1. Area (km^2) to be added if national commitments area implemented as proposed

Source of national commitment	Terrestrial and inland waters	Coastal and marine areas within national jurisdiction	Marine areas beyond national jurisdiction
National priority actions	611,943	353,258	0
Approved GEF-5 and GEF-6 projects	257,217	315,439	0
Post-COP10 NBSAPs	3,003,408	2,004,710	0
UN Ocean Conference		8,065,824	1,800,000
Other Large MPA proposals		1,931,409	1,550,000
Micronesia and Caribbean Challenges		272,549	0
Total additions:	3,872,568	12,943,189	3,350,000

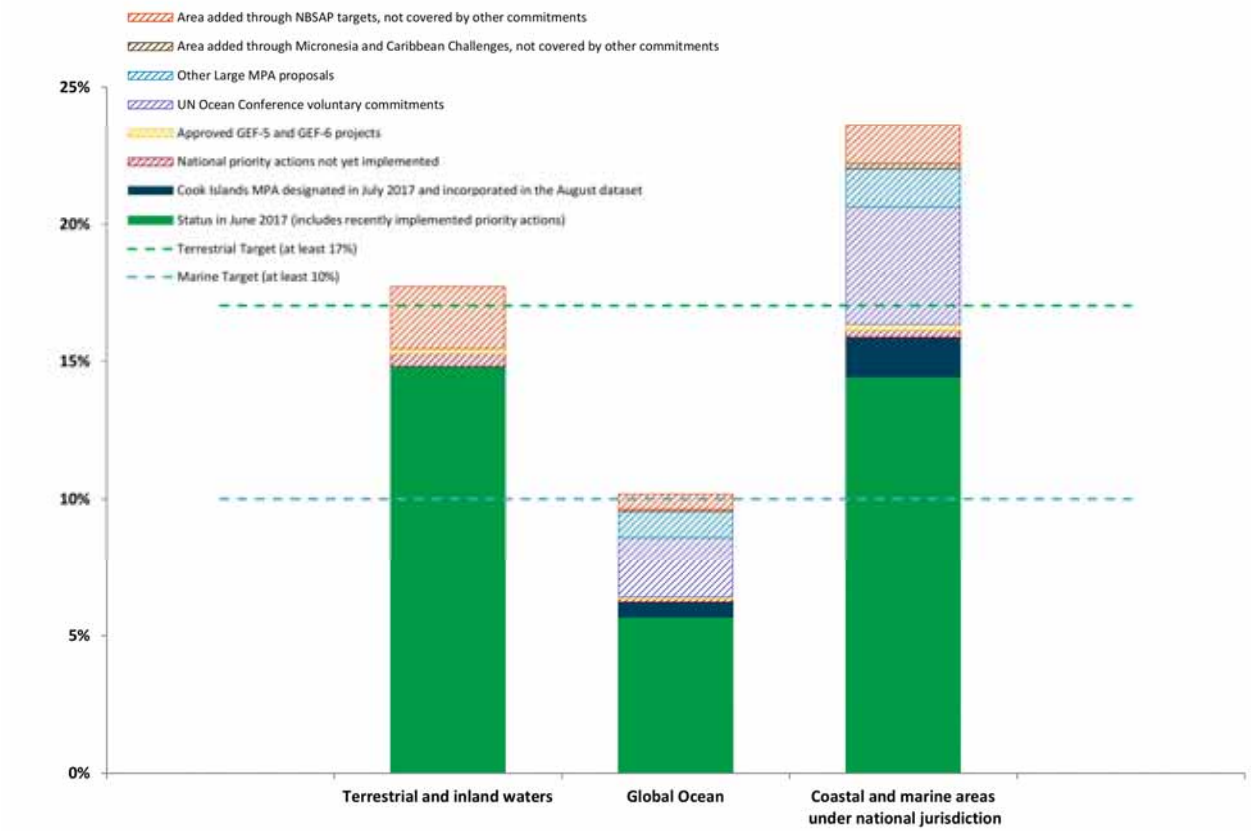


Figure 1. Progress towards the minimum coverage targets of Aichi Biodiversity Target 11 resulting from the implementation of national priority actions, approved GEF-5 and GEF-6 projects, NBSAP protected area targets and other commitments. Current coverage of protected areas from the June 2017 release of the WDPA (UNEP-WCMC, 2017a)

Other opportunities

In several decisions (e.g. IX/18 and X/31), Parties have been invited to recognise the contribution of privately protected areas (PPAs), and territories and areas conserved by indigenous peoples and local communities (ICCAs). However, both categories may be under-represented in the World Database on Protected Areas (WDPA), the global database that is used for assessing progress towards Target 11 (Kothari et al., 2012; Stolton et al., 2014; UNEP-WCMC & IUCN, 2017b). Efforts to recognise and report these areas, subject to the free, prior and informed consent of the relevant communities, would do much to address this knowledge gap and may change the outlook for Target 11 significantly.

Some national commitments included the intention to expand protected area networks (e.g. in national priority actions, NBSAPs, UN Ocean Conference voluntary commitments), yet they did not specify the extent of the planned expansions. Furthermore, 24 Parties submitted NBSAPs containing protected area targets with a deadline beyond 2020. If these targets are met, an additional 740,000 km2 in terrestrial and over 1.1 million km^2 in marine protected areas will be added globally by 2030. Any of these proposed additions implemented prior to 2020 will contribute further to Target 11.

At the recent UN Ocean Conference, the Wildlife Conservation Society committed to supporting the establishment of 3.7 million km^2 of marine protected areas in 19 countries (WCS, 2017). As information regarding the area being added in each country is currently unavailable, this commitment was not included in this assessment, to avoid potential overlaps with other national commitments. These proposed new protected areas will also contribute significantly to improving marine coverage.

Additionally, many countries still do not formally recognise existing reserves (e.g. for forests and water protection) as part of their national system of protected areas. In recent years some countries have updated their national legislation on protected areas, recognising diverse categories and governance systems. To the extent that more countries could contemplate such revisions, formally recognising some of these existing reserves, the situation for Target 11 would further improve. However, care needs to be taken to ensure that these reserves, and all national commitments, meet the CBD and IUCN definition of a protected area[2,3].

Other effective area-based conservation measures

The language of Target 11 allows for conservation goals to be met through either protected areas or other effective

Partnership for Achieving Aichi Biodiversity Target 11. © IISD/Kiara Worth (enb.iisd.org/biodiv/cop13/riopavilion/12dec.html)

area-based conservation measures (OECMs). OECMs offering conservation value in areas complementary to protected areas will provide many potential benefits for the elements of Target 11, provided these are well-defined and include measures that lead to long-term outcomes for the conservation of nature as a whole. There is some concern that too broad a definition may be applied, opening the possibility of including inappropriate land uses or management activities, or that the designation of OECMs may be used to avoid having to expand protected areas (Woodley et al., 2012; Jonas et al., 2014). Therefore, there is a need for specific guidance and an agreed upon working definition for OECMs to maximise their impacts. A Taskforce established through IUCN's World Commission on Protected Areas has begun the process of developing technical guidance on OECMs, including a draft screening tool, and discussion over the potential types of OECMs.

The Conference of the Parties, at its thirteenth meeting (COP-13), invited Parties to review experiences on "protected areas and other effective area-based conservation measures, taking into account the work of the International Union for Conservation of Nature and other appropriate expert bodies" (CBD, 2016a). The Executive Secretary was requested to develop voluntary guidance on OECMs and to organise a technical expert workshop "to provide scientific and technical advice on definition, management approaches and identification of other effective area-based conservation measures and their role in achieving Aichi Biodiversity Target 11" and to report on progress to the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA) before the fourteenth meeting of the COP (COP-14) in 2018 (CBD, 2016a). The conclusion of this process will enable the recognition of OECMs and support their contribution to Target 11.

Ecological representation and areas important for biodiversity and ecosystem services

Globally, ecological representation is generally assessed based on the representation of different ecoregions within protected area networks (UNEP-WCMC & IUCN, 2016). Comprehensive systems of terrestrial and marine ecoregions (extending to the 200m isobath) have been developed (Olson et al., 2001; Spalding et al., 2007) with a system of 37 pelagic provinces covering marine areas beyond the 200m isobath (Spalding et al., 2012).

As per the analysis carried out for the Protected Planet Report 2016, in April 2016, 349 of the 821 non-Antarctic terrestrial ecoregions (42.5 per cent) had reached 17 per cent coverage (JRC & UNEP-WCMC, 2016). Reaching 17 per cent in all ecoregions, however, may be unrealistic due to the small size and fragmentation of remaining habitat in some ecoregions. A recent assessment found that some ecoregions did not have enough remaining natural or semi-natural habitat to reach 17 per cent protected area coverage (Dinerstein et al., 2017).

As of April 2016, only 84 of 232 marine ecoregions (36.2 per cent) had more than 10 per cent coverage and one-third of them had less than 2 per cent coverage; for pelagic provinces, coverage was even lower, with only 3 out of 32 (9.4 per cent) reaching 10 per cent (JRC & UNEP-WCMC, 2016). This is in line with the poor coverage for high seas areas and the uneven distribution of marine protected areas around the globe.

Priority actions were submitted by 93 Parties to make their protected area networks more ecologically representative. Many of these involve the expansion of protected areas in under-protected regions, like in Sierra Leone, where they have made two terrestrial and one marine ecoregion priority sites for further protection, or

in Brazil, whose goal is to protect 30 per cent of the Amazon, and 17 per cent of all other biomes.

Key Biodiversity Areas (KBAs) are sites that make a substantial contribution to the persistence of biodiversity globally, at the level of genes, species or ecosystems. They are identified nationally using global criteria and thresholds, and are useful for targeting strategic expansion of protected area networks (IUCN, 2016). KBAs are being used as one measure for tracking progress towards this element of Target 11 (CBD, 2016b; UNEP-WCMC & IUCN, 2016).

By April 2016, 14,595 KBAs had been identified, with many more country assessments still in progress (BirdLife International, 2016). These included among others, 585 Alliance for Zero Extinction sites (AZEs), containing more than 95 per cent of the global populations of highly threatened species with restricted geographic distribution (Ricketts et al., 2005), and over 12,000 important bird and biodiversity areas (IBAs), which are sites of global importance primarily for avian conservation (BirdLife International, 2014). As of 2016, only 19.3 per cent of these KBAs were fully covered by existing protected areas, and only 114 out of 585 AZEs (19.5 per cent) were fully covered (BirdLife International, 2016). Although protected area coverage has been increasing in recent years, improvement in the protection of KBAs has slowed, increasing by only one per cent over the last decade (UNEP-WCMC & IUCN, 2016). As AZEs represent sites where extinction is imminent, it is necessary to fully protect all 585 sites. A marked growth in the number of IBAs and other KBAs that are covered by protected areas, other conserved areas or OECMs would constitute significant progress for this element.

Specific plans to protect KBAs were identified by 26 Parties in their priority actions, with 15 Parties providing the specific number of sites that will be protected. If implemented, the actions of these 15 Parties will improve protected area coverage for at least 84 IBAs and 12 AZEs by 2020. It is noteworthy that a majority of the terrestrial protected areas supported by the Global Environment Facility (GEF) funding over the years have addressed protection of KBAs (GEF, 2015). The proposed new or expanded protected areas in 98 GEF-5 and GEF-6 projects will certainly improve the coverage of KBAs.

For the coverage of areas important for ecosystem services, there is currently no indicator identified for use at the global level (CBD, 2016b), although many tools are available for mapping ecosystem service supply (Martínez-Harms & Balvanera, 2012) and demand (Wolff et al., 2015). These areas may also be poorly correlated with those areas of importance for biodiversity (Cimon-Morin et al., 2013). There is, therefore, a need to consider separately those areas important for biodiversity and for ecosystem services (Manhães et al. 2016).

Trevor Sandwith, IUCN, leading a session at the capacity-building workshop for East and South-East Asia on achieving Aichi Biodiversity Target 11 © Convention on Biological Diversity Secretariat

Several Parties have provided priority actions to address the protection of areas important for ecosystem services. For instance, Colombia plans to declare at least three areas for the protection of water resources, and to protect species contributing to the conservation of fisheries resources. Five countries have also proposed actions related to payment for ecosystem services programmes. Overall, there remains much work to be done to ensure that the contribution of the existing systems of protected and conserved areas to the conservation of ecosystem services is properly accounted for, and that the gaps in protecting areas important for a full range of ecosystem services are adequately addressed.

As spatial data for other proposed and newly established protected areas become available, and with the addition of PPAs, ICCAs and OECMs, it is likely that the status of the above three elements will improve further. There is a need for systematic mapping of all of these additions to assess the full extent of their contribution. There is work currently underway to assess OECM coverage of KBAs that fall outside protected areas in 10 countries (Cambridge Conservation Initiative, 2016). Better coordination with, and recognition of, biodiversity conservation efforts under way in other biodiversity-related conventions should also help countries to achieve the different elements of Target 11 by 2020. To this end, more explicit recognition of activities that contribute to Target 11 included in the national reports submitted by parties to these other conventions would be appropriate.

Connectivity and integration into the wider landscape and seascape

For connectivity, the proposed indicator, Protected Area Connectedness Index (GEO BON, 2015), is under active development and not yet available for use (CBD, 2016b). Recent studies have attempted to quantify the degree of connectivity of the global protected area network, at country and continent-wide scales (Santini et al., 2016) and within terrestrial ecoregions (Saura et al., 2017). These assessments were done using graph-based metrics that measure the amount of land that is reachable through dispersal by terrestrial birds and mammals across the protected area network, accounting for both the area reachable within a protected area and between protected areas. The application of this approach has led to the development of the Protected-Connected indicator, which measures connectivity as the proportion of some region (country, continent, ecoregion, etc.) that is covered by connected protected lands for some specified dispersal distance (Saura et al., 2017).

It is reported that between 25 and 37 per cent of terrestrial ecoregions had protected area networks of sufficient configuration and scale to permit dispersal for median dispersal distances of 1 to 100 km, covering the abilities of most terrestrial birds and mammals (Saura et al., 2017). Despite global protected area coverage approaching 15 per cent, only 8.5 to 11.7 per cent would meet this measure of connectivity for the same range of dispersal distances. Connectivity for marine protected areas has not yet been assessed, though with some modification, this indicator could be applied in the marine realm (Saura et al., 2017).

Alongside the expansion of protected areas, carrying out landscape-scale ecosystem restoration and the sustainable management of land-uses like agriculture and forestry, among others, is recognised as a required aspect of biodiversity conservation, enhancing ecosystem services and sustainable development (SCBD, 2014). In highly fragmented landscapes, these activities will be necessary to ensure appropriate levels of connectivity and encourage biodiversity conservation in protected areas (Janishevski et al., 2015).

Priority actions to address connectivity of protected area networks were provided by 91 Parties. Several of these actions address ecosystem restoration activities. For example, Bangladesh plans to restore degraded forests through assisted natural regeneration. As well, many actions include the creation of new, or improved management of existing biological corridors and connectivity areas (e.g. Timor-Leste and Samoa), or the development of transboundary conservation (e.g. several projects between Togo and its neighbours), among others.

Protected areas must also be integrated into the wider landscapes and seascapes, as well as broader sectoral plans and policies, to yield their full benefits (Ervin et al., 2010). In this context, the wider landscapes and seascapes include “the array of land and water uses, management practices, policies and contexts that have an impact within and beyond protected areas, and that limit or enhance protected area connectivity and the maintenance of biodiversity” (Ervin et al., 2010, p. 13), also including areas and sectors that can benefit from the biodiversity and associated ecosystem services provided by the protected areas.

The integration process is two-fold, involving not only linking protected areas into wider networks and with managed lands and waters, but also incorporating the design and management of protected areas into national and regional land-use plans, and other relevant laws and policies (Ervin et al., 2010).

No evaluation of progress for the integration element of Target 11 was included in the midterm assessment of GBO-4, and to date, no specific indicator is available (CBD, 2016b). Feasible early assessments could focus on the economic benefits provided by protected areas for water and hydropower supply, recovery of depleted

fisheries stocks and ecotourism. At COP-13, Parties were invited to review experiences on "additional measures to enhance integration of protected areas and other effective area-based conservation measures into the wider land- and seascapes", while the Executive Secretary was requested to develop voluntary guidance on integration and report progress to SBSTTA (CBD, 2016a).

The most common sectors for integration with protected areas, identified by the Parties that responded to the workshop questionnaire, were agriculture (80 per cent), forestry (73 per cent), water resources (64 per cent), and energy and mining (58 per cent) (Figure 2). For the integration of protected areas into the wider land- and seascapes, and relevant sectors, 85 priority actions were submitted by 50 Parties.

Effective and equitable management

Expansion of the global protected area estate, alone, will not be sufficient to halt global biodiversity losses if it is not managed effectively, and does not have appropriate governance and equity measures in place. In 2010, Parties were invited to implement management effectiveness evaluations in at least 60 per cent of their total protected areas (CBD, 2010b). As of January 2015, only 21.4 per cent of CBD Parties, excluding overseas territories, had met this target (Coad et al., 2015). However, the Global Database for Protected Area Management Effectiveness (GD-PAME) contains information for only a small portion of the sites listed in the WDPA (UNEP-WCMC, 2017b).

It is important that management effectiveness assessments are repeated at the same site (or system) to track changes over time and implement remedial measures as needed (Woodley et al., 2012). A recent study evaluating the 722 sites in the GD-PAME with multiple assessments carried out using the "management effectiveness tracking tool" (METT), found that 69.5 per cent showed improvement in management scores between assessments, while 25.1 per cent experienced decreases (Geldmann et al., 2015). This is positive in the sense that it illustrates how the implementation of adaptive processes may be improving protected area management, though the relation to biodiversity impacts is indirect. More work is needed to comprehend the connections between management effectiveness and biodiversity outcomes (Coad et al., 2015; Geldmann et al., 2015).

Although many protected area management effectiveness assessment tools, like METT, include questions for tracking biodiversity outcomes, they are primarily concerned with management processes and inputs.

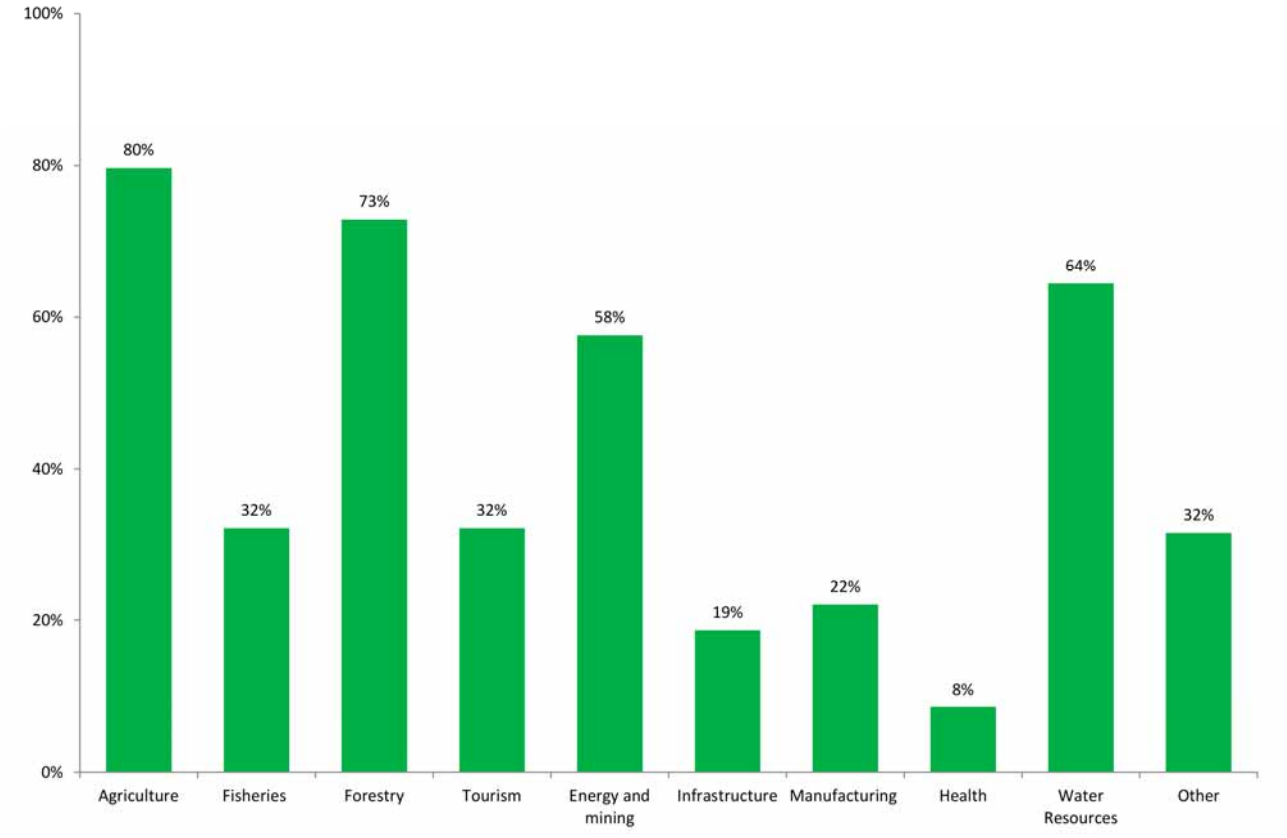


Figure 2. Responses from the workshop Questionnaire regarding the most important sectors for integration with the protected area system (n = 59). The fisheries sector includes aquaculture; mining and energy includes other extractive industries (oil and gas, etc.); others include an array of different sectors, common responses include security, science/research and cultural sectors

While these aspects of protected area management are important, there is also a need to track actual biodiversity outcomes in protected areas, which will require the use of other indicators. One of many possible measures of biodiversity outcomes related to effective management, the Wildlife Picture Index, has been proposed as an indicator for this element of the Target (CBD, 2016b). The Wildlife Picture Index measures the rate of change in the diversity of forest and savannah birds and mammals (O'Brien et al., 2010), though as of 2017, only 16 protected areas in 14 countries have been assessed using this indicator (TEAM Network, 2017).

The 240 priority actions submitted in the roadmaps of 95 Parties included: over 70 actions relating to protected area management plans, more than 45 actions involving management effectiveness evaluations, and over 100 other actions aimed at general improvements to protected area management effectiveness. For example, Republic of Korea aims to conduct management evaluations in at least 70 per cent of marine and terrestrial protected areas.

At least 74 Parties have approved GEF-5 and GEF-6 projects for expansion of protected areas that include management effectiveness evaluations, and numerous Parties have approved projects aimed at improving the management of existing protected areas. Actions identified in NBSAPs will also contribute to improving the effective management of protected areas. Examples include Swaziland's plan to create management plans for each Protection-Worthy Area that are in line with its conservation goals, and Belize's goal of increasing average management effectiveness of its protected area system to 80 per cent. The implementation of all of these actions should assist in both improving the state of management effectiveness assessments as well as actual biodiversity outcomes.

Protected area governance is also a key indicator to predict the success of protected areas (Barnes et al., 2016). Past COP decisions (e.g. Decision X/31) have invited Parties to diversify and strengthen protected area governance types, and governance quality; and the past decades have seen a general increase in the number of protected areas with shared or private governance, or governance by indigenous peoples or local communities (Juffe-Bignoli et al., 2014). It has also been shown that protected areas that consider broader social concerns, including the empowerment of local communities and the equitable sharing of costs and benefits, often demonstrate more positive conservation outcomes (Oldekop et al., 2015). Although many Parties are implementing methods for the assessment of protected area governance (e.g. Borrini-Feyerabend et al., 2013) and for the assessment of the social impacts of protected areas (Franks & Small, 2016), neither has yet been widely applied (Schreckenberg et al., 2016), and their global reporting is not comprehensive. Responding to the workshop questionnaire, 32 Parties reported completing some form of protected area governance assessment, while 81 have submitted priority actions to address governance and/or equity considerations for protected areas.

Decision XIII/28, on indicators for the Aichi Biodiversity Targets, did not include any specific indicator for equitable management (CBD, 2016b). However, there is an equity framework which has been proposed to assess progress on equitable management of protected areas, which includes 16 principles nested under three key dimensions (recognition of rights, procedure to promote participation in management decision making, and distribution of costs and benefits) all embedded within a set of enabling conditions (Schreckenberg et al., 2016). Many of the equity principles are included, to varying degrees, in several of the available governance and social assessment tools. The development of a focused equity assessment methodology, based around this framework, could be useful in situations where multiple assessments are not possible (Schreckenberg et al., 2016). A preliminary set of 10 indicators, covering the three dimensions of equity has been proposed, and could provide a useful means to address reporting on the equitable management element (Zafra-Calvo et al., 2017). Parties were invited to review experiences on "effective governance models for management of protected areas, including equity", while the Executive Secretary was requested to develop voluntary guidance and report progress to SBSTTA (CBD, 2016a).

The IUCN Green List of Protected and Conserved Areas Standard includes four components, addressing all aspects of the management elements of Target 11, namely, good governance, sound design and planning, and effective management, which all support successful conservation outcomes (IUCN & WCPA, 2016). The goal of the Green List is to "increase the number of Protected and Conserved Areas (PAs) that are effectively and equitably managed and deliver conservation outcomes" (IUCN & WCPA, 2016, p. 9). Parties were also invited to:

> promote the IUCN Green List of Protected and Conserved Areas as a voluntary standard to promote and encourage protected area management effectiveness; and to undertake or participate in, where relevant, national protected area governance assessments with a view to promoting, recognising and improving governance diversity, efficiency and equity in protected area systems (CBD, 2016a).

Further work needs to be done to ensure that criteria for assessing and reporting on this element of Target 11 are more systematically and broadly applied.

IMPORTANCE OF THE IMPLEMENTATION OF NATIONAL PRIORITY ACTIONS AND OTHER COMMITMENTS, AND THEIR IMPLICATIONS

For successful achievement of Target 11, all elements need to be considered, and significant progress should be made on each of them. It can be noted that the elements are closely linked; working towards one will influence the implementation of others. Results from the six regional workshops have provided a platform for participants to increase their understanding of the different elements, what information is needed for planning their contributions towards their achievement, and what actions they can undertake to realise the Target as a whole. CBD Parties from developing country regions identified over 1,400 actions to enhance the progress of these elements (Table 2), alongside the numerous commitments communicated through other fora by all CBD Parties.

Facilitating the implementation of the commitments, including monitoring and reporting, constitutes the main focus of the second phase (2017–2020) of the strategy of the CBD Secretariat.

What is needed to facilitate implementation?

To make implementation a reality, funding, technical support, monitoring and reporting are needed. A recent study on the performance of marine protected areas found a strong link between human and financial capacity for protected area management and actual ecological outcomes (Gill et al., 2017). All relevant partners, including government ministries/departments, GEF-implementing agencies, regional organisations, bilateral and multilateral funding agencies, the private sector, conservation and community organisations, should align their activities towards supporting implementation.

The second phase of the strategy of the CBD Secretariat is geared towards addressing this requirement. It includes, among other facets, the identification and mobilisation of relevant regional partners, bilateral and multilateral funding agencies and experts to enable regional implementation support networks that facilitate implementation on the ground, monitoring, and reporting to COP-14 in 2018. It is envisaged that these regional implementation support networks will coordinate and align ongoing capacity development activities by various agencies towards implementation of the national commitments, pursuant to Decision XIII/2 (CBD, 2016a). This would allow for mid-course corrections and continued support up to the 2020 target date and final reporting at the fifteenth meeting of the Conference of the Parties.

Hence, concerted efforts by all will be required to facilitate the implementation of national commitments and to put in place mechanisms for sustained capacity development, towards realising as many elements of the Target as possible by 2020, as called for in past COP decisions.

Table 2. Summary of priority actions submitted in Parties' roadmaps; 123 Parties attended one of the six workshops, while 5 Parties that did not attend submitted a roadmap

Element of Target 11	Number of Parties submitting at least one action	Number of priority actions submitted
Terrestrial Coverage	90	186
Marine Coverage	48	63
Ecological Representation	93	174
Areas Important for Biodiversity and Ecosystem Services*	91 (33)	207 (37)
Effective Management	94	238
Governance and Equity	80	163
Connectivity	91	173
Integrated into Wider Landscape and Seascapes	52	92
Other Effective Area Based Conservation Measures	84	158

* Actions for the conservation of areas important for biodiversity and ecosystem services were combined (numbers in brackets refer to actions directly addressing ecosystem services).

Implications of the implementation of commitments and the achievement of Target 11

If all national commitments are implemented as planned, taking consideration of their relative strength (e.g. availability of plans and funding for implementation), all elements of the Target will show improvements compared to the mid-term assessment of GBO-4. This will contribute to progress, both directly and indirectly, of many other Aichi Biodiversity Targets (SCBD, 2016a). Through the ecosystem services provided by protected areas, the implementation of the commitments could contribute to progress towards achievement of the goals and several targets of the 2030 Agenda for Sustainable Development, not only those on life on land and life below water, but also climate action, poverty eradication, and sustainable consumption and production, among others (SCBD, 2016b). It will also deliver various benefits with respect to climate change mitigation and adaptation (Gaüzère et al., 2016; Gross et al., 2016; Melillo et al., 2016), including to the (Intended) Nationally Determined Contributions of the Paris Agreement, the Sendai Framework for Disaster Risk Reduction 2015–2030 (Dudley et al., 2015), and the Land Degradation Neutrality goal of the United Nations Convention to Combat Desertification. In addition, there will also be contribution towards the fulfilment of requirements in other multilateral environmental agreements, such as UNESCO's World Heritage Convention and its Man and the Biosphere Programme, the Ramsar Convention, the Convention on Migratory Species, and other biodiversity-related conventions, in a synergistic manner.

These results will be important to inform the planning of the post-2020 global biodiversity framework and the setting of more ambitious goals for the future, as well as developing best practices for implementation based upon the lessons learned.

CONCLUSIONS

This review supports the statement that several elements of Target 11 may be achieved if the efforts in the past few years continue, if the means to address lagging aspects are further developed, and if all Parties and partners strive for enhanced and targeted implementation in a coherent and systematic manner. While at least 10 per cent coverage for marine areas under national jurisdiction has been surpassed, continued focused implementation of national priority actions and other commitments has the potential to lead to the achievement of this element for the global ocean, as well as at least 17 per cent of terrestrial areas. This will lead to substantial progress in some other elements of the Target, and even more so, if renewed attention is accorded to their requirements. Furthermore, guidance on OECMs and a comprehensive assessment of the contribution of PPAs and ICCAs, not currently accounted for in the WDPA, along with the mapping of these areas, will further improve the status of ecological representation, connectivity, and the coverage of areas important for biodiversity and ecosystem services. As more countries report on actions being taken to implement management effectiveness evaluations and begin to undertake assessments of protected area governance, equity and benefit sharing, a more encouraging picture will emerge regarding these elements of Target 11. Such expected progress and enhanced availability of information will certainly provide a sound basis for discussions regarding the post-2020 global biodiversity framework and the agreement of even more ambitious targets, as needed to achieve the agreed 2050 vision for biodiversity.

The achievement of Aichi Biodiversity Target 11 will generate multiple benefits for the well-being of society by contributing solutions to the most important of global challenges set out in the Strategic Plan for Biodiversity 2011–2020 and emphasised through the UN Sustainable Development Goals. It will also make a major contribution towards facilitating sustainable development through poverty alleviation and enhanced economic prosperity, towards a life in harmony with nature at the local, national and global levels, not only for the current but also future generations. The role and value of protected and conserved areas demonstrated in this way, we hope, will convince decision-makers and society at large that these areas are a valuable investment in the future of our planet.

ENDNOTES

[1]All priority actions are provided in the annexes of the final workshop reports, and are available at: www.cbd.int/meetings/.

[2]"A geographically defined area which is designated or regulated and managed to achieve specific conservation objectives" (CBD, 1992).

[3]"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" (Dudley, 2008).

SUPPLEMENTARY ONLINE MATERIAL

Supplementary Table 1. National commitments for terrestrial protected areas.

Supplementary Table 2. National commitments for marine protected areas.

ACKNOWLEDGEMENTS

We extend our utmost gratitude to the Focal Points of the Programme of Work on Protected Areas (PoWPA) of the Convention on Biological Diversity, our partners and friends in PoWPA, and participants of our regional capacity-building workshops, for their unending support

and contributions. We would also like to thank Dr Naomi Kingston, Head of Programme, Protected Areas and Dr Brian MacSharry, Senior Programme Officer, Protected Areas and Project Manager of the World Database on Protected Areas (WDPA) and associated products including the Protected Planet Report, at the UN Environment World Conservation Monitoring Centre, and our partners at the IUCN for their provision of updated data and information, inter alia, from the WDPA; Dr Stuart Butchart, Head of Science at BirdLife International for providing us with an analysis of the coverage of Key Biodiversity Areas (KBAs) by protected areas; as well as Dr Grégoire Dubois, Director for Sustainable Resources, and Mr Bastien Bertzky, Protected Area Specialist, at the European Commission's Joint Research Centre for sharing results of analyses on protected area coverage of terrestrial and marine ecoregions. Additionally, this work, among others, was made possible through the generous funding support of the Governments of Japan (Japan Biodiversity Fund), the Republic of Korea, and Germany (Gesellschaft für Internationale Zusammenarbeit (GIZ)), as well as the European Commission. Finally, the authors assume full responsibility for the views and opinions expressed in this article, that may not necessarily reflect the views and opinions of any organisations.

ABOUT THE AUTHORS

Patrick Gannon is a member of the Target 11 and 12 Team with the Conservation and Sustainable Use unit, Secretariat of the Convention on Biological Diversity. He was involved with providing an updated status of Aichi Biodiversity Target 11 and an analysis of national priority actions and approved GEF-projects, for CBD COP-13, as well as providing an analysis of the contribution of national commitments to the marine component of Target 11 and SDG 14.5 for the UN Oceans Conference. He is currently completing graduate studies in Environmental Assessment at Concordia University in Montreal.

Edjigayehu Seyoum-Edjigu is a member of the Target 11 and 12 Team with the Conservation and Sustainable Use unit, Secretariat of the Convention on Biological Diversity and protected area outreach with the United Nations Development Programme. She was closely involved in the Convention's three assessments of biodiversity funding needs and work related to biodiversity for poverty eradication and sustainable development. She has many years of experience including with the International Livestock Centre for Africa in Ethiopia and working on projects in agricultural and environmental economics, as well as climate change impact assessment. She holds a Master of Science in Agricultural Economics from McGill University in Montreal.

Dr David Cooper is Deputy Executive Secretary, Secretariat of the Convention on Biological Diversity (CBD). He was Secretary of the successful tenth meeting of the CBD Conference of the Parties, Nagoya, Japan, October 2010, which adopted the Strategic Plan for Biodiversity 2011–2020 and its twenty Aichi Biodiversity Targets. Previously, he has led the Convention's work on science, assessment and monitoring and to promote the implementation of the Convention through national biodiversity strategies and action plans. He holds a PhD in Plant Physiology from the University of Oxford.

Trevor Sandwith is an ecologist and nature conservation strategist who promotes the integration of biodiversity conservation and protected areas in sustainable economic and social development. He has experience in the governance and management of protected area systems, and in mainstreaming biodiversity considerations into development policies and planning. At the international level, he has specialised in transboundary governance of protected areas, equitably governed protected area programmes and in seeking recognition of ecosystem-based approaches to address climate change, and other global challenges. He is Director of IUCN's Global Protected Areas Programme, and was the Director of the IUCN World Parks Congress 2014.

Dr Braulio Ferreira de Souza Dias, former United Nations Assistant Secretary General and Executive Secretary of the Secretariat of the Convention on Biological Diversity, is currently Professor, Department of Ecology, University of Brasilia, Brasilia, Brazil. As the National Secretary for Biodiversity and Forests at the Brazilian Ministry of the Environment, he was deeply involved with the negotiations and implementation of the Convention on Biological Diversity since its origin. He was previously a Member of the Scientific and Technical Advisory Panel of the Global Environment Facility, Vice-President of the International Union of Biological Sciences and Coordinator of the Steering Committee of the Inter-American Biodiversity Information Network. He holds a PhD in Zoology from the University of Edinburgh.

Dr Cristiana Paşca Palmer is the United Nations Assistant Secretary General and Executive Secretary of the UN Convention on Biological Diversity. Prior to this appointment, she served as the Minister of Environment, Waters and Forests of the Government of Romania. She was also Head of the Climate Change, Environment, and Natural Resources Unit within the European Commission's International Development Agency, EuropeAID. Dr Paşca Palmer has over twenty years of experience in global policymaking and in coordinating the implementation of environment and sustainable development policies, programmes and projects at the

national and international levels. Dr Paşca Palmer received her PhD in International Relations from The Fletcher School of Law and Diplomacy at Tufts University in the US, and holds a Master in Public Administration from Harvard University's Kennedy School of Government, in addition to a Master of Science in Systems Ecology and Management of Natural Capital from the University of Bucharest in Romania.

Barbara Lang is an adviser at Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) in the headquarter -based Programme Implementing the Biodiversity Convention where she specialises in protected area governance. Trained as a forester, she has more than 15 years of experience in German development cooperation in the area of natural resource management.

Dr Jamison Ervin is Manager of the Global Programme on Nature for Development at the Bureau for Policy and Programme Support of the United Nations Development Programme (UNDP), in New York. She has worked with UNDP since 2008. Previously, she worked with The Nature Conservancy, World Wide Fund for Nature, and the Forest Stewardship Council. She holds a PhD. in Natural Resources from the University of Vermont.

Dr Sarat Babu Gidda is the Head of the Conservation and Sustainable Use unit, Secretariat of the Convention on Biological Diversity. He is an ecologist with over 25 years of experience in natural resource management, and in situ conservation. Dr Gidda served the Ministry of Environment of the Government of India, participated in the formulation of India's National Biodiversity Strategy and Action Plan, as well as the development and implementation of India's biodiversity legislation and biosafety regulations. He holds Masters and PhD degrees in Ecology, and another Masters in Rural Resources and Environment Policy from the University of London.

REFERENCES

Barnes, M.D., Craigie, I.D., Dudley, N. and Hockings, M. (2016). Understanding local-scale drivers of biodiversity outcomes in terrestrial protected areas. *Annals of the New York Academy of Sciences*. doi: 10.1111/nyas.13154.

BirdLife International (2014). *Important Bird and Biodiversity Areas: A global network for conserving nature and benefiting people*. Cambridge, UK: BirdLife International.

BirdLife International (2016). Analysis of protected area coverage of Key Biodiversity Areas using the April 2016 WDPA release for the *Protected Planet Report 2016*.

Borrini-Feyerabend, G., Dudley, N., Jaeger, T., Lassen, B., Broome, N.P., Phillips, A. and Sandwith, T. (2013). *Governance of Protected Areas: From understanding to action*. Best Practice Protected Area Guidelines Series No. 20, Gland, Switzerland: IUCN.

Cambridge Conservation Initiative (2016). The role of 'other effective area-based conservation measures' in achieving Aichi Target 11. Project: CCI-06-16-001. Available at: cambridgeconservation.org/collaboration/role-of-other-effective-area-based-conservation-measures-in-achieving-aichi-target-11.

CBD (Convention on Biological Diversity) (1992). *Convention on Biological Diversity. Article 2. Use of Terms*. Available at: cbd.int/convention/articles/default.shtml?a=cbd-02.

CBD (2010a). Decision adopted by the Conference of the Parties to the Convention on Biological Diversity at its tenth meeting. *Decision X/2. Strategic plan for biodiversity 2011–2020.* Available at: cbd.int/decision/cop/?id=12268.

CBD (2010b). Decision adopted by the Conference of the Parties to the Convention on Biological Diversity at its tenth meeting. *Decision X/31. Protected Area*s. Available at: cbd.int/decision/cop/default.shtml?id=12297.

CBD (2012). Decision adopted by the Conference of the Parties to the Convention on Biological Diversity at its eleventh meeting. *Decision XI/24. Protected Areas*. Available at: cbd.int/doc/decisions/cop-11/cop-11-dec-24-en.pdf.

CBD (2016a). Decision adopted by the Conference of the Parties to the Convention on Biological Diversity at its thirteenth meeting. *Decision XIII/2. Progress towards the achievement of Aichi Biodiversity Targets 11 and 12*. Available at: cbd.int/doc/decisions/cop-13/cop-13-dec-02-en.pdf.

CBD (2016b). Decision adopted by the Conference of the Parties to the Convention on Biological Diversity at its thirteenth meeting. *Decision XIII/28. Indicators for the Strategic Plan for Biodiversity 2011–2020 and the Aichi Biodiversity Targets*. Available at: cbd.int/doc/decisions/cop-13/cop-13-dec-28-en.pdf.

Cimon-Morin, J., Darveau, M. and Poulin, M. (2013). Fostering synergies between ecosystem services and biodiversity in conservation planning: a review. *Biological Conservation,* 166, 144-154. doi: 10.1016/j.biocon.2013.06.023.

Coad, L., Leverington, F., Knights, K., Geldmann, J., Eassom, A., Kapos, V., Kingston, N., de Lima, M., Zamora, C., Cuardros, I., Nolte, C., Burgess, N. and Hockings M. (2015). Measuring impact of protected area management interventions: current and future use of the Global Database of Protected Area Management Effectiveness. *Philosophical Transactions of the Royal Society B*, 370 (1681). doi: 10.1098/rstb.2014.0281.

Dinerstein, E., Olson, D., Joshi, A., Vynne, C., Burgess, N.D., Wikramanayake, E., Hahn, N., Palminteri, S., Hedao, P., Noss, R. and Hansen, M. (2017). An ecoregion-based approach to protecting half the terrestrial realm. *BioScience*, bix014, doi: 10.1093/biosci/bix014.

Dudley, N. (ed.) (2008). *Guidelines for Applying Protected Area Management Categories*. Gland, Switzerland: IUCN.

Dudley, N., Buyck, C., Furuta, N., Pedrot, C., Renaud, F. and Sudmeier-Rieux, K. (2015). *Protected Areas as Tools for Disaster Risk Reduction. A handbook for practitioners*. Tokyo and Gland, Switzerland: MOEJ and IUCN. doi: 10.2305/IUCN.CH.2015.02.en.

Ervin, J., Mulongoy, K.J., Lawrence, K., Game, E., Sheppard, D., Bridgewater, P., Bennett, G., Gidda, S.B. and Bos, P. (2010). *Making Protected Areas Relevant: A guide to integrating protected areas into wider landscapes, seascapes and sectoral plans and strategies*. CBD Technical Series No. 44, Montreal, Canada: Secretariat of the Convention on Biological Diversity.

Franks, P. and Small, R. (2016). *Understanding the social impacts of protected areas: a community perspective*. IIED Research Report. London: IIED.

Gaüzère, P., Jiguet, F. and Devictor, V. (2016). Can protected areas mitigate the impacts of climate change on bird's species and communities? *Diversity and Distributions*, 22 (6), 625–637. doi: 10.1111/ddi.12426.

GEF (Global Environment Facility) (2015). Impact evaluation of GEF support to protected areas and protected area systems, GEF/ME/C.49/Inf.02. Available at: thegef.org/.

Geldmann, J., Coad, L., Barnes, M., Craigie, I.D., Hockings, M., Knights, K., Leverington, F., Cuadros, I.C., Zamora, C., Woodley, S. and Burgess, N.D. (2015). Changes in protected area management effectiveness over time: A global analysis. *Biological Conservation*, 191, 692–699. doi: 10.1016/j.biocon.2015.08.029.

GEO BON (2015). *Global Biodiversity Change Indicators*. Version 1.2. Leipzig: Group on Earth Observations Biodiversity Observation Network Secretariat.

Gill, D.A., Mascia, M.B., Ahmadia, G.N., Glew, L., Lester, S.E., Barnes, M., Craigie, I., Darling, E.S., Free, C.M., Geldmann, J. and Holst, S. (2017). Capacity shortfalls hinder the performance of marine protected areas globally. *Nature*, 543(7647), 665-669. doi: 10.1038/nature21708.

Gross, J.E., Woodley, S., Welling, L.A. and Watson, J.E.M. (eds.) (2016). *Adapting to Climate Change: Guidance for protected area managers and planners*. Best Practice Protected Area Guidelines Series No. 24, Gland, Switzerland: IUCN. doi: 10.2305/IUCN.CH.2017.PAG.24.en.

IUCN (2016). *A Global Standard for the Identification of Key Biodiversity Areas*, Version 1.0, First Edition. Gland, Switzerland: IUCN.

IUCN and WCPA (World Commission on Protected Areas) (2016). IUCN Green List of Protected and Conserved Areas: User Manual, Version 1.0. Gland, Switzerland: IUCN.

Janishevski, L., Santamaria, C., Gidda, S.B., Cooper, H.D. and Brancalion, P.H.S. (2015). Ecosystem restoration, protected areas and biodiversity conservation. *Unasylva*, 66(245), 19-28.

Jonas, H.D., Barbuto, V., Jonas, H.C., Kothari, A. and Nelson, F. (2014). New steps of change: looking beyond protected areas to consider other effective area-based conservation measures. *Parks*, 20(2), 111-128. doi: 10.2305/IUCN.CH.2014.PARKS-20-2.HDJ.en.

JRC (European Commission Joint Research Centre) and UNEP-WCMC (2016). Global analyses of protected area coverage of marine and terrestrial ecoregions.

Juffe-Bignoli, D., Burgess, N.D., Bingham, H., Belle, E.M.S., De Lima, M.G., Deguignet, M., Bertzky, B., Milam, A.N., Martinez-Lopez, J., Lewis, E. and Eassom, A. (2014). *Protected Planet Report 2014*. Cambridge, UK: UNEP-WCMC.

Kothari, A., with Corrigan, C., Jonas, H., Neumann, A. and Shrumm, H. (eds.) (2012). *Recognising and Supporting Territories and Areas Conserved By Indigenous Peoples and Local Communities: Global Overview and National Case Studies*. CBD Technical Series No. 64, Montreal, Canada: Secretariat of the Convention on Biological Diversity, ICCA Consortium, Kalpavriksh, and Natural Justice.

Manhães, A.P., Mazzochini, G.G., Oliveira-Filho, A.T., Ganade, G., and Carvalho, A.R. (2016). Spatial associations of ecosystem services and biodiversity as a baseline for systematic conservation planning. *Diversity and Distributions*, 22(9), 932-943. doi: 10.1111/ddi.12459.

Martínez-Harms, M.J. and Balvanera, P. (2012). Methods for mapping ecosystem service supply: a review. International *Journal of Biodiversity Science, Ecosystem Services & Management*, 8(1-2), 17-25. doi: 10.1080/21513732.2012.663792.

Melillo, J.M., Lu, X., Kicklighter, D.W., Reilly, J.M., Cai, Y. and Sokolov, A.P. (2016). Protected areas' role in climate-change mitigation, *Ambi*o, 45(2), 133-145. doi: 10.1007/s13280-015-0693-1.

O'Brien, T.G., Baillie, J.E.M., Krueger, L. and Cuke, M. (2010). The Wildlife Picture Index: monitoring top trophic levels. *Animal Conservation*, 13, 335-343. doi: 10.1111/j.1469-1795.2010.00357.x.

Oldekop, J.A., Holmes, G., Harris, W.E. and Evans, K.L. (2015). A global assessment of the social and conservation outcomes of protected areas. *Conservation Biology*, 30(1), 133–141. doi: 10.1111/cobi.12568.

Olson, D.M., Dinerstein, E., Wikramanayake, E.D., Burgess, N.D., Powell, G.V., Underwood, E.C., D'amico, J.A., Itoua, I., Strand, H.E., Morrison, J.C. and Loucks, C.J. (2001). Terrestrial Ecoregions of the World: A New Map of Life on Earth. *Bioscience*, 51(11), 933-938. doi: 10.1641/0006-3568(2001)051%5B0933:TEOTWA%5D2.0.CO;2.

Ricketts, T.H., Dinerstein, E., Boucher, T., Brooks, T.M., Butchart, S.H., Hoffmann, M., Lamoreux, J.F., Morrison, J., Parr, M., Pilgrim, J.D. and Rodrigues, A.S. (2005). Pinpointing and preventing imminent extinctions. *Proceedings of the National Academy of Sciences of the United States of America*, 102(51), 18497–18501. doi: 10.1073/pnas.0509060102.

Santini, L., Saura, S. and Rondinini, C. (2016). Connectivity of the global network of protected areas. *Diversity and Distributions*, 22(2), 199-211. doi: 10.1111/ddi.12390.

Saura, S., Bastin, L., Battistella, L., Mandrici, A. and Dubois, G. (2017). Protected areas in the world's ecoregions: how well connected are they? *Ecological Indicators*, 76, 144–158. doi: 10.1016/j.ecolind.2016.12.047.

SCBD (Secretariat of the Convention on Biological Diversity) (2014). *Global Biodiversity Outlook 4*. Montreal, Canada: Secretariat of the Convention on Biological Diversity.

SCBD (2016a). Contribution of Aichi Biodiversity Target 11 National Priority Actions Identified in Regional Capacity-Building Workshops to Other Aichi Biodiversity Targets, UNEP/CBD/COP/13/INF/20. Available at: cbd.int/doc/meetings/cop/cop-13/information/cop-13-inf-20-en.pdf.

SCBD (2016b). Contribution of Aichi Biodiversity Target 11 to the Sustainable Development Goals: Potential impacts of national priority actions identified in the regional capacity-building workshops, UNEP/CBD/COP/13/INF/19. Available at: cbd.int/doc/meetings/cop/cop-13/information/cop-13-inf-19-en.pdf.

Schreckenberg, K., Franks, P., Martin, A., and Lang, B. (2016). Unpacking equity for protected area conservation. *Parks*, 22(2), 11-25. doi: 10.2305/IUCN.CH.2016.PARKS-22-2KS.en.

Spalding, M.D., Fox, H.E., Allen, G.R., Davidson, N., Ferdaña, Z.A., Finlayson, M.A.X., Halpern, B.S., Jorge, M.A., Lombana, A.L., Lourie, S.A. and Martin, K.D. (2007). Marine Ecoregions of the World: A Bioregionalization of Coastal and Shelf Areas. *Bioscience*, 57(7), 573–583. doi: 10.1641/B570707.

Spalding, M.D., Agostini, V.N., Rice, J. and Grant, S.M. (2012). Pelagic provinces of the world: a biogeographic classification of the world's surface pelagic waters. *Ocean & Coastal Management*, 60, 19-30. doi: 10.1016/j.ocecoaman.2011.12.016.

Stolton, S., Redford, K.H. and Dudley, N. (2014). The Futures of Privately Protected Areas. Gland, Switzerland: IUCN.

TEAM (Tropical Ecology, Assessment and Monitoring) Network (2017). About the Wildlife Picture Index (WPI) Analytics System. Available at: wpi.teamnetwork.org/wpi/about.

UNEP-WCMC (2017a). Global statistics from the World Database on Protected Areas (WDPA), June 2017. Cambridge, UK: UNEP-WCMC.

UNEP-WCMC (2017b). *Protected Planet: Global Database on Protected Area Management Effectiveness User Manual* 1.0. Cambridge, UK: UNEP-WCMC. Available at: wcmc.io/GDPAME_User_Manual_EN.

UNEP-WCMC and IUCN (2016). P*rotected Planet Report 2016*, Cambridge, UK and Gland, Switzerland: UNEP-WCMC and IUCN.

UNEP-WCMC and IUCN (2017a). Marine Protected Planet [September 2017]. Cambridge, UK: UNEP-WCMC and IUCN. Available at: protectedplanet.net/marine.

UNEP-WCMC and IUCN (2017b). The World Database on Protected Areas (WDPA) [June 2017]. Cambridge, UK: UNEP-WCMC and IUCN. Available at: protectedplanet.net.

WCS (Wildlife Conservation Society) (2017). Protecting 3.7 million sq kms through the $15 million WCS Marine Protected Area Fund, #OceanAction16178. Available at: oceanconference.un.org/commitments/?id=16178.

Wolff, S., Schulp, C.J.E. and Verburg, P.H. (2015). Mapping ecosystem services demand: A review of current research and future perspectives. *Ecological Indicators*, 55, 159-171. doi: 10.1016/j.ecolind.2015.03.016.

Woodley, S., Bertzky, B., Crawhall, N., Dudley, N., Londoño, J.M., MacKinnon, K., Redford, K. and Sandwith, T. (2012). Meeting Aichi Target 11: what does success look like for protected area systems. *Parks*, 18(1), 23-36. doi: 10.2305/IUCN.CH.2012.PARKS-18-1.SW.en.

Zafra-Calvo, N., Pascual, U., Brockington, D., Coolsaet, B., Cortes-Vazquez, J.A., Gross-Camp, N., Palomo, I. and Burgess, N.D. (2017). Towards an indicator system to assess equitable management in protected areas. *Biological Conservation*, 211, 134-141. doi.org/10.1016/j.biocon.2017.05.014.

RESUMEN

Este artículo examina el estado actual de la Meta 11 de Aichi para la Biodiversidad a escala mundial. Si bien aún existen diferencias en la cobertura de las regiones ecológicas y las áreas importantes para la biodiversidad y los servicios de los ecosistemas, ya se ha superado el 10% de cobertura de las zonas costeras y marinas bajo jurisdicción nacional. La implementación completa de las acciones nacionales prioritarias acordadas y otros compromisos, incluidos los de las estrategias y los planes de acción nacionales sobre biodiversidad, ampliará la cobertura de los océanos mundiales en más del 10% y dará lugar a más del 17% de cobertura de las aguas terrestres y continentales. Estos compromisos también conducirán a un progreso sustancial en otros elementos de la Meta. El reconocimiento apropiado de otras medidas eficaces de conservación y tipos de gobernanza basados en la zona, entre otros, áreas y territorios privados protegidos y áreas conservadas por pueblos indígenas y comunidades locales, que actualmente están subregistrados en las evaluaciones globales, mejoraría aún más las perspectivas para el logro de la Meta 11. Esto generará no solo beneficios múltiples para el bienestar de la sociedad al aportar soluciones a los desafíos mundiales más importantes, sino que también contribuirá a otras Metas de Aichi y objetivos acordados a nivel mundial. Por lo tanto, los esfuerzos concertados de todas las partes interesadas para facilitar la implementación de los compromisos para alcanzar la Meta 11 serán una buena inversión.

RÉSUMÉ

Ce document passe en revue l'état actuel de l'Objectif 11 du plan stratégique d'Aichi pour la biodiversité au niveau mondial. Bien qu'il subsiste des lacunes dans la couverture des régions écologiques, des zones particulièrement importantes pour la biodiversité et des services écosystémiques, une couverture de 10% des zones côtières et marines relevant de la juridiction nationale a déjà été dépassée. La pleine mise en œuvre des priorités approuvées au niveau nationale ainsi que d'autres engagements, y compris ceux dans le cadre des Stratégies et Plans d'Action Nationaux pour la diversité Biologique, élargiront la couverture de l'océan au-delà des 10% et résulteront en une couverture de plus de 17% des eaux terrestres et intérieures. Ces engagements conduiront également à de forts progrès sur d'autres aspects de l'Objectif. En effet, la bonne prise en compte d'autres mesures efficaces de conservation et de types de gouvernance, notamment dans les aires protégées privées et les territoires et aires conservés par les peuples autochtones et les communautés locales, qui sont actuellement sous-déclarés dans les évaluations mondiales, améliorerait les perspectives de réalisation de l'Objectif 11. Cela générera non seulement de multiples avantages pour le bien-être de la société en apportant des solutions aux plus grands défis mondiaux, mais contribuera également à d'autres objectifs d'Aichi et à des objectifs convenus à l'échelle mondiale. Par conséquent, les efforts concertés de toutes les parties prenantes en vue de faciliter la réalisation des engagements de l'Objectif 11 constituent un investissement judicieux.

MONITORING THE IMPACT OF FERAL HORSES ON VEGETATION CONDITION USING REMOTELY SENSED fPAR: A CASE STUDY IN AUSTRALIA'S ALPINE PARKS

Luciana L. Porfirio[1*], Ted Lefroy[2], Sonia Hugh[1] and Brendan Mackey[3]

*Corresponding author: Luciana.Porfirio@anu.edu.au (orcid.org/0000-0002-2208-1134)

1 The Fenner School of Environment & Society, The Australian National University, Building 48, Linnaeus Way Canberra, ACT, 0200, Australia.

2 Centre for Environment, University of Tasmania, Private Bag 14, Hobart, Tasmania 7001. orcid.org/0000-0002-3164-8948

3 Griffith Climate Change Response Program, Engineering and Architecture Building (G39), Gold Coast Campus, Griffith University, Parklands Drive, Southport, Qld 4222, Australia. orcid.org/0000-0003-1996-4064

ABSTRACT

Throughout the world, feral horses (*Equus caballus*) are causing environmental degradation and a decline in ecological integrity. Evidence from scientific monitoring is needed to inform the public debate and help land managers make informed decisions. We used field observations of vegetation condition at a network of sites in the Australian Alps where horses were present or absent. The data were combined with the remotely -sensed fraction of photosynthetic active radiation (fPAR) and topographic condition. Vegetation condition was assessed in the field by rangers using a modified version of the Landscape Function Analysis (LFA) index. We found significant differences in the LFA index between sites where horses were present or absent. Sites with presence of horses have 10 per cent lower fPAR than sites with absence of horses. The results also indicated a significant correlation between LFA and fPAR. Our analysis supports the hypothesis that feral horses have a negative impact on the condition of Australian alpine vegetation. This study provides a useful and relatively cost-effective method for monitoring the impact of feral horses on native vegetation, and can be used to support decision making and management interventions.

Key words: **Vegetation condition, Landscape Function Analysis, Propensity Score Matching, Australian Alps, fPAR, Decision tree, Recursive partitioning**

INTRODUCTION

Throughout the world, feral horses (*Equus caballus*) are causing environmental degradation and a decline in ecological integrity; defined in terms of the characteristic structure, composition and function of an ecosystem compared to the range of natural or historic conditions and disturbance regimes (Karr, 1996; Lindenmayer & Franklin, 2002; Parrish et al., 2003). Of particular concern is the extent to which feral horses degrade vegetation condition and associated ecosystem processes, which is a well-recognised conservation threat (Rogers, 1991). Feral horses have been shown to have negative impacts on the composition and structure of vegetation, and subsequently on landscape structure and ecological processes. For example, in the USA, Beever et al. (2008) identified positive associations between the presence of feral horses and soil compaction and subsequent increased runoff; reduced vegetation abundance; trampling and rubbing; removal of terminal meristems; and the distribution of nutrients. In Argentina, De Villalobos and Zalba (2010) found a negative association between total biomass and the presence of feral horses, and a positive association between the presence of forbs and bare soil and feral horses. However, effective control of feral horses remains a challenge due to various technical and social problems associated with the options available to land managers (Linklater et al., 2004; Nimmo & Miller, 2007; Reed, 2008).

In the face of the ecological impacts of feral horses, the impediments to management and the potential amplifying influences of climate change, improved information is essential for planning appropriate conservation responses. Field-based observations (i.e., *in -situ* techniques) are commonly used to assess the impacts of feral horses on natural ecosystems. However, to be effective for management, information is needed on a landscape-wide basis at short time periods. We suggest that remotely sensed satellite data can provide a cost-effective complementary source of information to assist land managers in monitoring the impacts of feral horses over regional extents and more frequently.

Previous studies have used remotely sensed Normalized Difference Vegetation Index (NDVI) to study wildlife habitat condition, vegetation dynamics and associated population dynamics. Henderson and Dawson (2009) detected significantly low values of NDVI in sites with presence of feral goats in the Galapagos Islands, indicating that the presence of feral goats has a negative impact on vegetation. However, Pettorelly et al. (2005) and Zinner's (2002) results suggest that topography can be a confounding factor when investigating relationships between vegetation condition and the presence or absence of big herbivores. These studies have found that invasive herbivores have a negative impact on the condition of vegetation. However, a method to remotely monitor this impact has not been proposed. Here, we test a new approach to assessing the impact of feral horses on vegetation condition using as a case study Australia's alpine parks. The approach is tested at a network of sites where horses were present or absent, using field observations of vegetation condition, remotely sensed data, and topographic data.

The ecological communities of the Australian Alps bioregion contain a unique composition of plant species, 39 of which are listed as vulnerable and 16 as endangered, along with four endangered and one critically endangered ecological community (Australian Government, 2001a) under federal legislation (Australian Government, 2008). While more than 70 per cent of this bioregion is in protected areas, feral animals represent a major threat to listed species and communities (Australian Government, 2001b). Feral horses in the Australian Alps are a major conservation management problem and, among other things, have been found to have negative impacts on the structure of vegetation (Whinam et al., 1994; Whinam et al., 2001; McDougall et al., 2005).

The current population of feral horses in Australia is estimated to be the largest in the world at around 400,000 individuals, with Dawson and Miller (2008) estimating the horse population within a 180 km² area of the Australian Alps in 2009 to be around 7,679 horses with an annual rate of increase of about 22 per cent. Recent modelling for the Victorian East Alps estimates a population of 8,200 to 10,900 (Parks Victoria, 2013). Furthermore, climate change imposes additional pressures on the bioregion's vegetation with a projected increase in the frequency and intensity of extreme droughts and fire events (Worboys, 2003; Williams et al., 2008).

To provide a suitable test of our approach, we investigated the following questions: (1) does vegetation condition of natural treeless drainage systems (riparian areas and wetlands) in the Australian Alps differ in areas with and without the presence of feral horses; (2) is there an interaction between the presence of horses and topography; and (3) can changes in vegetation condition (due to the presence of feral horses) be detected and monitored using remotely sensed data?

METHODS

Within our selected study region, we analysed three datasets at a network of field sites: (1) observations of horse presence and absence, (2) a Landscape Function Analysis (LFA) index was generated to provide an assessment of vegetation condition and (3) remotely sensed estimates of fraction of the photosynthetic active radiation (fPAR) were derived from a continental time series obtained from the Moderate Resolution Imaging Spectroradiometer (MODIS) product MOD13Q1. We used a set of statistical tests to balance and analyse the datasets. We balanced the landscape function analysis data using propensity score matching. We analysed the fPAR data using the 'breaks for additive and seasonal trend' (BFAST) model. Then, we used partitioning decision trees to explore (1) whether differences in the LFA index between sites were related to horse presence or site topographic attributes and (2) if there was a correlation between the LFA and fPAR. We also analysed if differences between sites with absence or presence of horses were statistically significant.

Study area

The study sites (n=171) were in the Australian Alps National Parks (35˚–38˚ S and 145˚–149˚ E) comprising an area of around 7,900 km² within New South Wales, Victoria and the Australian Capital Territory. The study sites were mostly located in subalpine areas (1,400 m to 1,900 m) with one site in alpine areas (> 1,900 m) (Green and Osborne, 1994). Ninety-one sites were in the state of Victoria, 76 in New South Wales and four in the Australian Capital Territory (Figure 1). The Australian Alps bioregion is dominated by a montane climate, with no dry season and a mild summer (Stern et al., 2000) with annual mean temperature 3 °C to 12 °C, mean minimum monthly temperature -7 °C to 0.4 °C, mean maximum monthly temperature 15.9 °C to 29.5 °C, mean annual rainfall 606 mm to 2,344 mm, minimum average monthly rainfall 44 mm to 126 mm, and mean maximum monthly rainfall 63 mm to 295 mm (NSW Government, 2013). Exploratory data analysis was undertaken to examine the pairwise correlation between all variables (see Supplementary Online Material).

Feral horse data and the Landscape Function Analysis

The Australian Alps Liaison Committee carried out an *in-situ* assessment to determine if natural treeless drainage systems (riparian areas and wetlands) were susceptible to the impacts of feral horses (Geoff Robertson pers. comm., June/July 2013). A total of 171 random points within treeless drainage systems were assessed between 2010 and 2012. Of these, 129 points were known to be occupied by feral horses. The feral horses occur within

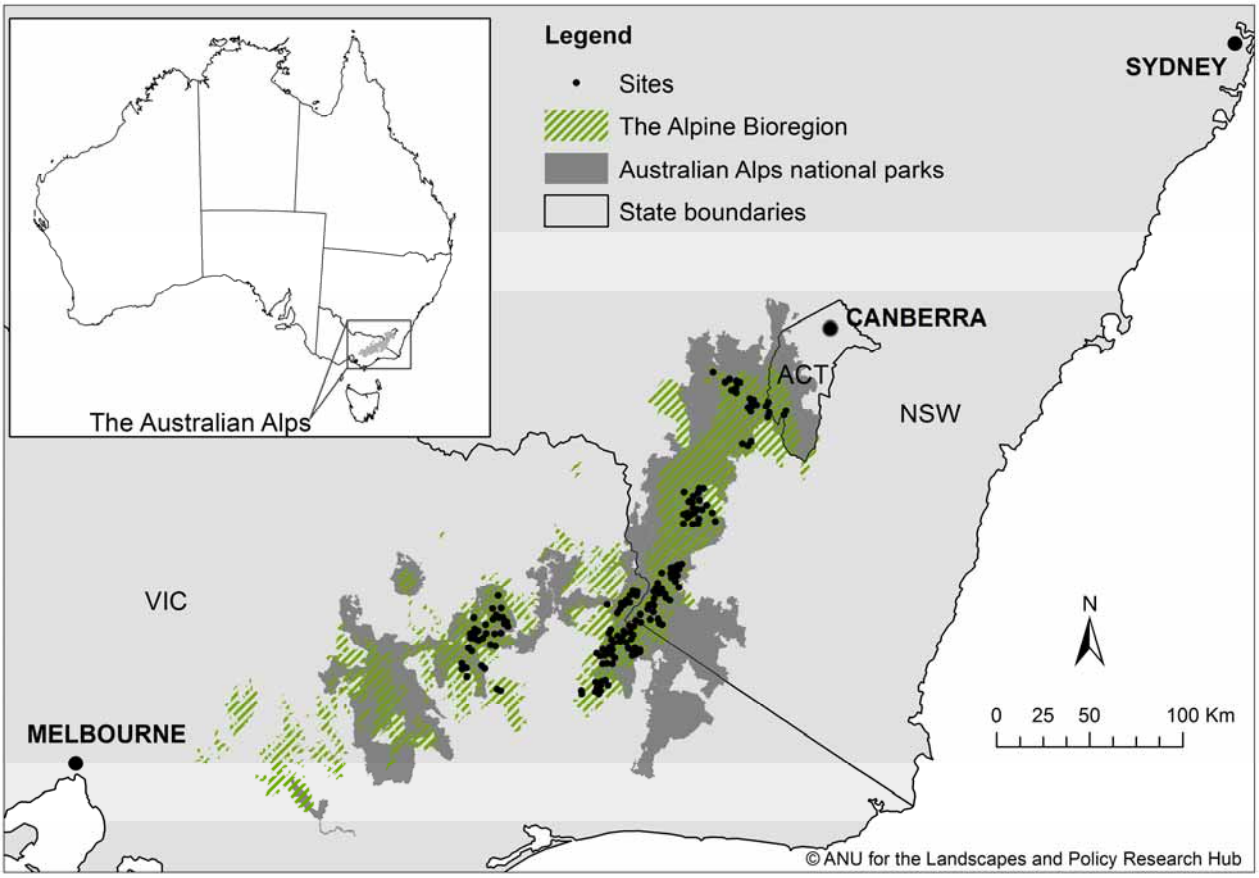


Figure 1. The Australian Alpine National Parks and the sites where the LFA index was assessed. Alpine National Parks - grey; Australian Alpine bioregion - hatched; VIC - Victoria; ACT - Australian Capital Territory; NSW - New South Wales.

more than 300,000 ha of Kosciuszko National Park and Bago and Maragle State Forests in New South Wales and around 330,000 ha of Victoria (Geoff Robertson pers. comm., June/July 2013).

The LFA index method applied at each site is an adaptation of the Landscape Function Analysis of Tongway and Hindley (2004). This is a monitoring procedure which uses visual indicators to assess the status of biotic and abiotic processes that retain water and nutrients. The visual indicators can be ranked from pristine to degraded, and when combined, they provide an overall estimate of the status of key soil properties using indices of soil stability, water infiltration and nutrient cycling. The modified LFA index included observations on the following variables: the number of defined animal tracks or pads within 20 m of a drainage system; the level of impact of defined animal tracks or pads; stream bank stability; longitudinal profile characteristics of a drainage line; sediment level on the stream bed; pugging damage (i.e. damage caused to grass by horses tearing up the soil structure); grazing disturbance on banks/in channel; percentage of vegetation cover; and percentage of the native foliage cover. The assessed features were combined into a single index for each site ranging from 0 to 100, representing degraded to pristine landscapes, respectively. As it was not feasible to map entire streams over the study area, a random 50 m length of drainage line was sampled at each location. If the 50 m length of drainage line possessed sections with different levels of impact, for example where a section of bank had collapsed, each section was assessed separately.

Remotely sensed fPAR

It has been well established that the remotely sensed Normalized Difference Vegetation Index (NDVI) is sensitive to changes in vegetation cover (Rouse et al., 1973; Holm et al., 1987; Reed, 2008). The NDVI is the normalised difference between the reflectance in the near infra-red and visible bands. As the NDVI increases, the proportion of green vegetation relative to soil cover increases. Radiation that is not reflected is intercepted. The greater the density of chlorophyll molecules in the vegetation, the greater the proportion of incoming radiation intercepted and available for photosynthesis (Berry et al., 2007). There is a linear relationship at time (t) between the proportion of photosynthetically active radiation that is intercepted by the green vegetation (fPAR), and the NDVI when $0 < NDVI < 1$ (Roderick et al., 2001).

Mean monthly estimates of fPAR data (250 m) were derived from MOD13Q1 NASA product (Schloss et al., 2002), resampled to a geographic projection and remapped to the Australian region using Berry and

Roderick's equations (Roderick et al., 2001; Berry & Roderick, 2002; Schloss et al., 2002; Berry et al., 2007; Paget & King, 2008) to isolate the turgor component, which represents the reflectance of radiation by the herbaceous vegetation within each pixel. The turgor component of the fPAR corresponds in this case to the productivity of native grasslands, which is the type of vegetation highly impacted by the presence of feral horses (Beever et al., 2008; de Villalobos & Zalba, 2010). The fPAR turgor values were extracted for the period 2000 to 2012 for 171 sites and the mean, maximum, minimum and coefficient of variation were calculated using the 'Raster' package (Hijmans & Etten, 2012) in R software (R Development Core Team, 2014) (Table 1). See Supplementary Online Material for detailed information about the formulae to obtain the fPAR proportions for different leaf functional types.

Breaks for additive and seasonal trend in vegetation

The break for additive and seasonal trend analysis (BFAST) (Verbesselt et al., 2010; Verbesselt et al., 2012) recognises seasonal trends in vegetation and detects anomalies in the seasonality that are commonly related to disturbances (Saatchi et al., 2013). We ran the 'BFAST' model (Verbesselt et al., 2010) in R software for each site and derived two indicators of change in the vegetation seasonality at the site level. The first indicator was the number of breaks in the fPAR seasonal component that were not related to seasonal changes (hereafter fPAR break index). The second indicator was the time, in months, taken for each site to recover to pre-break fPAR values (hereafter fPAR recovery index) (Table 1). Two examples of BFAST outcomes can be found in Figure 2, where the top panel shows a site (250 m pixel) with absence of horses and one abrupt change in 2009, as detected in the fPAR trend component. The bottom panel in Figure 2 shows a site with presence of feral horses and four abrupt changes are detected in the fPAR trend component.

Propensity score matching

The surveyed LFA data were not balanced, with just over twice as many sites where feral horses were present (n=116) as absent (n=55). Lack of balance is problematic when the objective is to test for differences between groups. To address this issue we used propensity score matching (Rosenbaum and Rubin, 1983) to balance the data. The propensity score matching for a site (i) is defined as the conditional probability of assignment to a particular treatment ($Ti = 1$) versus control ($Ti = 0$) given a set of observed covariates (Equation 1), where e = the propensity score, pr = the conditional probability and X = the background variables. The covariates were: LFA index; the mean, maximum, minimum and coefficient of variation of fPAR; slope; aspect; topographic position index; terrain ruggedness index; and roughness. The propensity score matching was then calculated using the nearest neighbour matching estimator without replacement using the 'Matching' package (Ho et al., 2006) and analysed using student's t-tests in R software.

$$e(x)_i = pr(T_i = 1|X = x_i)$$

Table 1. The list and description of the variables used in the analysis

Type of	Variable	Description
Ecosystem function indices	Coefficient of variation of fPAR	CV=□□□□□ (□□□□ 2000–2012) divided by □□□□ (□□□□ 2000–2012)
	Maximum of fPAR	Maximum fPAR value for the period 2000-2012
	Mean of fPAR	Mean fPAR value for the period 2000-2012
	Minimum of fPAR	Minimum fPAR value for the period 2000-2012
	fPAR break index	Number of breaks in the fPAR seasonal trend that are not related to seasonal changes. Modelled using BFAST.
	fPAR recovery index	Number of months to reach fPAR pre-disturbance values. Modelled using BFAST.
	Landscape function index	The assessed features in the survey were combined into the landscape function index for each site ranging from 0 to 100, representing degraded to pristine landscapes, respectively.
Terrain indices	Roughness	The difference between the maximum and the minimum value of a cell and its 8 surrounding cells.
	Slope	Radians.
	Topographic position index	The difference between the elevation value of a cell and the mean value of its 8 surrounding cells.
	Terrain ruggedness index	The mean of the absolute differences between the value of a cell and the value of its 8 surrounding cells.
	Aspect	Radians.

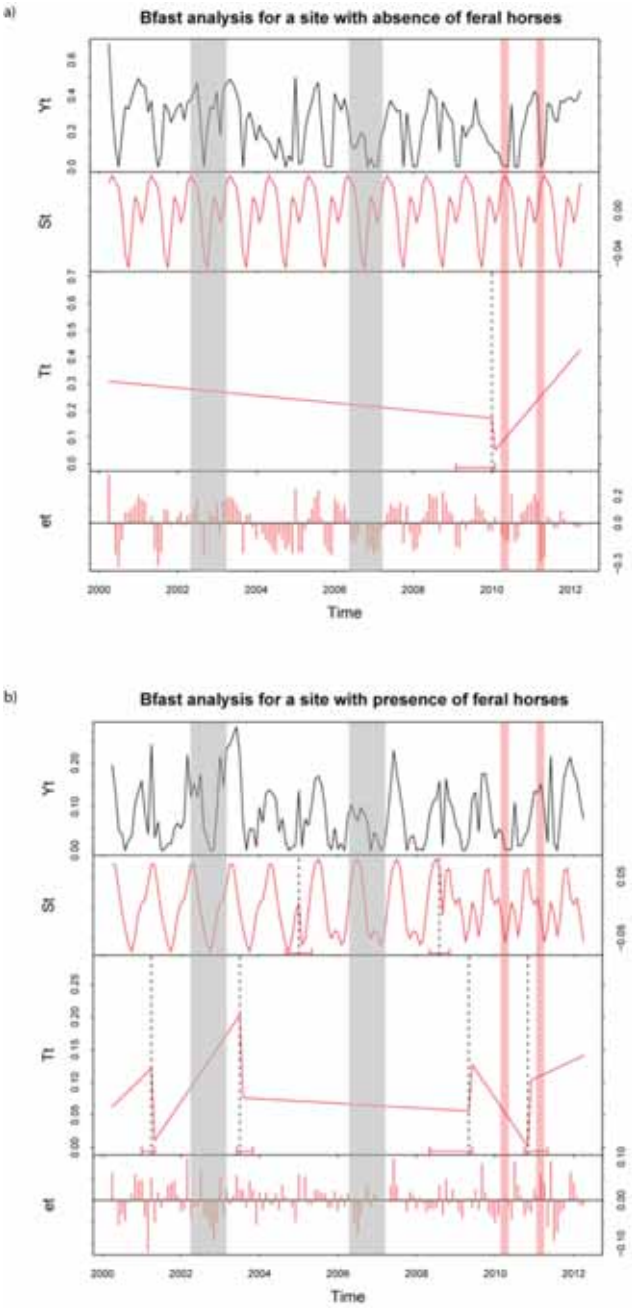


Figure 2. The observed fPAR (Yt), fitted seasonal (St), trend (Tt) and residuals (et) (i.e. estimated noise) components for a fPAR time series at two sites in the Australian Alps over the period 2000-2012. The top panel a) shows a site with absence of horses and one abrupt change (----) is detected in the trend component of the fPAR time series, associated with the drought in 2009. The bottom panel b) shows a site with presence of feral horses and four abrupt changes are detected in the fPAR trend component. The time (----), corresponding confidence interval (red horizontal lines at the bottom of dashed lines), direction and magnitude of abrupt change and slope of the gradual change are shown in the estimated trend component (red lines). The two severe droughts of the decade are shown in the grey bands, and dates when the LFA index was assessed are shown in the red bands across all estimates.

Decision tree analysis

We used decision tree analysis to investigate the relationships between the presence of horses, LFA index and fPAR values at the sites. Decision tree analysis is a multivariate analytical approach that allows sites to be grouped based on their similarity as measured by a set of variables (Hothorn et al., 2006). We calculated two models. The response variable in both models was the LFA index. The explanatory variables in the first model were the following topographic attributes: slope; topographic position index; roughness and aspect (see Table 1 for a description of the variables). The aim of the first model was to examine the interactions between the LFA index, the presence of horses and topography. To further analyse the level of significance in the interactions between presence of feral horses and topography we ran a variation of the first model, changing the α parameter to α=0.10; details provided in the Supporting Information. The second model used a set of explanatory variables derived from the fPAR time series data: mean and coefficient of variation of fPAR, fPAR Break Index; and fPAR Recovery Index. The aim of the second model is to examine whether there is an interaction between the LFA index and fPAR derivatives. We used only explanatory variables for which the correlation coefficient was lower than 0.5 (see Figure A1 in the Supplementary Online Material). We specified that the splits in the trees must not exceed α = 0.05 and the Nodes should contain at least 10 observations. The decision tree analysis was performed using the 'Party' package (Hothorn et al., 2006) in R software.

Brumbies, alpine region, Kosciuszko National Park
© Office of Environment and Heritage

RESULTS

Our results suggest that the presence of feral horses is correlated with the condition of natural treeless drainage systems (riparian areas and wetlands) in the Australian Alps. Decision tree models can be interpreted using 'if-then' rules (Markham et al., 2013). The decision tree for the first model is shown in Figure 3. In the first model, if the site was characterised by the absence of horses (Node 2 in Figure 3), then the LFA index presents values close to 100, representing a site with vegetation in good condition. If the site was characterised by the presence of feral horses (Node 3), then the LFA index was low, showing a mean of 50 (black line in Node 3's boxplot in Figure 3), representing sites with poor vegetation condition. There were no interactions between the presence or absence of feral horses and the terrain attributes at the P = 0.05 level. However, if feral horses are absent there was an interaction with a terrain attribute at the P = 0.06 level (see Figure A2 in the Supplementary Online Material).

The second decision tree model suggests that changes in vegetation condition at the landscape scale can be detected using remotely sensed data of 250 m pixel resolution. The second decision tree model, which did not include presence/absence of feral horses as a covariate, is shown in Figure 4. The two variables that were found to be most important in accounting for the variability of the LFA index were the mean fPAR and the fPAR break index. If the mean fPAR was lower than or equal to 0.12, the sites were allocated in Node 2 (see Figure 4) characterised by low LFA index (mean ~ 50), indicating sites in poor vegetation condition. If the mean fPAR was greater than 0.12, then the second most important variable was the fPAR break index (Node 3). If the number of breaks in the fPAR break index, which represent the seasonal component of vegetation, were lower than or equal to one, the sites were allocated to Node 4; which corresponds to high values and low variability of the LFA index (see Node 4 in Figure 4). Node 4 represents sites with the best vegetation

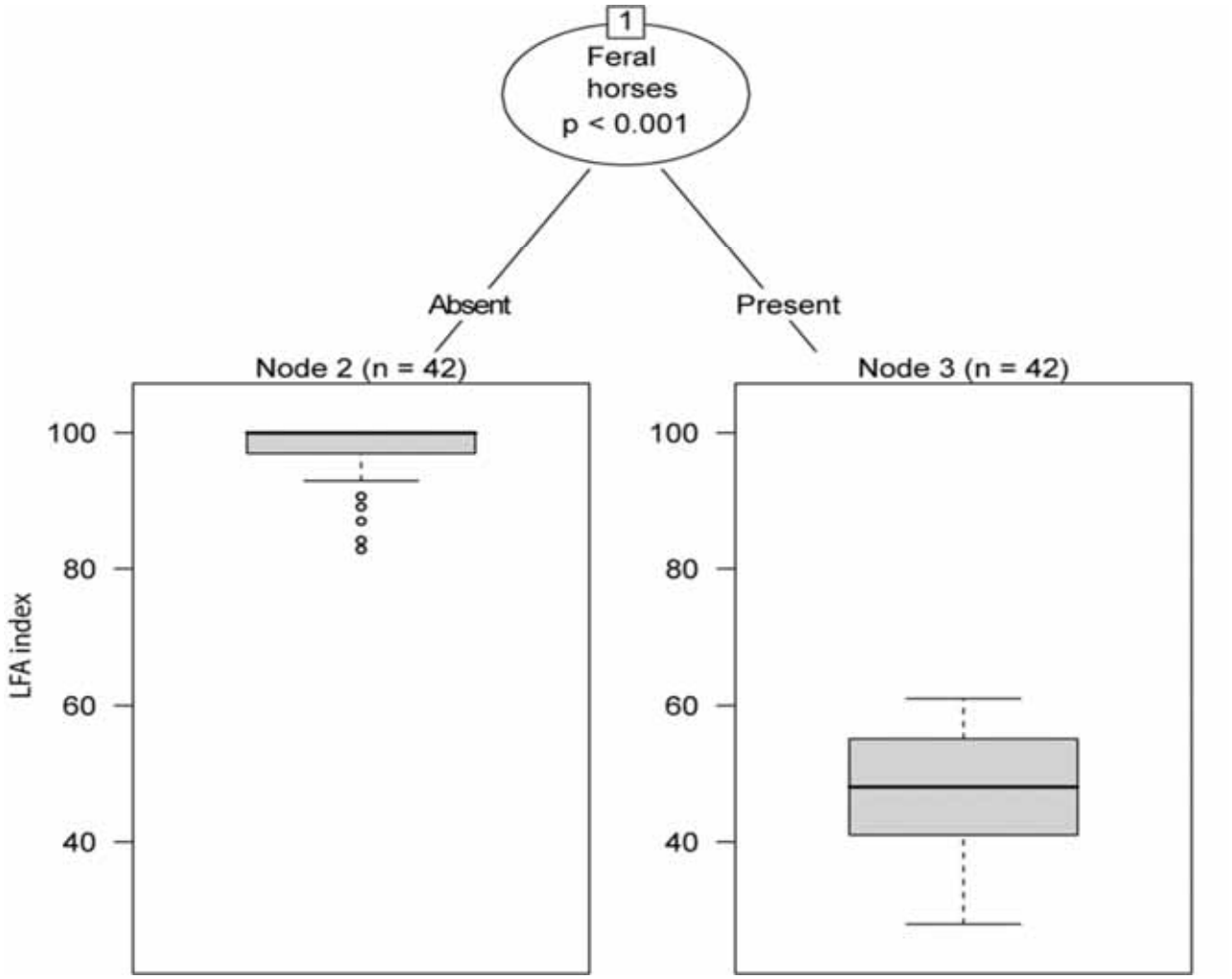


Figure 3. Decision tree model and the interaction between variables to explain the LFA index. The model uses the presence or absence of feral horses and terrain attributes to explain the LFA index (boxplots).

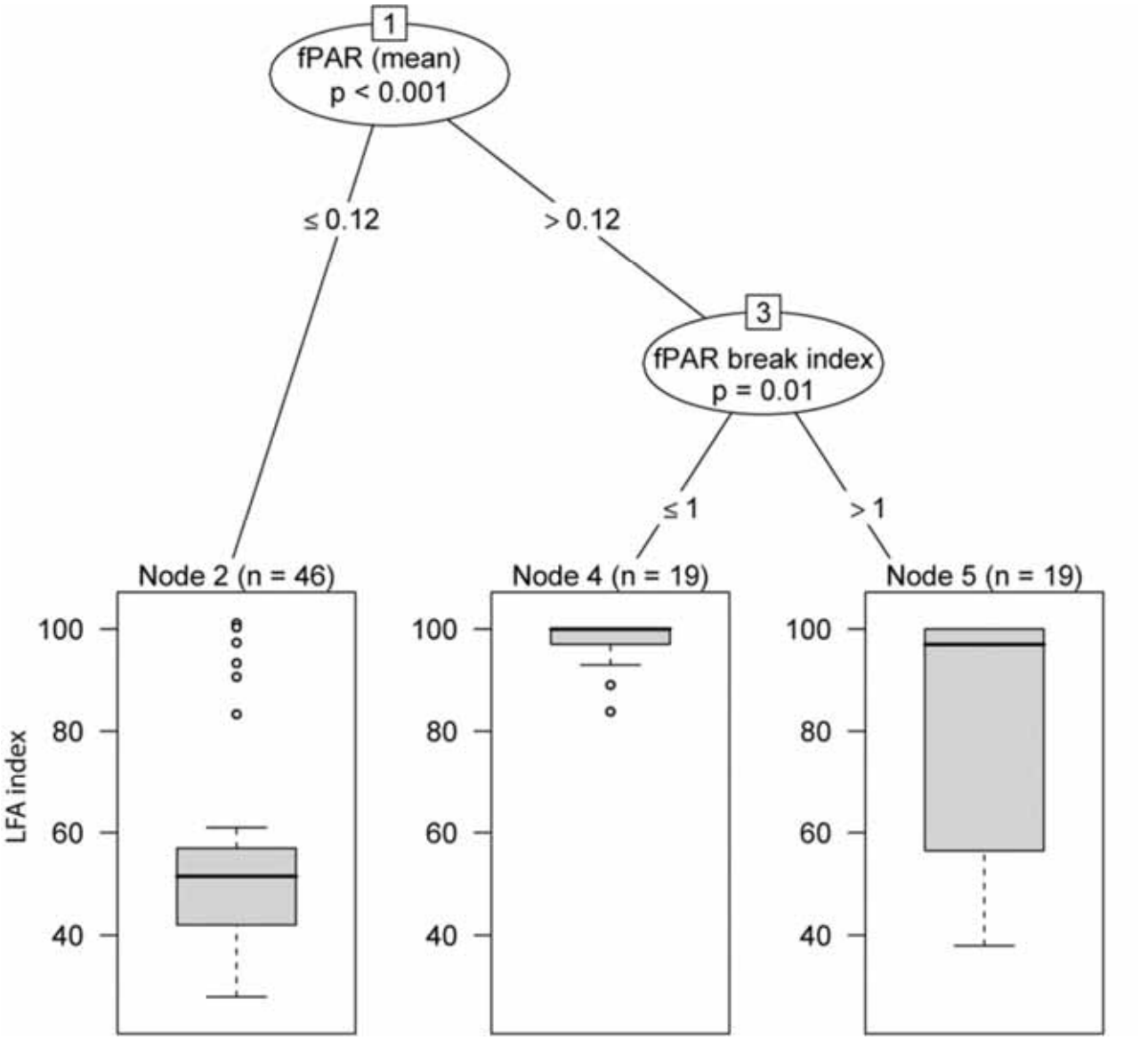


Figure 4. Decision tree model and the interaction between variables to explain the LFA index. The model uses the presence or absence of feral horses and ecosystem function attributes to explain the LFA index (boxplots)

condition. If the number of breaks in the fPAR seasonal component (Node 3 in Figure 4) were greater than one, then the sites were allocated to Node 5, characterised by sites with relatively high vegetation condition but high variability (see Node 5 in Figure 4).

These results aligned with the differences we found between sites with absence or presence of feral horses (see Table 2). The statistical analysis showed that the control group, which were sites characterised by the absence of feral horses, was statistically different to the treatment group (sites where horses were present) for four of the five fPAR variables, in addition to the Landscape function index, and the topographic variables of roughness and slope (Table 2). Sites characterised by the presence of feral horses presented less 20 per cent fPAR-maximum values than sites with absence of feral horses. The treatment groups also presented less 10 per cent fPAR-mean values, more breaks in the fPAR seasonal component (as modelled using the BFAST algorithm) and the LFA index values were two-fold the values for sites with absence of horses. The difference we found between the number of breaks in the fPAR seasonal component in sites with and without feral horses (Table 2) implies that sites with absence of feral horses are significantly less variable and had a lower number of breaks (disturbances) in the fPAR seasonal component.

DISCUSSION

The statistical analysis we used provided a robust basis for our results. Unbalanced data are common in ecology due to the difficulty and cost of large-scale, long term experiments. Propensity score matching has only

Table 2. The mean, P values and magnitude of the effect of the variables tested for sites with absence and presence of feral horses in the Australian Alps

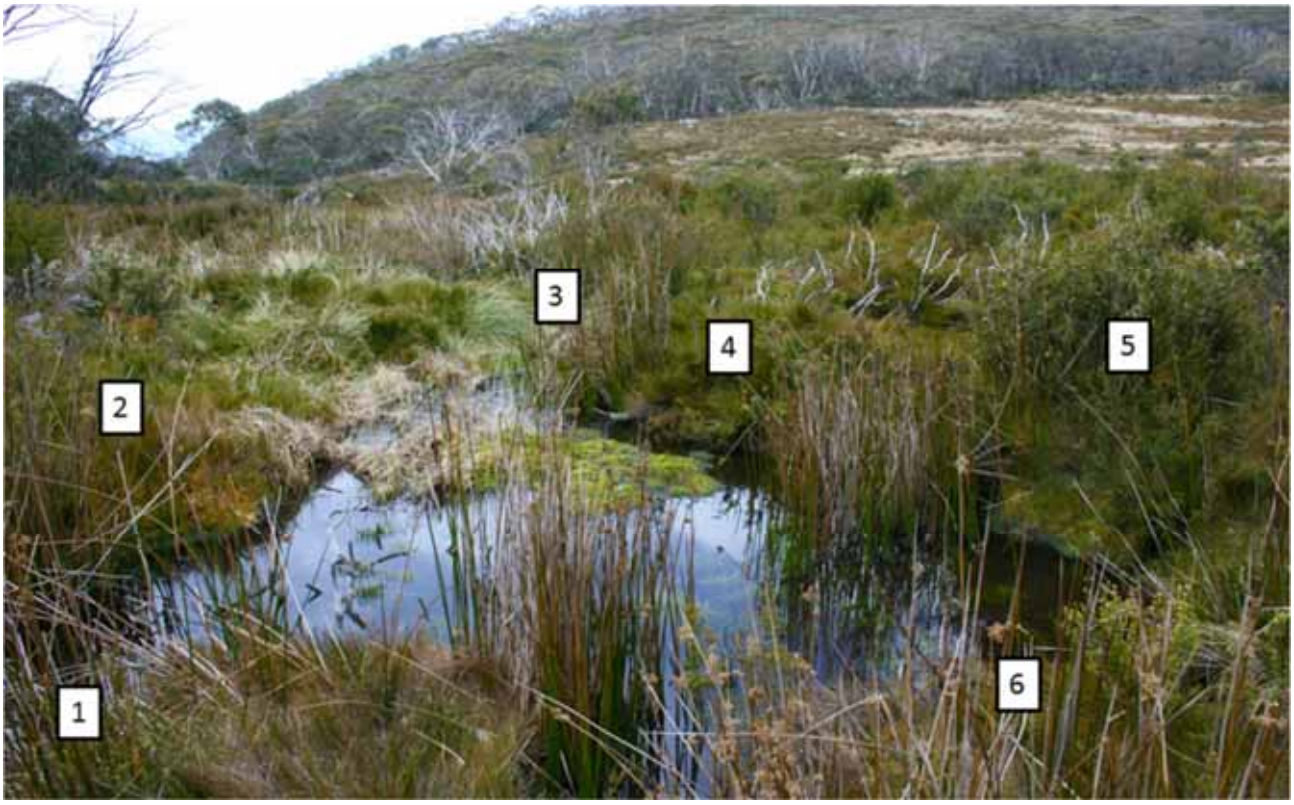
Type of indicator	Variable	Absence of feral horses (mean)	Presence of feral horses (mean)	P value	Magnitude of the effect
Ecosystem function indices	Coefficient of variation of fPAR	0.704	0.742	0.002	-0.04
	Maximum of fPAR	0.50	0.30	< 0.001	0.20
	Mean of fPAR	0.19	0.09	< 0.001	0.10
	Minimum of fPAR	0	0	Na	0.00
	fPAR break index	1.81	2.976	0.001	-1.17
	fPAR recovery index	11.976	15.214	0.495	-3.24
	Landscape function index	97.357	46.976	< 0.001	50.38
Terrain indices	Roughness	1607.071	1360.398	< 0.001	246.67
	Slope	0.125	0.095	0.039	0.03
	Topographic position index	-1.591	-4.915	0.274	3.32
	Terrain ruggedness index	27.588	22.412	0.073	5.18
	Aspect	3	3.318	0.386	-0.32

recently been used in ecological studies to deal with unbalanced data and has proved to be an effective tool for dealing with this issue (Bottrill et al., 2011). Here, it proved to be useful in helping to obtain two balanced and comparable groups of sites with absence and presence of feral horses.

Our study is, to the extent of our knowledge, the first that has used BFAST to generate fPAR derivatives to explore the link between feral herbivore impacts on the phenology of vegetation. The BFAST analysis provided an indicator of vegetation phenology associated with the seasonal component of the fPAR. The number of breaks in the seasonal component of the fPAR is quite different from the fPAR coefficient of variation as the latter does not account for the seasonality in the phenology of vegetation. The studied period, 2000-2012, had two severe droughts as determined by the Australian Bureau of Meteorology, one in 2003 and another in 2006. So, we were expecting high variability in terms of fPAR phenology over the 12-year period, represented by the coefficient of variation. However, this new technique enabled us to find that sites with absence of feral horses had, on average, more fPAR-mean and fPAR-maximum values (higher productivity) and a lower number of breaks in their seasonal component than sites with presence of horses (see Table 2).

Our results confirm that vegetation condition can be detected using remotely sensed data at 250 m pixel resolution. The second decision tree model indicated that the mean fPAR and the number of breaks in the fPAR seasonal component are the most important variables ($P < 0.05$) in explaining LFA index values. An increase in the number of breaks in the fPAR seasonal component correlated with sites in poor condition, as measured by the LFA index. One explanation is that the presence of feral horses adds pressure to the landscape so that it is more vulnerable to abrupt changes in the vegetation phenology when compared to sites with absence of horses. Therefore, the vegetation would change more often than would occur from seasonal variation alone. The results of the two decision tree models suggest that the presence of horses is correlated with sites that have poorer and more variable vegetation condition as represented by the LFA index.

Native alpine wetland damaged by feral horses' incursion © Suzie Gaynor



The characteristics of an alpine wetland in good vegetation condition: (1) Raised water table supporting sphagnum bog community and surrounding heathlands. (2) Dense and diverse vegetation cover protects the soil from erosion from adverse weather and protects soil carbon. (3) Ginini sphagnum bog and associated fens, a nationally threatened ecological community. (4) Sphagnum bog hummocks, habitat of the endangered Corroboree frog (Pseudophryne pengilleyi). (5) Dense heath vegetation, habitat for birds, amphibians, reptiles and mammals. And (6) high quality erosion free mountain water; protected from evaporation; with vegetation buffeting and slowing water flow regimes in serious storms. © ACT Government

The LFA index was strongly related to the presence and absence of feral horses and only weakly to the topographic attributes. However, in the models where feral horses were absent, we found an interaction with a terrain attribute at marginal significance level (see Figure A2 in the Supplementary Online Material). These results therefore suggest that topography, as represented by the terrain indices we used, is not a significant factor in determining either LFA index or the presence and absence of horses (Figure 3). This statistical result supports our hypothesis that feral horses impact on alpine vegetation.

CONCLUSION

Public opinion about the impact of feral horses on native vegetation is polarised. There are people who revere them because of their beauty, sense of freedom and historical bond to humans; and those who are concerned about their growing numbers and destructive impact on natural alpine vegetation (Forum, 2013). Our results provide further evidence that feral horses have a negative impact on Australian alpine and sub-alpine vegetation condition. Therefore, management of feral horse populations in Australia is an important conservation problem. Monitoring the impact of feral horses on native vegetation will remain an ongoing challenge for land managers in many regions of the world. Given the extensive landscapes that must be surveyed and analysed, cost-effective approaches are needed. Our results suggest that existing remotely sensed satellite data can provide useful information about feral horse impacts on vegetation condition. The approach we have presented provides a useful and relatively cost-effective method for monitoring the impact of feral horses on native vegetation in support of decision making and management interventions. This method could be used to map the extent of feral horse impact on alpine and sub-alpine vegetation using satellite data at various pixel resolutions (i.e. Landsat at 30 metres pixel, Aster at 15 metres pixel) to increase model accuracy.

ACKNOWLEDGEMENTS

We thank Charlie Pascoe and Graeme Worboys for helpful comments to improve the manuscript. Thanks to Suzie Gaynor for proof-reading the manuscript. To Geoff Robertson for making the data accessible for this study, for his help in understanding the data, his comments and feedback. The Landscapes and Policy Research Hub was supported through funding from the Australian

Government's National Environmental Research Program and involves researchers from the University of Tasmania (UTAS), The Australian National University (ANU), Murdoch University, The Antarctic Climate & Ecosystems Cooperative Research Centre (ACE CRC), Griffith University and Charles Sturt University (CSU).

ABOUT THE AUTHORS

Luciana Porfirio was a postdoctoral fellow at the Landscape and Policy Hub's Bioregional Futures team. She is an expert in climate adaptation and mitigation studies. Dr Porfirio uses an Integrated Assessment Modelling (IAM) framework to analyse the impact of climate on biodiversity and socio-economic systems. Dr Porfirio's experience as a scientist started in 2000 at the University of Buenos Aires (UBA), Argentina as undergraduate and research assistant. In 2013, Dr Porfirio obtained a PhD from the Australian National University (ANU).

Ted Lefroy is Director of the Centre for Environment at the University of Tasmania. His research interest is integrating biophysical and social research to solve problems in environmental management, policy and governance.

Sonia Hugh is a GIS analyst with extensive experience in spatial and temporal ecological modelling at multiple-scales from continent to catchment. Sonia worked for the Landscape and Policy Hub's Bioregional Futures team applying a range of tools and techniques to study characteristics of landscape ecosystems and the patterns of diversity under scenarios of natural and human induced change.

Brendan Mackey is Director of the Griffith Climate Change Response Program at Griffith University, Queensland, Australia. His research is currently focussed on the interactions between climate change, biodiversity and land use, and approaches to helping improve environment and conservation regulatory and management frameworks.

REFERENCES

Australian Government (2001a). Australian Government Department of the Environment, White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland. *Species Profile and Threats Database.* www.environment.gov.au/cgi-bin/sprat/public/publicshowcommunity.pl?id=43&status=Critically+Endangered.

Australian Government (2001b). Australian Government Department of the Environment, Feral animals in Australia. www.environment.gov.au/topics/biodiversity/invasive-species/feral-animals-australia.

Australian Government (2008). Environment Protection and Biodiversity Conservation Act 1999, Canberra: comlaw.gov.au. www.industry.gov.au/resource/Documents/upstream-petroleum/approvals/Strategic-Agreement.docx.

Beever, E. A., Tausch, R. J. and Thogmartin, W. E. (2008). Multi-scale responses of vegetation to removal of horse grazing from Great Basin (USA) mountain ranges. *Plant Ecology*, 196(2), 163–184. doi: 10.1007/s11258-007-9342-5.

Berry, S.L. and Roderick, M. L. (2002). Estimating mixtures of leaf functional types using continental scale satellite and climatic data. *Global Ecology and Biogeography*, 11, 23–39. doi: 10.1046/j.1466-822X.2002.00183.x.

Berry, S., Mackey, B. and Brown, T. (2007). Potential applications of remotely sensed vegetation greenness to habitat analysis and the conservation of dispersive fauna. *Pacific Conservation Biology*, 13(2), 120–127. doi: 10.1071/PC070120.

Bottrill, M. C., Walsh, J. C., Watson, J. E. M., Joseph, L. N., Ortega-Argueta, A. and Possingham, H. P. (2011). Does recovery planning improve the status of threatened species? *Biological Conservation*, 144(5), 1595–1601. doi: 10.1016/j.biocon.2011.02.008.

Dawson, M. J. and Miller, C. (2008). Aerial mark-recapture estimates of wild horses using natural markings. *Wildlife Research*, 35(4), 365–370. doi: 10.1071/WR07075.

Forum, P. (2013). A Critical Crossroad for BLM's Wild Horse Program. *Science*, 341(6148), 847–848. doi: 10.1126/science.1240280.

Green, K. and Osborne, W. S. (1994). *Wildlife of the Australian snow-country: A comprehensive guide to alpine fauna.* Sydney: Reed.

Henderson, S. and Dawson, T. P. (2009). Alien invasions from space observations: Detecting feral goat impacts on Isla Isabela, Galapagos Islands with the AVHRR. *International Journal of Remote Sensing*, 30(2), 423–433. doi: 10.1080/01431160802339472.

Hijmans, R. J. and Etten, J. (2012). raster: Geographic analysis and modeling with raster data. R package version 1. https://cran.r-project.org/web/packages/raster/index.html.

Ho, D., Imai, K., King, G. and Stuart, E. (2006). MatchIt: Nonparametric preprocessing for parametric causal inference. *Journal of Statistical Software*. doi: 10.18637/jss.v042.i08.

Holm, A., Burnside, D. and Mitchell, A. (1987). The development of a system for monitoring trend in range condition in the arid shrublands of Western Australia. *The Rangeland Journal*, 9(1), 14. doi: 10.1071/RJ9870014.

Hothorn, T., Hornik, K. and Zeileis, A. (2006). Unbiased Recursive Partitioning: A Conditional Inference Framework. *Journal of Computational and Graphical Statistics*, 15(3), 651–674. doi: 10.1198/106186006X133933.

Karr, J. R. (1996). Ecological Integrity and Ecological Health Are Not the Same. *Engineering Within Ecological Constraints*, 97–109. doi:10.17226/4919.

Lindenmayer, D. B. and Franklin, J. F. (2002). *Conserving forest biodiversity: A comprehensive multiscale approach.* Island Press.

Linklater, W. L., Cameron, E. Z., Minot, E. O. and Stafford, K. J. (2004). Feral horse demography and population growth in the Kaimanawa Ranges, New Zealand. *Wildlife Research*, 31(2), 119–128. doi: 10.1071/WR02067.

Markham, F., Young, M. and Doran, B. (2013). Detection of problem gambler subgroups using recursive partitioning. *International Journal of Mental Health and Addiction*, 11 (3), 281–291. doi: 10.1007/s11469-012-9408-z.

McDougall, K. L., Morgan, J. W., Walsh, N. G. and Williams, R. J. (2005). Plant invasions in treeless vegetation of the Australian Alps. *Perspectives in Plant Ecology, Evolution and Systematics*, 7(3), 159–171. doi: 10.1016/j.ppees.2005.09.001.

Nimmo, D. G. and Miller, K. K. (2007). Ecological and human dimensions of management of feral horses in Australia: A review. *Wildlife Research,* 34(5), 408–417. doi: 10.1071/WR06102.

NSW Government (2013). Australian Alps – climate. www.environment.nsw.gov.au/bioregions/AustralianAlps-Climate.htm.

Paget, M. and King, E. A. (2008). MODIS land data sets for the Australian region. doi: /10.4225/08/585c173339358.

Parks Victoria (2013). *The Ecology of Wild Horses and their Environmental Impact in the Victorian Alps*.

Parrish, J. D., Braun, D. P. and Unnasch, R. S. (2003). Are We Conserving What We Say We Are? Measuring Ecological Integrity within Protected Areas. *BioScience*, 53(9), 851. doi: 10.1641/0006-3568(2003)053[0851:AWCWWS]2.0.CO;2.

Pettorelli, N., Weladji, R. B., Holand, Ø., Mysterud, A., Breie, H. and Stenseth, N. C. (2005). The relative role of winter and spring conditions: Linking climate and landscape-scale plant phenology to alpine reindeer body mass. *Biology Letters*, 1(1), 24–26. doi: 10.1098/rsbl.2004.0262.

R Development Core Team (2014). *R: A language and environment for statistical computing, reference index version 3.1.2.* R Foundation for Statistical Computing. www.R-project.org. Edited by R. F. for S. Computing. Vienna, Austria.

Reed, M. S. (2008). Stakeholder participation for environmental management: A literature review. *Biological Conservation*, 141(10), 2417–2431. doi: 10.1016/j.biocon.2008.07.014.

Roderick, M. L., Farquhar, G. D., Berry, S. L. and Noble, I. R. (2001). On the direct effect of clouds and atmospheric particles on the productivity and structure of vegetation. *Oecologia*, 129(1), 21–30. doi: 10.1007/s004420100760.

Rogers, G. M. (1991). Kaimanawa feral horses and their environmental impacts. *New Zealand Journal of Ecology*, 15(1), 49–64. doi: 10.1016/0006-3207(92)90880-V.

Rosenbaum, P. R. and Rubin, D. B. (1983). The Central Role of the Propensity Score in Observational Studies for Causal Effects. *Biometrika*, 70(1), 41–55. doi: 10.1093/biomet/70.1.41.

Rouse, J., Hass, R. and Deering, J. (1973). *Monitoring the vernal advancement and retrogradation (green wave effect) of natural vegetation*. https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/19730017588.pdf.

Saatchi, S., Asefi-Najafabady, S., Malhi, Y., Aragao, L. E. O. C., Anderson, L. O., Myneni, R. B. and Nemani, R. (2013). Persistent effects of a severe drought on Amazonian forest canopy. *Proceedings of the National Academy of Sciences*, 110(2), 565–570. doi: 10.1073/pnas.1204651110.

Schloss, A., Moore, B. and Braswell, R. (2002). EOS-WEBSTER-Providing Satellite Imagery for Everyone. *AGU Fall Meeting*. http://adsabs.harvard.edu/abs/2002AGUFMOS51B0153S.

Stern, H., de Hoedt, G. and Ernst, J. (2000). Objective classification of Australian climates. *Australian Meteorological Magazine*, 49(2), 87–96. www.bom.gov.au/climate/environ/other/koppen_explain.shtml.

Tongway, D., Hindley, N., (2004). Landscape function analysis: a system for monitoring rangeland function.

African Journal of Range & Forage Science, 21, 109–113. doi:10.2989/10220110409485841

Verbesselt, J., Hyndman, R., Newnham, G. and Culvenor, D. (2010). Detecting trend and seasonal changes in satellite images time series. *Remote Sensing of Environment*, 114 (114), 106–115. doi: 10.1016/j.rse.2009.08.014.

Verbesselt, J., Zeileis, A. and Herold, M. (2012). Remote sensing of environment near real-time disturbance detection using satellite image time series. *Remote Sensing of Environment*, 123, 98–108. doi: 10.1016/j.rse.2012.02.022.

de Villalobos, A. E. and Zalba, S. M. (2010). Continuous feral horse grazing and grazing exclusion in mountain pampean grasslands in Argentina. *Acta Oecologica*, 36(5), 514–519. doi: 10.1016/j.actao.2010.07.004.

Whinam, J., Cannell, E. J., Kirkpatrick, J. B. and Comfort, M. (1994). Studies of potential impact of recreational horseriding on some alpine environments of Central Plateau Tasmania. *Journal of Environmental Management*, 40, 103–117. doi: 10.1006/jema.1994.1007.

Whinam, J., Chilcott, N. and Barmuta, L. A. (2001). Floristic description and environmental relationships of Tasmanian Sphagnum communities and their conservation management. *Australian Journal of Botany*, 49(6), 673–685. doi: 10.1071/BT00095.

Williams, R. J., Wahren, C. H., Tolsma, A. D., Sanecki, G. M., Papst, W. A., Myers, B. A., McDougall, K. L., Heinze, D. A. and Green, K. (2008). Large fires in Australian alpine landscapes: Their part in the historical fire regime and their impacts on alpine biodiversity. *International Journal of Wildland Fire*, 17(6), 793–808. doi: 10.1071/WF07154.

Worboys, G. L. (2003). A brief report on the 2003 Australian Alps bushfires. *Mountain Research and Development,* 23 (3), 294–295. doi: 10.1659/0276-4741(2003)023%5B0294:ABROTA%5D2.0.CO;2.

Zinner, D. (2002). Distribution and habitat of grivet monkeys (*Cercopithecus aethiops aethiops*) in eastern and central Eritrea. *African Journal of Ecology*, v40(2), 151. http://onlinelibrary.wiley.com/doi/10.1046/j.1365-2028.2002.00360.x/full.

RESUMEN

La presencia de caballos salvajes cuasa degradación ambiental y pone en riesgo la integridad de sistemas ecológicos. Nueva evidencia científica es necesaria para informar al debate público y asistir a las personas encargadas del manejo de parques en la toma de decisiones. En este studio usamos observaciones sobre la condición de la vegetación hechas en el campo. Estas observaciones fueron tomadas en la zona Alpina Australiana, en sitios caracterizados por tener presencia y ausencia de caballos salvajes. Estas observaciones fueron combinadas con datos de sensores remotos, más precisamente datos de la fracción de la vegetación fotositéticamente activa (fPAR), así también con datos de topografía del terreno. La condición de la vegetación fue estimada en el campo usando una técnica llamada analisis de función del paisaje, del inglés Landscape Function Analysis (LFA). La técnica LFA genera un índice que fue cotejado con los datos de fPAR derivados de sensors remotos. Nuestros resultados indican que existe una diferencia significativa en el índice LFA entre sitios con o sin presencia de caballos salvajes. Los sitios con presencia de caballos salvajes, muestran valores de alrededor de 10 por ciento menos fPAR que los sitios sin caballos salvajes. Los resultados también indican que existe una correlación entre el índice de LFA y los datos de fPAR. Nuestro análisis apoya la hipótesis que los caballos salvajes generan un impacto negativo en la vegetación alpina en Australia. Este studio provee un método útil y relativamente económico para monitorear el impacto de los caballos salvajes en la vegetación nativa alpina. Este método puede ser usado para la toma de decisiones y para intervenciones de manejo del paisaje.

RÉSUMÉ

A travers le monde, les chevaux sauvages (*Equus caballus)* provoquent une dégradation de l'environnement et un déclin de l'intégrité écologique. L'analyse scientifique de cette dégradation peut fournir les informations nécessaires pour alimenter les débats publics et assister les gestionnaires des terres dans leurs prises de décisions. Nous avons réalisé des observations de l'état de la végétation sur de nombreux sites des Alpes australiennes où des chevaux sont présents ou absents. Les données ont été combinées avec la fraction détectée à distance du rayonnement photosynthétiquement actif (fRPA), et l'état topographique. L'état de la végétation a été évalué sur le terrain par les gardes forestiers en utilisant une version modifiée de l'Analyse de la Fonction des Paysages (LFA). Des différences significatives sont apparues dans l'indice LFA entre les sites selon la présence ou non de chevaux. Le fFAR des sites ayant une présence de chevaux est inférieur de 10% par rapport aux sites où les chevaux sont absents. Les résultats indiquent également une corrélation significative entre LFA et fPAR. Notre analyse confirme l'hypothèse selon laquelle les chevaux sauvages ont un impact négatif sur l'état de la végétation alpine australienne. Cette étude fournit une méthode utile et relativement peu onéreuse pour surveiller l'impact des chevaux sauvages sur la végétation indigène, et peut être utilisée pour soutenir la prise de décision et décider de la nécessité d'une intervention.

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

James R. Allan[1*], Falk Grossmann[2,3], Rob Craig[2], Alastair Nelson[2], Joseph Maina[4], Kathleen Flower[2], James Bampton[2], Jean-Baptiste Deffontaines[2], Cornelio Miguel[5], Baldeu Araquechande[5] and James E.M. Watson[1,6]

* Corresponding author: J.allan2@uq.edu.au

[1] School of Earth and Environmental Sciences, University of Queensland, Australia
[2] Wildlife Conservation Society, Mozambique Country Programme, Maputo, Mozambique
[3] Faculty of Geo-Information Science and Earth Observation, University of Twente, Enschede, The Netherlands
[4] Department of Environmental Sciences, Macquarie University, Sydney, Australia
[5] National Administration of Conservation Areas, Ministry of Land, Environment and Rural Development, Mozambique
[6] Wildlife Conservation Society, Global Conservation Programme, Bronx, NY, USA

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 (*Lycaon 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.

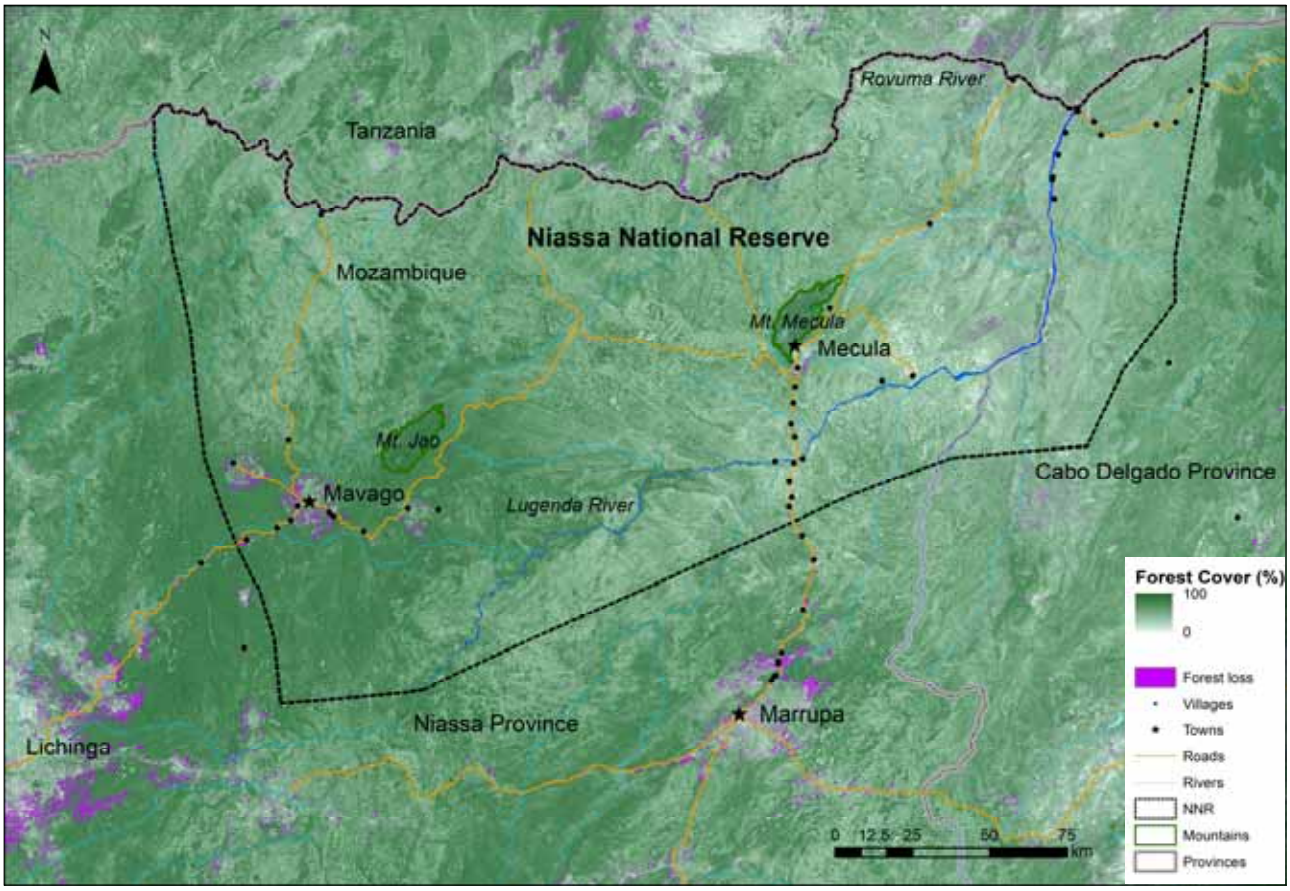


Figure 1. The extent of forest loss in Niassa National Reserve

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

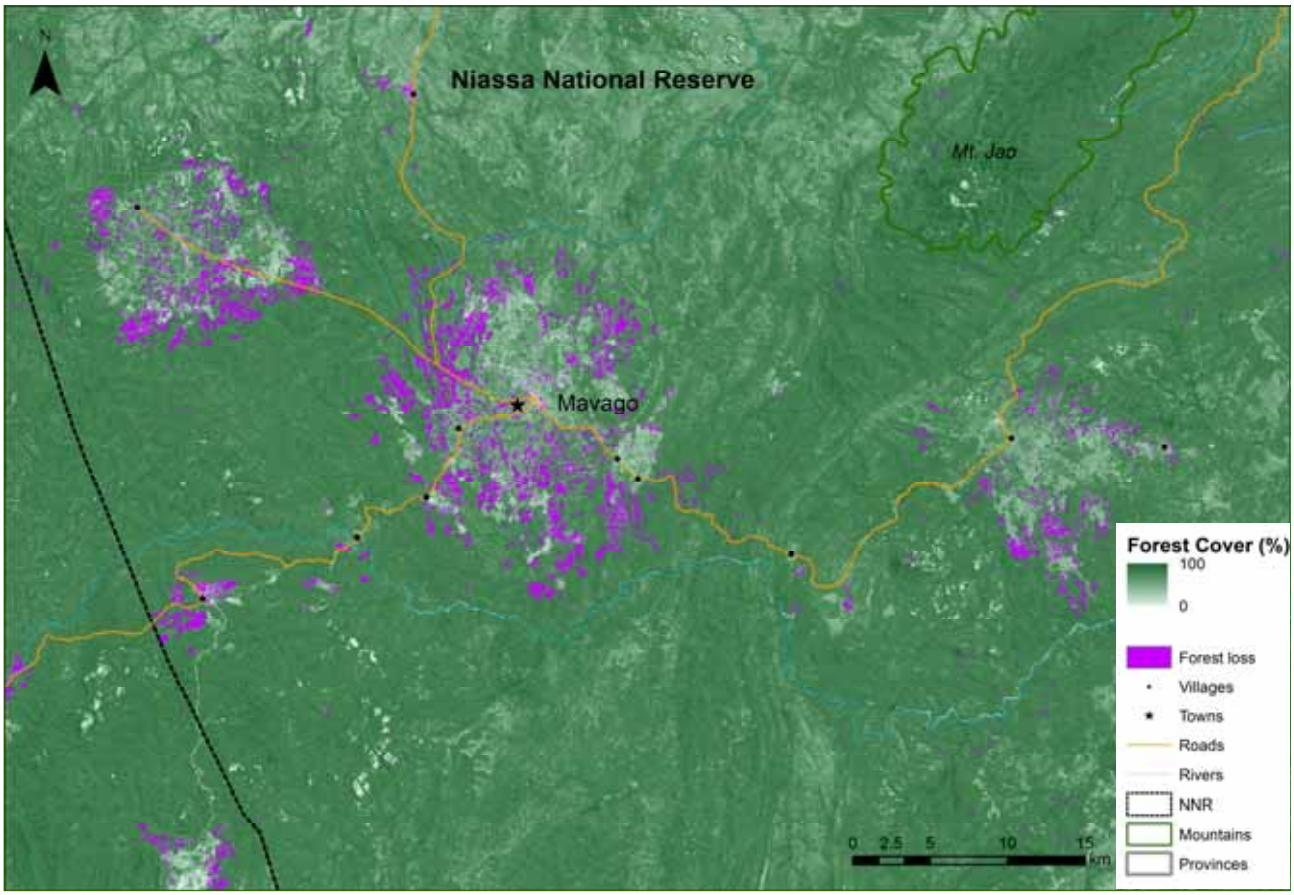


Figure 3. The extent of forest loss around Mavago Town

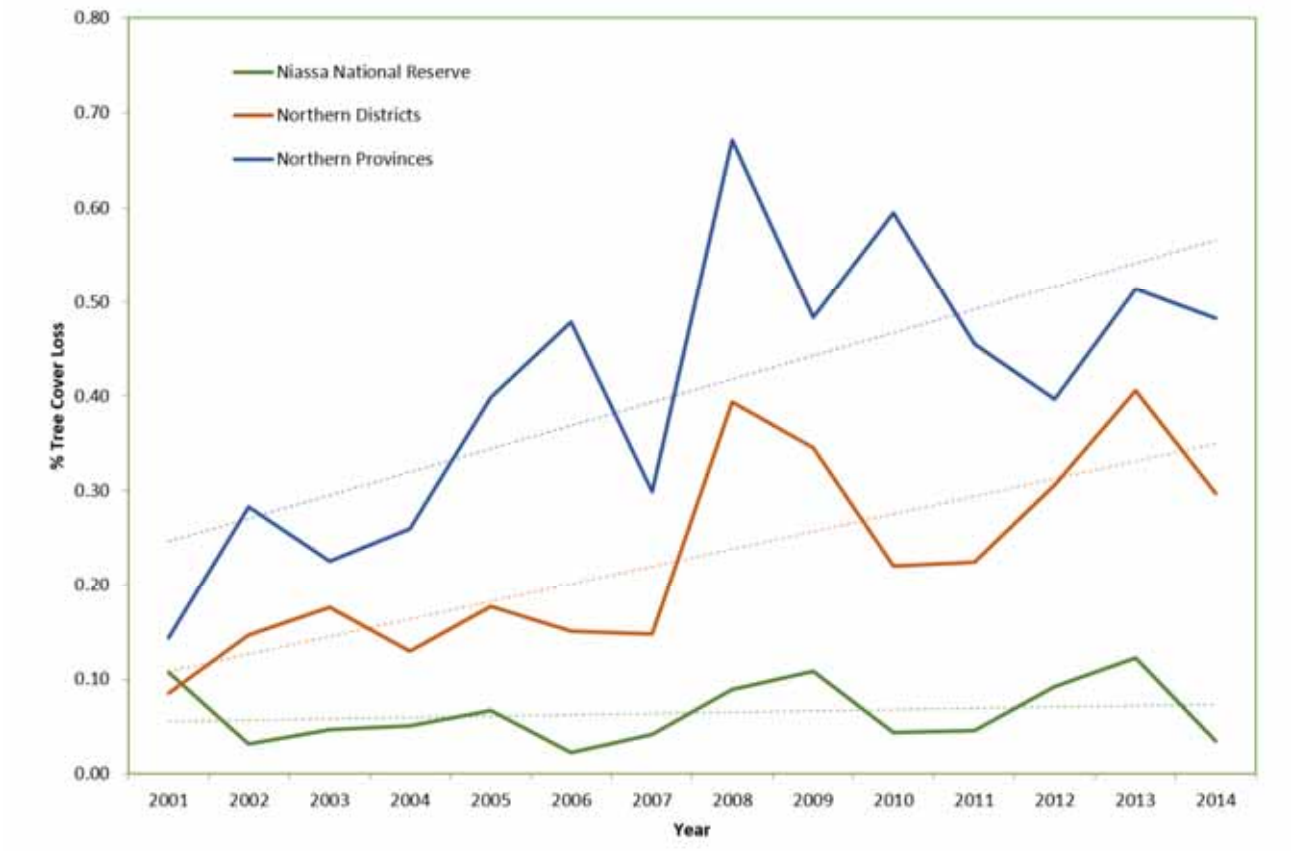


Figure 4. The yearly percentage forest loss between 2001 and 2015 for Niassa National Reserve, and Northern Mozambican provinces and districts

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 (km2)	Tree-loss (km2)	per cent Tree loss	Tree-gain (km2)	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.

ACKNOWLEDGEMENTS

We would like to thank all of the NNR concession holders and stakeholders who shared their extensive experience of NNR's biodiversity and conservation challenges with the authors. In particular we would like to thank Keith Begg, Colleen Begg, Wim Ebersohn, Derek Littleton and

Paul Davies for their time, hospitality and valuable discussions. We would also like to thank Guillermo Placci and Matt Jordan for their valuable input.

ABOUT THE AUTHORS

James Allan is a PhD student in the School of Earth and Environmental Sciences at the University of Queensland. His research uses quantitative metrics to monitor the ecological state of protected areas, and map threats which could compromise protected area success.

Falk Grossmann is a PhD student at the Faculty of Geo-Information Science and Earth Observation, University of Twente. He has worked as an ecologist and survey scientist in Niassa and across Mozambique since 2014. His current research uses airborne /spaceborne sensors to monitor herbivore resource patterns and dynamics.

Rob Craig has been the Wildlife Conservation Society (WCS) Niassa Program Director since January 2015. Rob has a background in environment and international development and previously worked for the Wildlife Conservation Society in South Sudan.

Alastair Nelson is currently the WCS Director for Counter Wildlife Trafficking in east and southern Africa. Prior to this he established and led the Wildlife Conservation Society's Mozambique country programme from 2012 until May 2017.

Joseph Maina is a landscape and seascape ecologist specialising in coral reefs based at Macquarie University in Sydney.

Kathleen Flower is an ecologist and conservation planning specialist. She co-ordinated the development of NNR's new ten-year general management plan from 2016–2017.

James Bampton is currently the WCS Mozambique Country Director.

Jean-Baptiste Deffontaines is WCS Niassa National Reserve eastern section manager. Jean-Baptiste has a background in forest management and ecology.

Cornelio Miguel is the previous warden of NNR for the National Administration for Conservation Areas in Mozambique. He is the current warden of Limpopo National Park.

Baldeu Araquechande is the current warden of NNR for the National Administration for Conservation Areas in Mozambique.

James E.M. Watson is the global Director of Science and Research for WCS, and is an Associate Professor at the University of Queensland. He leads the Green Fire Science team which specialises in applied conservation science.

REFERENCES

Achard, F., Beuchle, R., Mayaux, P., Stibig, H.-J., Bodart, C., Brink, A., Carboni, S., Desclée, B., Donnay, F., Eva, H. D., Lupi, A., Raši, R., Seliger, R. and Simonetti, D. (2014). Determination of tropical deforestation rates and related carbon losses from 1990 to 2010. *Global Change Biology* 20: 2540-2554. doi.org/10.1111/gcb.12605

Allan, J.R., Venter, O., Maxwell, S., Bertzky, B., Jones, K., Shi, Y. and Watson, J.E.M. (2017). Recent increases in human pressure and forest loss threaten many Natural World Heritage Sites. *Biological Conservation* 206: 47-55. doi.org/10.1016/j.biocon.2016.12.011

Bailey, K.M., McCleery, R.A., Binford, M.W. and Zweig, C. (2016). Land-cover change within and around protected areas in a biodiversity hotspot. *Journal of Land Use Science* 11: 154-176. doi.org/10.1080/1747423X.2015.1086905

Barlow, J., Lennox, G.D., Ferreira, J., Berenguer, E., Lees, A.C., Nally, R.M., Thomson, J.R., et al. (2016). Anthropogenic disturbance in tropical forests can double biodiversity loss from deforestation. *Nature* 535: 144-147. doi.org/10.1038/nature18326

Barnes, M.D., Craigie, I.D., Harrison, L.B., Geldmann, J., Collen, B., Whitmee, S., Balmford, A., Burgess, N.D., Brooks, T., Hockings, M. and Woodley, S. (2016). Wildlife population trends in protected areas predicted by national socio-economic metrics and body size. *Nature Communications* 7: 12747. doi.org/10.1038/ncomms12747

Bauer, H., Chapron, G., Nowell, K., Henschel, P., Funston, P., Hunter, L.T.B., Macdonald, D.W. and Packer, C. (2015). Lion (Panthera leo) populations are declining rapidly across Africa, except in intensively managed areas. *Proceedings of the National Academy of Sciences* 112: 14894-14899. doi.org/10.1073/pnas.1500664112

Begg, C. and Begg, K. (2007). *Niassa African Wild Dog Project Monitoring and Conservation: 2004-2006*, Technical Report produced for SDGRN, Maputo.

Begg, C. M. and Begg, K.S. (2012). *The status of lions and their threats in Niassa Reserve, Mozambique*, Technical Report produced for SDGRN, Maputo.

Booth, V.R. and Dunham, K.M. (2014). Elephant poaching in Niassa Reserve, Mozambique: population impact revealed by combined survey trends for live elephants and carcasses. *Oryx* 50: 94-103. doi.org/10.1017/S0030605314000568

Bowker, J.N., De Vos, A., Ament, J.M. and Cumming, G.S. (2017). Effectiveness of Africa's tropical protected areas for maintaining forest cover. *Conservation Biology* 31: 559-569. doi.org/10.1111/cobi.12851

Bruner, A.G. (2001). Effectiveness of parks in protecting tropical biodiversity. *Science,* 291: 125-128. doi.org/10.1126/science.291.5501.125

Campbell, B., Frost, P. and Byron, N. (1996). Miombo woodlands and their use: overview and key issues. In Campbell, B. (ed.), *The Miombo in Transition: Woodlands and Welfare in Africa*, Bogor: CIFOR.

Chase, M.J., Schlossberg, S., Griffin, C.R., Bouché, P.J.C., Djene, S.W., Elkan, P.W., Ferreira, S., Grossmann, F., Kohi, E.M., Landen, K., Omondi, P., Peltier, A., Selier, S.A.J. and Sutcliffe, R. (2016). Continent-wide survey reveals massive decline in African savannah elephants. *PeerJ* 4: e2354. doi.org/10.7717/peerj.2354

Crist, E., Mora, C. and Engelman, R. (2017). The interaction of human population, food production, and biodiversity protection. *Science,* 356: 260-264. doi.org/10.1126/science.aal2011

Cunliffe, R., Mandondo, A., Games, I., Ngarivhume, J. and Dore, D. (2009). *Reconciling conservation goals with agriculturally based livelihoods. A proposal for future development of the Niassa National Reserve and surrounding areas*. Harare, Zimbabwe: Imperial Tobacco Project.

DeFries, R., Hansen, A., Newton, A.C. and Hansen, M.C. (2005). Increasing isolation of protected areas in tropical forests over the past twenty years. *Ecological Applications* 15: 19-26. doi.org/10.1890/03-5258

Desmet, P.G. (2004). *Mapping the vegetation and extent of agriculture in the Niassa Reserve using Landsat imagery*. Mozambique: Sociedade para a gestao e desenvolvimento da Reserva do Niassa Mocambique.

Ferraro, P.J., Hanauer, M.M. and Sims, K.R.E. (2011). Conditions associated with protected area success in conservation and poverty reduction. *Proceedings of the National Academy of Sciences* 108: 13913-13918. doi.org/10.1073/pnas.1011529108

Fischer, J. and Lindenmayer, D.B. (2007). Landscape modification and habitat fragmentation: a synthesis. *Global Ecology and Biogeography* 16: 265-280. doi.org/10.1111/j.1466-8238.2007.00287.x

Games, I. (2004). *Regional map of the broad vegetation types of the Niassa National Reserve*, Niassa National Reserve: Management Plan: Sociedade para a gestao e desenvolvimento da Reserva do Niassa Mocambique.

Ganzin, N., Poilecot, P. and Prin, T. (2010). *Vegetation survey of Niassa National Reserve oriented for vegetation mapping and range resources assessment using satellite imagery*, Niassa National Reserve Buffalo Project.

Geldmann, J., Barnes, M., Coad, L., Craigie, I.D., Hockings, M. and Burgess, N.D. (2013). Effectiveness of terrestrial protected areas in reducing habitat loss and population declines. *Biological Conservation* 161: 230-238. doi.org/10.1016/j.biocon.2013.02.018

Gross, D., Achard, F., Dubois, G., Brink, A. and Prins, H.H.T. (2017). Uncertainties in tree cover maps of Sub-Saharan Africa and their implications for measuring progress towards CBD Aichi Targets. *Remote Sensing in Ecology and Conservation*. doi.org/10.1002/rse2.52

Grossmann, F., Lopes Pereira, C., Chambal, D., Maluleque, G., Bendzane, E., Mclellan, P., Bay, C., Mudluli, A., Peltier, A., Foloma, M., Ntumi, C., Polana, E. and Nelson, A. (2014). *Aerial Survey of Elephant, Other Wildlife and Human Activity in the Niassa Reserve and Adjacent Areas*.

Hansen, M.C., Potapov, P.V., Moore, R., Hancher, M., Turubanova, S.A., Tyukavina, A., Thau, D., Stehman, S.V., Goetz, S.J., Loveland, T.R., Kommareddy, A., Egorov, A., Chini, L., Justice, C.O. and Townshend, J.R.G. (2013). High-resolution maps of 21st-century forest cover change. *Science* 342: 850 - 853. doi.org/10.1126/science.1244693

Heino, M., Kummu, M., Makkonen, M., Mulligan, M., Verburg, P.H., Jalava, M. and Räsänen, T.A. (2015). Forest loss in protected areas and intact forest landscapes: A global analysis. *PLoS ONE* 10: e0138918. doi.org/10.1371/journal.pone.0138918

INE. (2008a). *(Instituto Nacional de Estatisticas) Estatisticas distrital. Estatisticas do distrito de Mavago. Maputo, Mozambique*.

INE. (2008b). *(Instituto Nacional de Estatisticas) Estatisticas distrital. Estatisticas do distrito de Mecula. Maputo, Mozambique*.

Jew, E.K.K., Dougill, A.J., Sallu, S.M., O'Connell, J. and Benton, T.G. (2016). Miombo woodland under threat: Consequences for tree diversity and carbon storage. *Forest Ecology and Management* 361: 144-153. doi.org/10.1016/j.foreco.2015.11.011

Joppa, L. and Pfaff, A. (2010). Reassessing the forest impacts of protection. *Annals of the New York Academy of Sciences* 1185: 135-149.

Joppa, L.N. and Pfaff, A. (2011). Global protected area impacts. *Proceedings of the Royal Society B: Biological Sciences* 278: 1633-1638. doi.org/10.1098/rspb.2010.1713

Jorge, A.A., Vanak, A.T., Thaker, M., Begg, C. and Slotow, R.O.B. (2013). Costs and benefits of the presence of leopards to the sport-hunting industry and local communities in Niassa National Reserve, Mozambique. *Conservation Biology* 27: 832-843. doi.org/10.1111/cobi.12082

Laurance, W.F., Useche, D.C., Rendeiro, J., Kalka, M., Bradshaw, C.J., Sloan, S.P., Laurance, S.G. et al. (2012). Averting biodiversity collapse in tropical forest protected areas. *Nature* 489: 290-294. doi.org/10.1038/nature11318

Lindsey, P.A., Petracca, L.S., Funston, P.J., Bauer, H., Dickman, A., Everatt, K., Flyman, M. et al. (2017). The performance of African protected areas for lions and their prey. *Biological Conservation* 209: 137-149. doi.org/10.1016/j.biocon.2017.01.011

Lupala, Z.J., Lusambo, L.P. and Ngaga, Y.M. (2014). Management, growth, and carbon storage in Miombo woodlands of Tanzania. *International Journal of Forestry Research* 2014: 11. doi.org/10.1155/2014/629317

Maekawa, M., Lanjouw, A., Rutagarama, E. and Sharp, D. (2013). Mountain gorilla tourism generating wealth and peace in post-conflict Rwanda. *Natural Resources Forum* 37: 127-137. doi.org/10.1111/1477-8947.12020

Maquia, I., Ribeiro, N.S., Silva, V., Bessa, F., Goulao, L.F. and Ribeiro, A.I. (2013). Genetic diversity of Brachystegia boehmii Taub. and Burkea africana Hook. f. across a fire gradient in Niassa National Reserve, northern Mozambique. *Biochemical Systematics and Ecology* 48: 238-247. doi.org/10.1016/j.bse.2012.12.020

Maxwell, S.L., Fuller, R.F., Brooks, T.M. and Watson, J.E.M. (2016). Biodiversity: The ravages of guns nets and bulldozers *Nature* 536: 143-145. doi.org/10.1038/536143a

Mayaux, P., Bartholomé, E., Fritz, S. and Belward, A. (2004). A new land-cover map of Africa for the year 2000. *Journal of Biogeography* 31: 861-877. doi.org/10.1111/j.1365-2699.2004.01073.x

McNeely, J.A. (2003). Conserving forest biodiversity in times of violent conflict. *Oryx* 37: 142-152. doi.org/10.1017/S0030605303000334

McRoberts, R.E., Vibrans, A.C., Sannier, C., Næsset, E., Hansen, M.C., Walters, B.F. and Lingner, D.V. (2016). Methods for evaluating the utilities of local and global maps for increasing the precision of estimates of subtropical forest area. *Canadian Journal of Forest Research* 46: 924-932. doi.org/10.1139/cjfr-2016-0064

Mittermeier, R.A., Mittermeier, C.G., Brooks, T.M., Pilgrim, J.D., Konstant, W.R., da Fonseca, G.A.B. and Kormos, C. (2003). Wilderness and biodiversity conservation. *Proceedings of the National Academy of Sciences of the United States of America,* 100 (18): 10309-10313. doi.org/10.1073/pnas.1732458100

Morales-Hidalgo, D., Oswalt, S.N. and Somanathan, E. (2015). Status and trends in global primary forest, protected areas, and areas designated for conservation of biodiversity from the Global Forest Resources Assessment 2015. *Forest Ecology and Management* 352: 68-77. doi.org/10.1016/j.foreco.2015.06.011

Mpanduji, D.G., Hofer, H., Hilderbrandt, T.B., Goeritz, F. and East, M.L. (2002). Movement of elephants in the Selous-Niasa wildlife corridor, southern Tanzania. *Pachyderm* 33: 13-31.

Mpanduji, D.G. and Ngomello, K.A.S. (2007). Elephant movements and home range determinations using GPS/ ARGOS satellites and GIS programme: Implication to conservation in southern Tanzania, in *6th TAWIRI Annual Scientific Conference*, Arusha, Tanzania.

Nagendra, H., Lucas, R., Honrado, J.P., Jongman, R.H.G., Tarantino, C., Adamo, M. and Mairota, P. (2013). Remote sensing for conservation monitoring: Assessing protected areas, habitat extent, habitat condition, species diversity, and threats. *Ecological Indicators* 33: 45-59. doi.org/10.1016/j.ecolind.2012.09.014

Naughton-Treves, L., Alix-Garcia, J. and Chapman, C.A. (2011). Lessons about parks and poverty from a decade of forest loss and economic growth around Kibale National Park, Uganda. *Proceedings of the National Academy of Sciences* 108: 13919-13924. doi.org/10.1073/pnas.1013332108

Negret, P.J., Allan, J., Braczkowski, A., Maron, M. and Watson, J.E.M. (2017). Need for conservation planning in postconflict Colombia. *Conservation Biology*. doi.org/10.1111/cobi.12902

Newmark, W.D. (2008). Isolation of African protected areas. *Frontiers in Ecology and the Environment* 6: 321-328. doi.org/10.1890/070003

Niassa Carnivore Project. (2015). *Annual Report*. Mozambique: Niassa Carnivore Project.

Noe, C. (2015). The Selous-Niassa transfrontier conservation area and tourism: evolution, benefits and challenges. In: van der Duim, R., Lamers, M. and van Wijk, J. (eds.), *Institutional Arrangements for Conservation, Development and Tourism in Eastern and Southern Africa: A Dynamic Perspective*, pp. 181-201. Dordrecht: Springer Netherlands. doi.org/10.1007/978-94-017-9529-6_10

Papworth, S., Rao, M., Oo, M.M., Latt, K.T., Tizard, R., Pienkowski, T. and Carrasco, L.R. (2017). The impact of gold mining and agricultural concessions on the tree cover and local communities in northern Myanmar. *Scientific Reports* 7: 46594. doi.org/10.1038/srep46594

Prin, T., Chamaille, S., Grosbois, V., Fritz, H., Guerbois, C., Chardonnet, P. and Cornelis, D. (2014). Understanding the mechanisms limiting the buffalo population in Niassa National Reserve, Mozambique. In *1st Symposium on African Buffalo*, Paris, France.

Pringle, R.M. (2017). Upgrading protected areas to conserve wild biodiversity. *Nature* 546: 91-99. doi.org/10.1038/ nature22902

Ribeiro, N.S., Matos, C.N., Moura, I.R., Washington-Allen, R.A. and Ribeiro, A.I. (2013). Monitoring vegetation dynamics and carbon stock density in miombo woodlands. *Carbon Balance and Management* 8: 11. doi.org/10.1186/1750-0680-8-11

Ribeiro, N.S., Saatchi, S.S., Shugart, H.H. and Washington-Allen, R.A. (2008a). Aboveground biomass and leaf area index (LAI) mapping for Niassa Reserve, northern Mozambique. *Journal of Geophysical Research* 113: G02S02. doi.org/10.1029/2007JG000550

Ribeiro, N.S., Shugart, H.H. and Washington-Allen, R. (2008b). The effects of fire and elephants on species composition and structure of the Niassa Reserve, northern Mozambique. *Forest Ecology and Management* 255: 1626-1636. doi.org/10.1016/j.foreco.2007.11.033

Riggio, J., Jacobson, A., Dollar, L., Bauer, H., Becker, M., Dickman, A., Funston, P., Groom, R., Henschel, P., de Iongh, H., Lichtenfeld, L. and Pimm, S. (2013). The size of savannah Africa: a lion's (Panthera leo) view. *Biodiversity and Conservation* 22: 17-35. doi.org/10.1007/s10531-012-0381-4

Ripple, W.J., Estes, J.A., Beschta, R.L., Wilmers, C.C., Ritchie, E.G., Hebblewhite, M., Berger, J., Elmhagen, B., Letnic, M., Nelson, M.P., Schmitz, O.J., Smith, D.W., Wallach, A.D. and Wirsing, A.J. (2014). Status and ecological effects of the world's largest carnivores. *Science* 343: 6167. https:/ doi.org/10.1126/science.1241484

Robson, A.S., Trimble, M.J., Purdon, A., Young-Overton, K.D., Pimm, S.L. and van Aarde, R.J. (2017). Savanna elephant numbers are only a quarter of their expected values. *PLoS ONE* 12: e0175942. doi.org/10.1371/ journal.pone.0175942

Ryan, P.G., Bento, C., Cohen, C., Graham, J., Parker, V. and Spottiswoode, C. (2010). The avifauna and conservation status of the Namuli Massif, northern Mozambique. *Bird Conservation International* 9: 315-331. doi.org/10.1017/ S0959270900003518

Sassen, M., Sheil, D., Giller, K.E. and ter Braak, C.J.F. (2013). Complex contexts and dynamic drivers: Understanding four decades of forest loss and recovery in an East African protected area. *Biological Conservation* 159: 257-268. doi.org/10.1016/j.biocon.2012.12.003

SDGRN. (2006). *Management Plan of Niassa National Reserve 2007 – 2012*. Maputo, Mozambique: Ministry of Tourism and Sociedade para a Gestão e Desenvolvimento da Reserva do Niassa.

Soto, B. (2009). Protected areas in Mozambique. In Suich, H., Child, B. and Spenceley, A. (eds.), *Evolution and innovation in wildlife conservation: Parks and game ranches to Transfrontier conservation areas*, pp. 85-111. Earthscan, United Kingdom.

Temudo, M.P. and Silva, J.M.N. (2012). Agriculture and forest cover changes in post-war Mozambique. *Journal of Land Use Science* 7: 425-442. doi.org/10.1080/1747423X.2011.595834

Temundo, M.P. (2004). *Seeds of War, Seeds of Resilience: Conflict and the remaking of life in Northern Mozambique,* translated by Khartoum, Sudan.

Tracewski, Ł., Butchart, S.H.M., Donald, P.F., Evans, M., Fishpool, L.D.C. and Buchanan, G.M. (2016). Patterns of twenty-first century forest loss across a global network of important sites for biodiversity. *Remote Sensing in Ecology and Conservation* 2: 37-44. doi.org/10.1002/rse2.13

Tranquilli, S., Abedi-Lartey, M., Abernethy, K., Amsini, F., Asamoah, A., Balangtaa, C., Blake, S. et al. (2014). Protected areas in tropical Africa: assessing threats and conservation activities. *PLoS ONE* 9: e114154. doi.org/10.1371/journal.pone.0114154

Tropek, R., Sedláček, O., Beck, J., Keil, P., Musilová, Z., Šímová, I. and Storch, D. (2014). Comment on "High-resolution global maps of 21st-century forest cover change". *Science* 344: 981-981. doi.org/10.1126/science.1248753

Turner, W., Spector, S., Gardiner, N., Fladeland, M., Sterling, E. and Steininger, M. (2003). Remote sensing for biodiversity science and conservation. *Trends in Ecology & Evolution* 18: 306-314. doi.org/10.1016/S0169-5347(03) 00070-3

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.

FROM FORESTRY TO PROTECTED AREA AND ECOSYSTEM MANAGEMENT: ORGANISATIONAL CHANGE IN SAINT LUCIA, WEST INDIES

Michael R. Appleton[1,3,*], Adams Toussaint[2] and Jennifer C. Daltry[3]

Corresponding author: mappleton@globalwildlife.org

[1] Global Wildlife Conservation, PO Box 129, Austin, TX 78767, USA.
[2] Saint Lucia Forestry Department, Union Forestry Complex, Union, Castries, Saint Lucia.
[3] Fauna & Flora International, David Attenborough Building, Pembroke Street, Cambridge CB2 3QZ, UK.

ABSTRACT

While global expectations of what protected areas should deliver are evolving (e.g. through the Aichi Targets and the UN Sustainable Development Goals), little attention has been paid to how government protected area agencies can adapt and improve their performance accordingly. The remit of the Saint Lucia Forestry Department has gradually extended from production forestry to, inter alia, protected area management, wildlife research and conservation, watershed management, tourism and environmental education. In 2014, in response to a widespread consensus on the need to update its ways of working, the Department initiated a participatory process of strategic planning and organisational change, comprising: (1) Organisational review and capacity needs assessment; (2) Development of a new strategic plan and corresponding restructuring of the organisation; and (3) Institutionalisation of the plan. This generally successful process provides important lessons with potentially wider application on 'change readiness', leadership, capacity, communication, participation, and the value of 'quick wins'. While further work is needed on capacity development and full institutionalisation of the changes, the Forestry Department is now better able to articulate its roles and needs and to ensure long-term conservation and sustainable use of Saint Lucia's globally important biodiversity, both inside and outside its protected areas. We call for further studies and initiatives on organisational change in government agencies responsible for protected areas and biodiversity conservation.

Key words: Caribbean, forestry, management, organisational change, participatory planning, protected areas, strategic planning

INTRODUCTION

Organisational change is simply defined by Dawson (2003) as "new ways of organizing and working". Among the abundant literature on the topic, far less attention is given to the public sector than the private sector (Pick et al., 2015; Kuipers et al., 2013). In the forestry sector, a range of studies have addressed change management (e.g. World Bank, 2005; Durst et al., 2008; Spathelf, 2010), mainly in the context of shifting economic trends. Organisational change specifically related to agencies responsible for protected areas has received very limited attention (examples include Anon., 2014 from New Zealand and Colwell et al., 2014 from the USA), and the topic is addressed in only one short paragraph in the landmark publication of Worboys et al. (2015).

This apparent lack of attention to how protected area management agencies can adapt and improve is surprising, given the increase in the global number and coverage of protected areas (UNEP-WCMC & IUCN, 2016) and the widening global expectations of what protected areas should deliver, articulated in Aichi Biodiversity Target 11 (Convention on Biological Diversity, 2010) and United Nations Sustainable Development Goals 14 and 15 (United Nations, 2015). The 'Promise of Sydney' (Sandwith et al., 2014), agreed at the 2013 IUCN World Parks Congress, includes "a commitment to transforming perspective, policy and practice to enhance protected areas as one of the best investments in our planet's and our own future" and includes dozens of recommendations under "twelve

innovative approaches for transformative change". Translating these aspirations into real change and improvements in protected area management remains a challenge, however. In general, the protected area sector is under-resourced, lacks capacity, and is subject to frequent enforced changes resulting from budget cuts and political factors (Worboys, 2015). To address these issues and to meet the global standards defined for the IUCN Green List of Protected and Conserved Areas (IUCN and WCPA, 2016), protected area authorities need to be up-to-date, flexible, responsive and exemplars of good governance: characteristics not normally associated with typically centralised, bureaucratic government agencies.

This study documents a strategic planning and organisational change process in the Forestry Department (hereafter Department) of the Eastern Caribbean island of Saint Lucia, which was explicitly undertaken to strengthen this organisation's ability to rise to the new expectations and challenges of managing the protected areas and natural resources under its responsibility.

View across the Forest Reserve from Mont Troumassee (© Jenny Daltry, FFI)

THE SAINT LUCIA FORESTRY DEPARTMENT

Saint Lucia is the second largest island of the Lesser Antilles, with an area of 616 km2 and a population of close to 167,000. The Forestry Department was established in 1946 to manage timber production and maintain the mountainous Central Forest Reserve (now the country's largest protected area, IUCN Category II, 9,196 ha.) that protects the island's main water supplies. In the 1980s, under the pioneering leadership of Gabriel 'Coco' Charles, the Department started expanding its remit to include watershed management, nature conservation, forest visitation, environmental education and community outreach. In response to climatic trends in the Eastern Caribbean (notably, lower and less predictable rainfall and more frequent storms), forestry work today mainly focuses on maintaining and restoring tree cover, protecting water courses and controlling erosion across the island, while timber production is now limited to small-scale harvesting for local community needs.

More than 70 per cent of Saint Lucia is forested and supports a rich diversity of wildlife, including the emblematic Saint Lucia parrot (*Amazona versicolor*), one of six country-endemic bird species, whose population has recovered from fewer than 100 to over 2,000 individuals since the 1950s. The forests also support 10 native mammals (mostly bats), 17 native reptiles (nine endemic), over 1,100 native plants and an exceptional diversity of invertebrates (Daltry, 2009). The 1980 Wildlife Protection Act mandated the Forestry Department as the principal authority for terrestrial biodiversity, including the protection of globally threatened native species (e.g. the white-breasted thrasher [*Ramphocinclus brachyurus sanctaeluciae*] and Saint Lucia racer [*Erythrolamprus ornatus*]), ensuring wildlife use is sustainable, and addressing human-wildlife conflict (Daltry, 2009). In 2015, the Department had 82 staff based at its headquarters and at five 'range stations' surrounding the Central Forest Reserve.

Since the plan of Godlet (1970), the Department has been the subject of at least five strategies and plans at the national/sectoral level and six at the Departmental level. These were implemented to varying extents, but none were fully institutionalised and 'owned' by the Department. Managers reported they had not been sufficiently involved in their development, and that implementation had declined when donor support ended. Despite this, in 2014, the Chief Forest Officer (CFO) requested assistance from Fauna & Flora International (FFI) to develop a new 'management plan' for the Department. The impetus for a new plan was the transfer of the Department in 2012 from the Ministry of Agriculture to the new Ministry of Sustainable Development, Energy, Science and Technology (MSDEST), which required a more strategic approach and better evidence of organisational impact and cost-effectiveness. An international consultant (MA) with previous experience of working with the Department was appointed by FFI to support the planning process.

FROM MANAGEMENT PLAN TO AN ORGANISATIONAL CHANGE PROCESS

The most widely used models for understanding organisational change include the three-stage model of Lewin (1947) and the more recent eight-stage model of Kotter (1996). Biech (2007) provides a useful comparison of these and other change management models. For this study, we used Lewin's (1947) model (unfreezing; movement; refreezing) because it is still

widely used (Burnes & Bargal, 2017) and was considered the more straightforward model for introducing organisational change in the Department.

Step 1: 'Unfreezing' – preparing the ground for change, initial problem identification and data collection

Organisational review

Our starting point was a desktop review of documentation, followed by interviews with senior staff and middle managers, group discussions with staff at all levels, discussions with the Minister and Permanent Secretary at the MSDEST, interviews with representatives of 10 main partners of the Department and an internal workshop attended by all managers and forest officers.

Many of the consultees shared the view that although the history and work of the Department were widely recognised and respected, its influence and status had declined in recent years, leading to concerns about its ability to meet the growing threats to forests and biodiversity. Specific issues included the following:

- Despite its changing role, the strategic approach and institutional culture of the Department were still grounded in forest protection and timber production.
- The Department had sufficient personnel, but they were not deployed as effectively as could be.
- To meet shortfalls in Government funding, the Department had successfully developed a range of partnerships and secured significant international project funding. Some projects, however, were considered to have been driven more by the needs of donors than the priorities of the Department, which were not always clearly defined.
- Older staff had accumulated extensive experience working under 'Coco' Charles and had benefitted from scholarships for international study. Without these opportunities, younger staff felt less able to take on managerial roles once their leaders had retired and expressed concern about a lack of 'succession planning'.
- Underdeveloped information management was hampering effective planning, decision-making and adaptive management.
- Declining morale was leading to high staff turnover and concerns about staff performance. Reasons given included cuts in budgets and salaries, a freeze on staff recruitment, inadequate resources for work, difficult working conditions in the field and the lack of a clear, shared and motivating direction.

Capacity needs assessment

In May 2015, 65 of the 82 staff of the Department (including contract forest workers, forest officers, managers, directors and administrative staff) anonymously completed competence-based self-assessment questionnaires, using the methods described

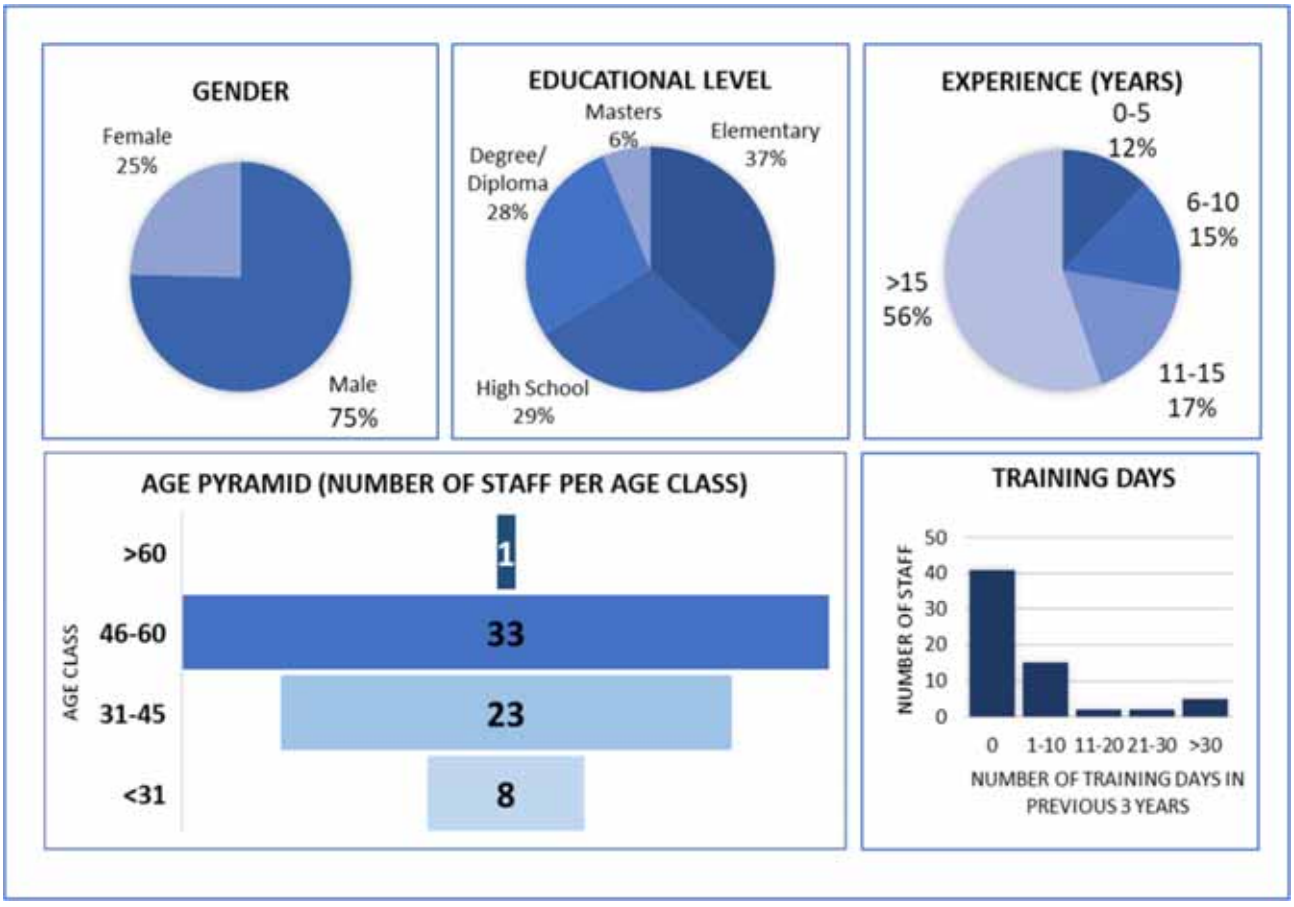


Figure 1. Personnel profile of the Forestry Department (responses from 65 of the 82 staff)

by Appleton (2016). Figure 1 shows the resulting statistics concerning the workforce. Educational levels varied greatly: while 37 per cent of the staff (all rangers) had only elementary education, most Forest Officers were university or college graduates. Although some staff had benefitted from considerable recent training, most had received no training in the previous three years. The age pyramid showed an ageing staff, mainly a result of Government hiring freezes and of junior staff leaving the Department. These findings supported the widely felt need, especially among the Forest Officers, for change within the Department.

The needs assessment report (Appleton, 2015a) recommended the following priorities for building staff capacity: first aid, safety and security; law enforcement and protection; working with communities; applied conservation biology and conservation management; sustainable forest use and management; protected area and natural resource management planning, monitoring and reporting; information technology; and management, leadership and communication.

The report also recommended moving from donor-driven, short-term training, to a more structured, internally driven approach, making better use of existing resources through sharing skills, mentoring, improved internal communications and information management, and formalisation of internal standards and good practice (e.g. through defining core competences for all positions and preparing a new Forestry Officers' handbook). In the absence of international scholarships, the report suggested that staff could be supported to engage in distance learning and that the Department could work with local and regional educational institutions to develop relevant new courses and to adapt current courses to their specific needs.

Unfreezing: lessons learned

The unfreezing stage involves ensuring both the ability of an organisation to change and the readiness of individuals to change (Lewin, 1947). Several factors contributed to an advanced state of change readiness in the Department.

There was an existing consensus on the need for change. Kotter (1996) highlighted the need to persuade staff to embrace change, but in this case staff at all levels in the Department were ready for change, and this view was supported by many of its partner organisations.

Change was needed, not just planning. Staff realised at an early stage that rather than another management plan, the Department needed more fundamental changes in terms of its function, direction and structure. It was agreed that this required a more comprehensive process of organisational change that should be formalised within a new Strategic Plan for the Department.

Pride and loyalty can support positive attitudes to change in the face of adversity. Despite issues with morale, it was evident that many staff were loyal to the Department and proud of their work. Given the chance, they were motivated to participate and to offer constructive criticism as well as positive ideas for improvement.

Exposure to new values and approaches can be a catalyst for change. The transfer to a new Ministry put the Department outside its 'comfort zone', exposed it to new approaches and values, and required it to prove its worth among a new set of decision makers and peers.

Change needs good leadership. Since the Chief Forest Officer (CFO) was approaching retirement, he delegated management of the process to his Deputy (DCFO) and eventual successor to provide the continuity required. The DCFO had worked his way up through the Department and so had a good understanding of its work and the challenges faced by the staff.

Good communication is vital. Staff and stakeholders had already identified many of the problems and potential solutions among themselves and felt able to share their views with senior managers, who were ready to listen and learn from what they heard.

Constructive consultation supports the change process. The consultative process helped to generate support for the Department and greatly added to the understanding of the staff who were involved. Change is much easier where your friends and peers want you to succeed.

Long-term partnerships can build capacity and support change. Long-term training and mentoring through partnerships with the Durrell Wildlife Conservation Trust (Durrell) and FFI had helped build confidence in external support and establish a cadre of confident and motivated individuals, who were active participants in the change process. The fact that MA was known to the Department, FFI and Durrell, having previously worked on participatory planning in Saint Lucia, helped to overcome a common scepticism of consultants.

Institutional memory can be vital to supplement documented information. Assembling information and documentation was challenging because the Department had no central database and many documents were difficult to trace. Interviews with long-serving staff were essential for understanding past events and processes and for locating important documents.

Step 2: 'Movement' – strategizing, action planning, implementation and follow up

At a two-day workshop in 2014, senior managers and section leaders identified future directions, policies and priorities for the work of the Department, realigning its approaches, structure and practices to fit its *de facto* role

as a natural resource management body. The workshop used four participatory tools:

1. Assessment of external influences through PESTLE (Political, Economic, Social, Technological, Legal, Environmental) Analysis (FME, 2013a).
2. Assessment of the current position of the Department through SWOT (Strengths, Weaknesses, Opportunities, Threats) Analysis (FME, 2013b).
3. Threat assessment, using the Conservation Measures Partnership's taxonomy of threats to biodiversity. (see http://cmp-openstandards.org/using-os/tools/threats-taxonomy/)
4. Management effectiveness assessment, using the Protected Area Management Effectiveness Tracking Tool (METT) (Stolton & Dudley, 2016). The resulting METT score was 55 per cent, close to the global average of 53 per cent calculated by Leverington et al. (2010).

These processes aided participants to develop and agree on a new vision, mission and set of guiding principles for the Department. Participants also agreed to adopt an 'ecosystem approach', using the four main categories of ecosystem service (supporting, provisioning, regulating and cultural) from the Millennium Ecosystem Assessment (2005) to define new strategic directions and policies for the Department. Thirty-six participants at a multi-stakeholder workshop in January 2015 reviewed and amended a first draft of the Strategic Plan.

The Department then prepared a five-year plan specifying actions to be taken for implementing the Strategic Plan, listing collaborating partners, and

Box 1. Main elements of the new Strategic Plan for the Saint Lucia Forestry Department, framed around the delivery of ecosystem services

Vision

"A healthy natural environment for a healthy and productive nation"

Mission

"Collaboration and partnership for the preservation and sustainable use of forests, nature and the benefits they provide"

Motto

"La foway et terre se la vie" (forest and land are life)

Strategy 1: Maintaining healthy ecosystems and thriving species.

The Department will work towards ensuring the conservation of the species and natural communities of Saint Lucia and the integrity of the ecosystems that provide critical services for the country.

Strategy 2: Ensuring sustainable flows of products that support both local economies and biodiversity conservation.

The Department will work with partners to enable regulated and sustainable use of defined forest areas in support of local livelihoods and economies, while maintaining the biodiversity, recreational and aesthetic values of the forest and the environmental services it provides.

Strategy 3: Protecting water supplies, soils and coastal zones and ensuring resilience to climate change.

The Department will work in partnership with other stakeholders to establish integrated programmes that sustain and enhance the vital regulating services provided by Saint Lucia's forests and other ecosystems. The Department will also work to ensure that Saint Lucia participates in and benefits from global initiatives to address climate change and its impacts.

Strategy 4: Promoting awareness, visitation and cultural enrichment.

The Department should ensure that all stakeholders are aware of its work and the benefits that it brings to Saint Lucia. It should make parts of the Forest Reserve available for non-motorised access and nature-based recreation and provide basic access facilities. The provision of visitor services should be contracted out, to benefit local communities and the wider economy, and to provide an income to the Department to support monitoring and maintenance.

Strategy 5: Organisational strengthening

The Department should review and strengthen its organisational structure and working practices, and build the capacity of its personnel to implement Strategies 1–4.

emphasising what could be done using existing resources and ongoing projects before identifying needs for new additional funding.

Senior managers also realised that implementing the new Strategic Plan would require restructuring of the Department. A new organisational structure, position descriptions and terms of reference were therefore prepared, clustering work teams around each of the five new strategic directions, strengthening central coordination, administration, information management and communication and realigning the forest ranges (operational zones) with natural watershed boundaries.

The final Strategic Plan was approved and launched by the MSDEST in 2015, published online (Saint Lucia Forests and Lands Resources Department, 2015) and distributed to all staff and main stakeholders (see Box 1 for a summary). The Department organised external and internal meetings to explain the plan and its associated changes, including visits to all the forest range (field) stations.

Movement: lessons learned

A powerful shared vision, mission and guiding principles create a strong sense of ownership and purpose. Visions and missions can have limited utility (Bartkus et al., 2000), but those developed by the Department strongly reflected a shared view among staff and stakeholders that it should be working not only to protect nature and natural systems, but also wherever possible to benefit people. Alongside the new mission and vision, staff decided to retain the Department's existing motto in the Kweole language: "La foway et terre se la vie" (forest and land are life), reflecting both the national culture and the link between nature and human well-being. Feedback from workshop participants led to inclusion of a set of guiding principles to define not only what needed to be done, but also how the Department should approach its work.

Participation is vital, but must take place in the right cultural context. Participation from an early stage enabled most staff to contribute to the process, creating a sense of ownership absent from previous strategies. Because the participants in this case much preferred interpersonal (rather than written) methods, most contributions were verbal, conducted through interviews, workshops and structured and informal discussions. When written questionnaires were used (in the capacity needs assessment), they were completed by individuals working in facilitated groups. This mainly oral and often informal process may not be appropriate or effective in all countries and cultures, but illustrates the importance of matching the methods to the cultural context.

High-level support is required, but ideally with a light touch. The Minister and Permanent Secretary were highly supportive of this project, followed its progress,

Figure 2. The new vision and mission displayed at the entrance to the Forestry Department headquarters (© Jenny Daltry, FFI).

Planning workshop with Forestry Department staff and other stakeholders (© Jenny Daltry, FFI)

and were accessible and responsive throughout, but they also clearly delegated direction and supervision of the process to the CFO and DCFO. This approach was conducive to building ownership and confidence at Departmental level.

Strategic planning can make problematic decisions easier. The Department had long been encouraged by the Government to initiate the complex process of contracting out management of visitor access in the Central Forest Reserve. The planning process helped prioritise the allocation of the Department's staff and resources on its core responsibilities, making this decision more logical and therefore easier.

People prefer short documents. All those consulted agreed that the strategic plan should be clearly presented and not too long. The final document had 50 pages in total, and the main text covered 30 pages.

'Quick wins' are important. The following examples from the initial stages of implementation in 2015 were 'quick wins' as recommended by Kotter (1996) – priority actions that could be undertaken without delay, demonstrating rapid adoption of the new plan:

- Redecoration of the Department office and installation of prominent signs showing the new vision and mission (Figure 2). This promoted the Department's new approach and provided a visible indication of a 'fresh start', helping to boost staff interest and morale.
- Rapid reorganisation of the forest range areas to coincide with watersheds, providing more logical operational zones that reflect the new ecosystem-based approach.
- Rapid engagement of a specialist consultant to plan the contracting out of visitor services in the Forest Reserve.
- Clarifying to staff how several ongoing activities that appear in the new plan (e.g. tree planting to stabilise eroded slopes areas and removal of invasive alien species from offshore islands) contribute to the overall goals of the Department.
- Launching of new initiatives already in the pipeline, such as the GEF-funded 'Iyanola Project' to protect and rehabilitate dry forests in north-east Saint Lucia (identified as a priority in the strategic plan).

The Forest Reserve plays a vital role in water management (© Jeremy Holden FFI)

Step 3: 'Refreezing' – institutionalisation of the change, assessment of consequences, follow up and monitoring, learning from the process

Overall, the adoption and implementation of the changes proposed in the new plan have been remarkably swift. A contributing factor may have been that in a small country, lines of communication are quite short and agreed changes can be quickly communicated and realised at both central and protected area levels.

Reorganisation of staffing structures and responsibilities has been completed and, at the time of writing, work planning and reporting is increasingly based on the five-year action plan.

By highlighting the diverse functions of the Department, the Strategic Plan has enabled talented staff qualified in subjects other than forestry to be retained and promoted, and has helped the Department to secure Government support for retired forest officers to train current staff and for sending some staff for training overseas.

The process has also helped the Department manage its unexpected transfer back to the Ministry of Agriculture in 2016, which not only accepted and welcomed the Strategic Plan, but adopted a similar approach for its own new strategy. There have been other unexpected consequences. For example, the Ministry of Public Service has acknowledged the Strategic Plan and the reorganisation of the Department as a model for upgrading and modernising public service organisations, while the Productivity Council of the Ministry of Finance has agreed to use the Department to pilot public service productivity reform.

Refreezing: lessons learned

Effective internal change can help an organisation adapt to externally driven change. The changes are enabling the Department to be well prepared to address, benefit from and even positively influence ongoing political and administrative changes in Saint Lucia.

The change process generates new capacity development needs. The process identified many specific needs for capacity development. Implementation of the Strategic Plan has made these needs more urgent and highlighted needs that had not previously been recognised.

It should not be assumed that all staff will immediately understand new strategic directions. Despite efforts to explain the new plan, some staff have not yet fully understood the 'ecosystem approach' that underpins it.

The existence of a new plan does not automatically generate the resources needed to implement it. The new plan has not yet led to any direct budget increases from the Government, and full adoption is hampered by lack of support for some key elements, notably training and the establishment of an IT network and management information system. However, government officials are now much more aware of the Department's objectives and priorities, and regularly inform managers about suitable opportunities for projects and funding. Department staff also now use the Strategic Plan as a basis for new grant proposals.

Indicators should have been included in the Strategy. The Ministry of Public Service recently requested identification of Key Performance Indicators (KPIs) across the Government. These were not included in the new Strategy, but the Department is now working with the Productivity Council to identify KPIs for the goals and targets of the Strategic Plan. This should lead to improvements in both internal and external reporting.

DISCUSSION

Kuipers et al. (2013) note that while rapid, top-down approaches to organisational change tend to prevail in US/Anglo-centric countries, bottom-up approaches are more widely adopted in countries with more consensual systems of governance. Rusaw (2007) characterised four approaches to change in public organisations: a) Planned, rational approaches to select best interventions and implement long-term, comprehensive change (e.g. through strategic planning); b) Incremental models, that make minor changes in existing systems to achieve limited but tangible and quick results; c) Pluralistic models, that cultivate multiple stakeholder input, resources, and commitment to resolving local social or economic problems; and d) Individual models, such as training and development programmes.

The change process in Saint Lucia was multifaceted, incorporating all these approaches:

- 'Top down': through the new requirements of the Ministry, imposed financial constraints and a move towards more accountability in the public sector.
- 'Middle out': through the desire of senior and middle managers to address shortcomings in the organisation and the need for succession planning.
- 'Bottom up': in response to the impacts of declining morale and underperformance.
- 'Outside in': through encouragement from the Department's partners for improvements in its capacity and status.
- 'Inside out': through the need for the Department to influence and engage in sectors and activities related to its evolving and expanding role.

This situation is probably quite rare, but illustrates a set of conditions under which the state of change readiness, as identified in the section 'Unfreezing: lessons learned', was so advanced that the process was widely supported and to some extent spontaneous. These lessons may assist other organisations in establishing an enabling environment that would make their change process easier and more constructive. Strategic planning is defined by Bryson (2011) as "a deliberate, disciplined approach to producing fundamental decisions and actions that shape and guide what an organization is and what it does". However, its role and function are not generally well defined in the protected area sector, where more emphasis is placed on site-based management planning and where planning guidance tends to focus on rational identification of what is needed for that specific protected area, with less attention paid to establishing the organisational enabling environment required for effective plan implementation. A notable exception is Amend et al. (2003).

Kohl and McCool (2016) were highly critical of strategic planning in the natural and cultural heritage sector, highlighting the widespread perception that most plans are 'left on the shelf' and largely blaming 'rational comprehensive' approaches adopted by managers, donors and consultants. They advocated adoption of 'holistic planning', defined as "*a facilitated, continuous dialogue with heritage area constituencies designed eventually to construct a consensus about a desired evolving future"*, and encouraged planners to acknowledge individual, collective and cultural factors, alongside the rational and technical considerations that normally dominate planning and plans.

In the case of Saint Lucia, the original intent to produce a site-based management plan was superseded by a strategic planning and change process that has embraced many of the principles of the holistic approach advocated by Kohl and McCool (2016), but whose end-product has been a concise, but conventionally structured plan designed to be accessible to staff, partners and government officials. We suggest that prioritising participatory strategic planning at the organisational level can help establish the institutional and individual capacities and 'enabling environment' that will create more relevant and sustainable site-based plans (reflecting Kotter's, 1996, seventh stage: 'Build on the Change').

Morales-Hidalgo et al. (2015), using data from FAO (2015), report that 17 per cent of the world's forests are in legally established protected areas, accounting for 651 million ha. Globally, forestry-related authorities are responsible for more than 19,400 protected areas, at least 10.5 per cent of those in the World Database on Protected Areas that identify a managing authority[1]. The change process in Saint Lucia demonstrates how a forestry authority responsible for protected areas has successfully adapted to changing policies, priorities and environmental conditions by responding to demands for change that were internal as well as external, and by realigning its strategic directions and structure to reflect its evolving role.

The need for organisational capacity in the conservation NGO sector is attracting increasing attention and support (e.g. through the website capacityforconservation.org). Much less attention is being given to addressing the specific needs and challenges facing government organisations (which manage most of the world's protected areas) if they are to meet global expectations for biodiversity conservation and protected area management (Appleton, 2015b; WCPA Capacity Development Thematic Group, 2017). We encourage further studies, publications and practical initiatives to understand and address this issue.

ACKNOWLEDGEMENTS

The work described in this paper was funded by the Saint Lucia Forestry Department, Fauna & Flora International, Halcyon Land and Sea (supported by Arcadia, a charitable fund of Lisbet Rausing and Peter Baldwin), and (specifically for the capacity needs assessment in Step 1) the IUCN BIOPAMA Programme. The authors thank all the many staff and stakeholders who contributed, the former Minister of Sustainable Development, Energy, Science and Technology Dr James Louis Fletcher, former Permanent Secretary at the MSDEST Sylvester Clauzel, Chief Forest Officer (retd.) Michael Bobb, Deputy Chief Forest Officers Alfred Prospere and Alwin Dornelly, Bishnu Tulsie (Director, Saint Lucia National Trust), Matthew Morton (Eastern Caribbean Manager, Durrell Wildlife Conservation Trust) and James Crockett (Responsible Tourism Specialist).

The authors are also grateful to the two anonymous reviewers for their constructive comments that greatly helped improve this manuscript.

ENDNOTES

[1]Analysis conducted on www.protectedplanet.net on 28/04/2017 using the following search terms: forest, forêt, forst, silv, sylv, mets, bosc, bosq, sumar, skog and hutan.

ABOUT THE AUTHORS

Michael Appleton is Director of Protected Area Management for Global Wildlife Conservation (since January 2017) and Vice-Chair for Capacity Development for the IUCN World Commission on Protected Areas. He was contracted as a consultant by Fauna & Flora International to facilitate the work described in this paper between 2014 and 2016.

Adams Toussaint is Chief Forest Officer for the Saint Lucia Forestry Department and an authority on ornithology in the country. He oversaw the strategic planning and organisational change processes described in this paper.

Jennifer Daltry is Senior Conservation Biologist and Head of Caribbean at Fauna & Flora International. Since she started working in Saint Lucia in 2000, Dr Daltry's work has focused on the recovery of endangered species, habitat restoration and tackling threats from invasive alien species and unsustainable exploitation.

REFERENCES

Amend, S., Giraldo, A., Oltremari, J., Sánchez, R., Valerio, V. and Verena, E. (2003). *Management Plans: Concepts and Proposals.* Parques Nacionales y Conservación Ambiental No. 11. Panama.

Anon (2014). Performance Improvement Framework Review: Department of Conservation. Wellington, New Zealand: State Services Commission, the Treasury, and the Department of the Prime Minister and Cabinet. www.ssc.govt.nz/sites/all/files/pif-review-doc-july14.PDF

Appleton, M.R. (2015a). Assessment of capacity development needs of conservation staff in Saint Lucia. Unpublished report to IUCN Biodiversity and Protected Areas Management Programme. Gland, Switzerland: IUCN.

Appleton, M.R. (2015b). *Capacity Development Needs and Priorities for Nature Conservation in South-Eastern Europe.* Gland, Switzerland and Belgrade, Serbia: IUCN and IUCN Regional Office for Eastern Europe and Central Asia.

Appleton, M.R. (2016). *A Global Register of Competences for Protected Area Practitioners*. Gland, Switzerland: IUCN.

Bartkus, B., Glassman, M. and McAfee, R. B. (2000). Mission statements: are they smoke and mirrors? *Business Horizons*, 43(6), 6–23. doi.org/10.1016/S0007-6813(00)80018-X

Biech, E. (2007). *Thriving Through Change: A Leader's Practical Guide to Change Mastery*. Alexandria, Virginia, USA: ASTD Press.

Bryson, J.M. (2011). *Strategic Planning for Public and Nonprofit Organizations*. Fourth Edition. San Francisco, USA: Jossey-Bass.

Burnes, B. and Bargal, D. (2017). Kurt Lewin: 70 Years on. *Journal of Change Management*, 17 (2), 91–100. doi.org/10.1080/14697017.2017.1299371

Colwell, R., Avery, S., Berger, J., Davis, G.E., Hamilton, H., Lovejoy, T., Machlis, G., Malcom, S., McMullen, A., Novacek, M., Roberts, R.J. and Tapia, R. (2014). *Revisiting Leopold: Resource Stewardship in the National Parks.*

Washington, D.C., USA: National Park System Advisory Board Science Committee.

Convention on Biological Diversity (2010). *The Strategic Plan for Biodiversity 2011–2020 and the Aichi Biodiversity Targets.* Montreal, Canada: Convention on Biological Diversity. www.cbd.int/doc/decisions/cop-10/cop-10-dec-02-en.pdf

Daltry, J.C. (2009). *Biodiversity Assessment of Saint Lucia's Forests, with Management Recommendations*. Technical Report No. 10 to the National Forest Demarcation and Bio-Physical Resource Inventory Project. Helsinki, Finland: FCG International Ltd.

Dawson, P. (2003). *Understanding Organizational Change: The Contemporary Experience of People at Work*. London, UK: Sage.

Durst, P., Brown, C., Broadhead, J., Suzuki, R., Leslie, R. and Inoguchi, A. (eds) (2008). *Re-inventing Forestry Agencies: Experiences of Institutional Restructuring in Asia and the Pacific*. Bangkok, Thailand: UN Food and Agriculture Organization (FAO).

FAO – Food and Agriculture Organization (2015). *Global Forest Resources Assessment 2015: How Are the World's Forests Changing?* Rome, Italy: FAO.

FME (2013a). *PESTLE Analysis: strategy skills*. Free Management Ebooks. www.free-management-ebooks.com/dldebk-pdf/fme-pestle-analysis.pdf

FME (2013b). *SWOT Analysis: strategy skills.* Free Management Ebooks. www.free-management-ebooks.com/dldebk-pdf/fme-swot-analysis.pdf

Godlet, I. (1970). *Forest Work Plan 1970-1980*. Castries, Saint Lucia: Ministry of Agriculture.

IUCN and WCPA – World Commission on Protected Areas (2016). *IUCN Green List of Protected and Conserved Areas: Standard*, Version 1.0. Gland, Switzerland: IUCN.

Kohl, J. and McCool, S. (2016). *The Future has Other Plans. Planning Holistically to Conserve Natural and Cultural Heritage.* Golden Colorado, USA: Fulcrum Publishing.

Kotter, J.P. (1996). *Leading Change*. Boston, USA: Harvard Business School Press.

Kuipers, B.S., Higgs, M.J., Kickert, W.J.M., Tummers, L.G, Grandia, J. and van der Voet, J. (2013). The management of change in public organisations: A literature review. *Public Administration*, 92, 1–20. doi.org/10.1111/padm.12040

Leverington, F., Costa, K., Courrau, J., Pavese, H., Nolte, C., Marr, M., Coad, L., Burgess, N., Bomhard, B. and Hockings, M. (2010). *Management Effectiveness Evaluation in Protected Areas – A Global Study*. Second edition. Brisbane, Australia: University of Queensland.

Lewin, K. (1947). Frontiers in group dynamics. In D. Cartwright (Ed.), *Field Theory in Social Science*. London, UK: Social Science Paperbacks.

Millennium Ecosystem Assessment (2005). *Ecosystems and Human Well-Being*. Washington, D.C, USA: Island Press.

Morales-Hidalgo, D., Oswalt, S.N. and Somanatan, E. (2015). Status and trends in global primary forest, protected areas, and areas designated for conservation of biodiversity from the Global Forest Resources Assessment 2015. *Forest Ecology and Management,* 352, 68–77. doi.org/10.1016/j.foreco.2015.06.011

Pick, D., Teo, S., Tummers, L. and Newton, C. (2015). Advancing knowledge on organizational change and public-sector work. *Journal of Organizational Change Management*, 28 (4). doi.org/10.1108/JOCM-06-2015-0088

Rusaw, A.C. (2007). Changing public organizations: four approaches. *International Journal of Public Administration*, 30 (3), 347–361. doi.org/10.1080/01900690601117853

Saint Lucia Forests and Lands Resources Department (2015). *Strategy 2015–2025*. Union, Saint Lucia: Saint Lucia Forestry Department. www.malff.com/images/stories/forestry/resources/Forests%20and%20Lands%20Resources%20Department%20Strategy%202015-2025%20ver%205.pdf

Sandwith, T., Enkerlin, E., MacKinnon, K., Allen, D., Andrade, A., Badman, T., Brooks, T., Bueno, P., Campbell, K., Ervin, J., Laffoley, D., Hay-Edie, T., Hockings, M., Johansson, S., Keenleyside, K., Langhammer, P., Mueller, E., Smith, T., Vierros, M., Welling, L., Woodley, S. and Dudley, N. (2014). The Promise of Sydney: An editorial essay. *Parks*, 20 (1), 7–18.

Spathelf, P. (ed.) (2010). *Sustainable Forest Management in a Changing World: A European Perspective*. New York, USA: Springer. doi.org/10.1007/978-90-481-3301-7

Stolton, S. and Dudley, N. (2016). *METT Handbook: A Guide to Using the Management Effectiveness Tracking Tool (METT)*. Woking, UK: WWF-UK.

RESUMEN

Si bien las expectativas mundiales acerca de los servicios que deben prestar las áreas protegidas están evolucionando (por ejemplo, a través de los Objetivos de Aichi y los Objetivos de Desarrollo Sostenible de las Naciones Unidas), poca atención se ha prestado a cómo pueden las dependencias gubernamentales que se ocupan de las áreas protegidas adaptar y mejorar su desempeño en consecuencia. El ámbito de competencia del Departamento Forestal de Santa Lucía se ha ido ampliando progresivamente desde la producción forestal hasta, entre otras cosas, la gestión de áreas protegidas, investigación y conservación de la vida silvestre, gestión de cuencas hidrográficas, turismo y educación ambiental. En 2014, en respuesta a un consenso generalizado sobre la necesidad de actualizar sus métodos de trabajo, el Departamento inició un proceso participativo de planificación estratégica y cambio institucional, que comprende: (1) Análisis organizativo y evaluación de las necesidades en materia de capacitación; (2) Desarrollo de un nuevo plan estratégico y la correspondiente reestructuración de la organización; y (3) Institucionalización del plan. Este proceso positivo en general proporciona lecciones importantes con una aplicación potencialmente más amplia sobre "predisposición al cambio", liderazgo, capacidad, comunicación, participación y el valor de "logros rápidos". Aunque es necesario seguir trabajando en el desarrollo de capacidades y la institucionalización total de los cambios, el Departamento Forestal puede ahora articular mejor sus funciones y necesidades y garantizar la conservación a largo plazo y el uso sostenible de la biodiversidad de importancia mundial de Santa Lucía, tanto dentro como fuera de sus áreas protegidas. Hacemos hincapié en la necesidad de contar con más estudios e iniciativas sobre cambios organizativos en las dependencias gubernamentales responsables de las áreas protegidas y la conservación de la biodiversidad.

RÉSUMÉ

Alors que les attentes, au niveau mondial, liées aux aires protégées sont en train d'évoluer (par exemple, les Objectifs d'Aichi et les Objectifs de développement durable des Nations Unies), peu d'attention a été accordée à la manière dont les agences gouvernementales peuvent adapter et améliorer leurs performances en conséquence. Les attributions du Département des Forêts de Sainte-Lucie se sont progressivement étendues de la production forestière à la gestion des aires protégées, à la recherche et à la conservation de la faune, à la gestion des bassins versants, au tourisme et à l'éducation environnementale. En 2014, en réponse à un large consensus sur la nécessité de mettre à jour ses méthodes de travail, le Ministère a lancé un processus participatif de planification stratégique et de changement organisationnel comprenant: 1) un examen organisationnel et une évaluation des besoins en capacités ; 2) le développement d'un nouveau plan stratégique et la restructuration correspondante de l'organisation; et (3) l'institutionnalisation du plan. Ce processus, généralement couronné de succès, fournit des leçons importantes ayant potentiellement une application plus large sur l'adaptation au changement, le leadership, les compétences, la communication, la participation et l'intérêt de sécuriser rapidement des 'petits succès'. Bien qu'il soit nécessaire de renforcer encore les capacités et d'institutionnaliser pleinement les changements, le Département des Forêts est désormais mieux à même d'articuler ses rôles et ses besoins et d'assurer la conservation et l'utilisation durable de la diversité biologique de Sainte-Lucie, que ce soit au sein de ses aires protégées ou non. Nous préconisons la mise en place d'études et d'initiatives nouvelles visant un changement organisationnel dans les agences gouvernementales responsables des aires protégées et de la conservation de la biodiversité.

WILL 'OTHER EFFECTIVE AREA-BASED CONSERVATION MEASURES' INCREASE RECOGNITION AND SUPPORT FOR ICCAs?

Harry D. Jonas[1*], Emma Lee[2], Holly C. Jonas[3], Clara Matallana-Tobon[4], Kim Sander Wright[3], Fred Nelson[5] and Eli Enns [3]

*Corresponding author: harry@naturaljustice.org

[1] Natural Justice, Cape Town, South Africa
[2] Centre for Marine Socioecology, University of Tasmania, Hobart, Tasmania, Australia
[3] ICCA Consortium, Bugnaux (Essertines-sur-Rolle), CH 1180, Canton de Vaud, Switzerland
[4] Humboldt Institute, Bogota D.C. PBX: 3202767, Colombia
[5] Maliasili Initiatives, Underhill VT 05489, USA

ABSTRACT

This paper reflects on IUCN's ongoing progress to develop technical guidance on 'other effective area-based conservation measures' (OECMs) and begins to explore under what conditions OECMs – as a new form of recognition – might make a positive contribution to territories and areas conserved by Indigenous peoples and local communities (abbreviated to 'ICCAs'). It argues that while the protected areas framework is a potentially useful means by which to recognise the biodiversity contributions of some ICCAs, it is not universally appropriate. In this context, and subject to important caveats, OECM-related frameworks offer an important opportunity to increase recognition and support for ICCAs. The paper concludes with two practical recommendations: first for the development of supplementary guidance on OECMs and ICCAs; and second, for further discussion by a wide range of interested parties on whether 'OECMs' should be referred to as 'conserved areas'.

Key words: Aichi Biodiversity Targets, protected areas, other effective area-based conservation measures, Indigenous peoples and local communities, ICCAs, conserved areas

INTRODUCTION

In the closing hours of the 10th Conference of the Parties to the Convention on Biological Diversity (COP/CBD), Parties finalised their negotiations of Aichi Target 11, which resulted in the following formulation:

> By 2020, at least 17 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well connected systems of protected areas and ***other effective area-based conservation measures***, and integrated into the wider landscapes and seascapes. (Emphasis added).

This was the first appearance of the term 'other effective area-based conservation measures' (OECMs), and over the following four years, discussions within CBD fora and the International Union for Conservation of Nature (IUCN) underscored the need for guidance on the matter, including in relation to the potential for making a direct link between OECMs and ICCAs (see, for example Lopoukhine and de Souza Dias, 2012; IUCN, 2012a; IUCN, 2012b; Woodley et al., 2012; CBD, 2013; CBD, 2014).[1]

In 2015, and in line with the recommendation of several of the authors of this paper (Jonas et al., 2014), the WCPA established a Task Force to "develop guidance for IUCN members and CBD Parties on the definition of 'other effective area-based conservation measures'".[2] At the time of writing (November 2017) the draft definition of OECMs used by the Task Force is as follows:

> "A geographically defined space, not recognised as a protected area, which is governed and managed over the long-term in ways that deliver the effective and enduring in-situ conservation of biodiversity, with associated ecosystem services and cultural and spiritual values." (IUCN-WCPA, 2017a).

The core difference between this definition and the IUCN definition of a protected area[3] is that protected areas must have conservation as the primary objective of management but OECMs are defined by outcomes rather

than objectives: an OECM must *deliver* the effective and enduring in-situ conservation of biodiversity and this is regardless of the management objectives.

This paper explores under what conditions recognition as OECMs might make a positive contribution to territories and areas conserved by Indigenous peoples and local communities (ICCAs). Even though the concept of ICCAs in policy and academic writing is a recent phenomenon, sites of this kind have been in existence since humans began to govern and manage landscapes and seascapes purposefully. They are referred to by a wide range of terms in their local contexts. Underpinned by cultural, spiritual, economic, political and other motivations, they are the basis of survival, livelihoods, identity, and wellbeing for millions of people (Kothari & Neumann, 2014).

ICCAs are one of four governance types of both protected areas and OECMs (see Table 1) and are defined by three essential characteristics:

- An Indigenous people or local community possesses a close and profound relationship with a site (territory, area or habitat);
- The people or community is the major player in decision-making related to the site and has *de facto* and/or *de jure* capacity to develop and enforce regulations; and
- The people's or community's decisions and efforts lead to the conservation of biodiversity, ecological functions and associated cultural and spiritual values, regardless of original or primary motivations. (Borrini-Feyerabend, 2010; Borrini-Feyerabend et al., 2014).

The third characteristic specifies that like OECMs (and in contrast to IUCN protected areas), ICCAs are defined by outcomes rather than objectives: decisions and efforts must *lead* to conservation "*regardless of … motivations*". Therefore not all ICCAs will be eligible for recognition as protected areas, but those that are not may still qualify as OECMs.

Returning to OECMs, the draft Guidelines set out three types of approaches that can lead to OECMs, subject to consent by the area's governance authority (discussed below). These include: areas where conservation is the primary management objective (*primary conservation*) that may meet all elements of the IUCN definition of a protected area, but which are not officially recognised as such because the governance authority does not want the area to be designated as a protected area; areas where conservation is an outcome of management but is a secondary management objective (*secondary conservation*), which therefore do not meet the IUCN definition of a protected area; and areas that deliver conservation outcomes as a by-product of management activities even though biodiversity conservation is not a management objective at all (*ancillary conservation*). All three types of OECM-related approaches have clear relevance for ICCAs (IUCN-WCPA, 2017a).

ICCAs REQUIRE GREATER RECOGNITION AND SUPPORT

It is estimated that ICCAs equal or exceed the number and extent of state protected areas (Kothari et al., 2012) and there is increasing evidence that under certain conditions (Ostrom, 1990, 2000), areas and resources under the governance and/or management of Indigenous peoples and local communities can be, with certain scale-specific qualifications (Shahabuddin & Rao, 2010), as or more effective than strictly protected areas at preventing deforestation, maintaining forest health and ecosystem connectivity, and conserving biodiversity and natural resources (Kothari et al., 2000; Lovgren, 2003; Molnar

Table 1. The continuum of governance types across IUCN protected areas and OECMs, with illustrative examples[4]

Governance types → / Form of conservation ↓	Governments (at various levels)	Private individuals, organisations and companies	Indigenous peoples and/or local communities	Shared
Protected Areas	A government national park	A privately owned wetland managed primarily for its conservation values	An Indigenous or community forest managed primarily for its conservation values	Any of the kinds of areas listed to the left (among others) where governance is shared
OECMs	A government water conservation area that contributes to biodiversity conservation as a secondary objective	A privately owned disused quarry that provides avian habitat as a by-product of the area's exclusion of activities.	An Indigenous or community sacred grove that prohibits destructive activities for spiritual reasons	Any of the kinds of areas listed to the left (among others) where governance is shared

et al., 2004; White et al., 2004; Hayes & Ostrom, 2005; Nepstad et al., 2006; Nagendra, 2008; World Bank, 2008; Bray et al., 2008; Nelson & Chomitz, 2011; Porter-Bolland et al., 2011; Nolte et al., 2013; CIPTA & WCS, 2013; Stevens, 2014). In the context of the downward trends in global biodiversity (UNEP-WCMC and IUCN, 2016; Ceballos et al., 2017), therefore, appropriately recognising and supporting ICCAs becomes ever more important.

Yet ICCAs and their custodians are under threat from multiple sources, including the influence of traditional systems of mainstream economies, languages, education and health care systems, media and religions (United Nations, 2009; International Work Group for Indigenous Affairs, 2017); imposed forms of 'development' such as industrial agriculture, extractive industries and physical infrastructure in both terrestrial (Coalition Against Land Grabbing, 2015) and marine contexts (Bennett et al., 2015); armed conflicts and establishment of illegal crops due to a growing demand for drugs (IDMC, 2017); and displacement of Indigenous peoples from their traditional territories as a result of exclusionary forms of conservation (Adams & Mulligan, 2004; Dowie, 2009; Indian Law Resource Centre and IUCN, 2015). In many instances, laws (such as those related to weak tenure rights), judicial processes and related institutions facilitate and protect the interests of more powerful groups against Indigenous peoples and local communities (Minority Rights Group, 2012; Rights and Resources Initiative, 2012). Associated violence against environmental and human rights defenders (including 200 reported murders in 2016) is occurring at an alarming rate (Global Witness, 2017).

Respecting and supporting Indigenous peoples and local communities who choose to steward, govern, manage or otherwise control the territories and areas they depend upon securely is a human rights imperative that also supports the integrity of ecosystem functions and the conservation of biodiversity (Tauli-Corpuz, 2016; Knox, 2017). Towards this end, Indigenous peoples and local communities continue to gain hard-fought recognition of a broad range of rights, across multiple laws and policy statements at the international and national levels (Jonas, 2012; Jonas, 2016), all of which are critical to their social, cultural, spiritual and ecological integrity. Indigenous peoples and local communities have made significant international legal gains within the CBD relating to conservation, customary sustainable use of biodiversity, and traditional knowledge, including in dedicated processes on Articles 8(j) and 10(c). In the protected areas context, major breakthroughs at the international policy level include the development of the CBD's Programme of Work on Protected Areas (2004) and several CBD COP decisions on protected areas since then, as well as adoption by the IUCN of four protected areas governance types, including governance 'by Indigenous peoples and local communities' (Phillips, 2004; Dudley, 2008; Borrini-Feyerabend et al., 2013; Worboys et al., 2015).

Despite these advances, and subject to the caveats in Box 1, in 2017 the World Database on Protected Areas included only 1,351 protected areas that were governed by Indigenous peoples and local communities. This stands in contrast to 186,391 protected areas governed by governments.[5] The former amounts to an area of 1,896,321.7 km2, which is under 5 per cent of the total area of terrestrial and marine protected areas (UNEP-WCMC & IUCN, 2017).

Box 1. Placing the WDPA data on ICCAs in context

The data held by the WDPA on ICCAs, referenced above, should be read in the context of two important caveats. First, despite the global nature of such protected areas, the reporting of such areas is from only 27 countries and territories, and Brazil's level of reporting of such protected areas (499 areas) accounts for more than one third of the total. This suggests that the current global levels of reporting of protected areas governed by Indigenous peoples and local communities are significantly lower than the total number of areas that may meet the definition. This presumption is bolstered by unofficial figures that suggest Indigenous peoples alone strongly influence governance of over a third of all lands designated as protected areas and that a fifth of all Indigenous lands are listed as protected areas (Garnett, pers. comm.). For example, in Australia, 75 Indigenous Protected Areas cover approximately 67 million hectares, which comprise 44 per cent of the National Reserve System and 7.5 per cent of all protected areas in Australian territories (CAPAD, 2014). This figure does not include jointly-managed World Heritage Areas, such as Kakadu National Park (Lee, 2016a). Second, a number of the protected areas within which Indigenous peoples and local communities have an important influence are reported as 'shared governance'. It is also important to note that, despite the principle that reporting of protected areas should be undertaken on the basis of the free, prior and informed consent of the respective governance authority (Borrini-Feyerabend et al., 2014), it is likely that not all data-providers reporting to the WDPA follow this principle (Stevens et al., 2016a; Stevens et al., 2016b).

POTENTIAL MISALIGNMENT BETWEEN PROTECTED AREAS AND ICCAs

Despite these advancements, ICCAs still sit uncomfortably or even in direct conflict with protected areas in many national contexts. Recent reports by two UN Special Rapporteurs – the first on the rights of Indigenous peoples and the second on human rights and the environment – clearly set out the historical and present day injustices suffered by Indigenous peoples and local communities in the context of conservation initiatives (Tauli-Corpuz, 2016; Knox, 2017).

At one level, injustices continue to occur because, among other things, many national-level protected areas frameworks have failed to keep up with international advances in human rights and environmental law and jurisprudence (Kothari et al., 2012; Stevens, 2010; Stevens, 2014; Rights and Resources Initiative, 2015). The result is that many national conservation frameworks either do not provide for the recognition of ICCAs – including in situations of overlap with protected areas (Stevens, 2014; Stevens et al., 2016a; Stevens et al., 2016b) – or do so in ways that some Indigenous peoples' or communities' governing authorities[6] deem inappropriate or in violation of their human rights (Burnham, 2000; Poirier & Ostergren, 2002; Brockington & Igoe, 2006; Phyälä, 2016).

At a deeper, structural level, the seeds of these injustices were sown into 'conservation' at its founding in the form of game reserves and national parks in the nineteenth century (Stevens, 1997; Colchester, 2003; Adams & Mulligan, 2004; Dowie, 2009, Stevens, 2014). Through a lens that prioritises biodiversity, Indigenous peoples' and local communities' connections to land, sea and sky have long been delineated in conservation policy as being either 'natural' or 'cultural'. This has led in many instances to the objectification of cultural values (Cohen, 1978; Lee, 2016a) and the associated undervaluing and undermining of the broader and more intricate social-ecological systems (Berkes et al., 2003; Folke et al., 2005) and relationships that exist across landscapes and seascapes with which Indigenous peoples and local communities have close connections (Pathak, 2009; Robson & Berkes, 2010; Brown & Kothari, 2011; Bhatt et al., 2012; AIPP, 2013).

This approach has led to holistic and inextricably linked forms of culture, spirituality, knowledge and practices being presented as "those that contribute to conservation outcomes" (Dudley, 2008) and those that do not. According to this approach, Indigenous peoples' and local communities' worldviews matter, but only if they accord with what is desired and acceptable within a protected areas framework (Wilk, 1995; Morel, 2010). While this approach may have an inherent logic from a 'conservation' perspective, this binary approach leaves a wealth of Indigenous and local worldviews (including ontologies and ethics) unrecognised, disrespected and marginalised (Indian Law Resource Centre and IUCN, 2015). Inherent values that are characterised by the variability of diverse, changing and complex connections to both the physical and non-physical worlds (Gibbs, 2006; Johnson & Morton, 2007) and relational ways of knowing (Healey & Tagak, 2014) are obscured by the poor fit into either 'natural' or 'cultural' values (Lee, 2016a).

Tebrakunna Visitors Centre, Tasmania © Hilary Burden

The issues set out above have been the subject of CBD deliberations and are widely referenced in – among other places – IUCN World Parks Congresses' outcome documents such as the Durban Accord (IUCN, 2003), the Promise of Sydney and New Social Compact (IUCN, 2014a; IUCN, 2014b), and other international instruments (Tauli-Corpuz, 2016; Knox, 2017). To address past wrongs and establish just approaches to conservation (Greiber et al., 2009; Kashwan, 2013), many national protected area frameworks are undergoing reforms to ensure their adherence to international and regional human rights norms. The advent of OECMs – as a body of technical guidance, laws, institutional frameworks and practices operating at the international and (sub-)national levels – has the potential to augment that encouraging trend. First, they may be a useful means by which to provide an additional layer of recognition to ICCAs that either do not meet the definition of a protected area or do not want to be recognised as such. The effectiveness of this approach will be contingent on governmental and private actors respecting and supporting OECMs, which is not a given, considering alarming trends towards protected area downgrading, downsizing and degazettement[7] may also extend to OECMs. Second, if crafted sensitively and with wisdom, OECMs have the potential to directly address the foundational misalignment between Indigenous peoples' and local communities' traditional approaches to territories, land and sea, on the one hand, and Western scientific (often dualist) approaches to conservation, culture and nature on the other. The nuances of these statements are elaborated in the next section.

RECOGNISING OECMS, RESPECTING ICCAs

There are several potential benefits of recognising OECMs as a complement to protected areas (IUCN-WCPA, 2016a, 2016b, 2017b; Juffe-Bignoli et al., 2016; Diz et al., 2017; Laffoley et al., 2017), including: increasing the potential to engage and support a range of new partners in global conservation efforts; incentivising the recognition or application of robust conservation and management measures to areas of biodiversity significance; and contributing to improved management and restoration of areas that could usefully support long-term *in situ* conservation of biodiversity. The latest *Protected Planet Report* adds to this list, stating that: "In the long term, OECMs could have the potential to contribute greatly to elements such as representativeness and connectivity, and to contribute to conservation in important places such as KBAs [key biodiversity areas], especially in cases where protected areas are not an option" (UNEP-WCMC & IUCN, 2016). This section provides a preliminary analysis of the issues relevant to the future recognition of some ICCAs as OECMs.

Equality of standing between conservation measures

The relative value of OECMs vis-à-vis protected areas is a key issue that has been discussed within and beyond the OECM Task Force (IUCN-WCPA, 2015, 2016a; Borrini-Feyerabend, 2016). The deliberations are clear that while protected areas and OECMs are mutually exclusive frameworks, both have value for biodiversity conservation. In doing so, OECMs have the potential to advance the international recognition of the *in situ* conservation of biodiversity outside protected areas,

Example 1. Tebrakunna Visitors Centre, Tasmania

On *tebrakunna*[7] country, northeast Tasmania, Australia, *trawlwulwuy* peoples negotiated an offset agreement for a culture centre as a fair exchange for a windfarm development. The resulting Tebrakunna Visitors Centre (TVC) is also sited at the location of Australia's first land rights agreement. Made in 1831 between the *trawlwulwuy* chief, *Mannalargenna*, and the colonial government, this agreement was never fulfilled and lay broken, dormant and forgotten. However, it was revitalised in 2015-2016 by *trawlwulwuy* peoples as the basis for constitutional recognition as Tasmania's First Peoples (Lee, 2015; Lee, 2016b).

Conservation of nature was not the priority for the creation of the Tebrakunna Visitors Centre. The focus on repairing relationships between Indigenous and other Tasmanians has positively influenced government and business policy through the sharing of cultural and historical knowledges stemming from the Tebrakunna Visitors Centre. In turn, conservation of *tebrakunna* country has resulted, including though protection of wildlife corridors for the reintroduction of healthy Tasmanian Devils. This reflects a deep desire by *trawlwulwuy* peoples to continue current cultural practices, recover others and have access to valued cultural and natural resources. Interestingly, the agreement has been used subsequently to assist in brokering the first joint management arrangement for a Tasmanian protected area, the Tasmanian Wilderness World Heritage Area, situated in the southwest of the state.

In summary, political and territorial recognition of the *trawlwulwuy* peoples has led, among many other positive trends, to the more equitable conservation of biodiversity in the form of one potential OECM (the Tebrakunna Visitors Centre's surrounding area) and an existing protected area (the Tasmanian Wilderness World Heritage Area).

including through primary, secondary or ancillary forms of conservation and by Indigenous peoples and local communities. This is particularly important in the context of the latest *Protected Planet Report* (UNEP-WCMC & IUCN, 2016) and related research (Bingham et al., 2017) that underscore that protected areas are not yet meeting Target 11's terrestrial and marine targets, either at a global level or with regard to their coverage of ecoregions (UNEP-WCMC & IUCN, 2016) and species (Butchart et al., 2015). The future equality of standing between protected areas and OECMs may have a number of beneficial effects, including the diversification of governance and management arrangements that are considered to contribute to qualitative and quantitative conservation targets at both international and (sub-) national levels. National agencies may thus be incentivised to better understand the worldviews, practices, responsibilities and rights of Indigenous peoples and local communities (Rights and Resources Initiative, 2015) and work with them to appropriately respect, support and report ICCAs that meet the definition of an OECM.

Understanding and embracing holistic social-ecological systems

The kinds of ICCAs that might also meet the definition of an OECM will likely have long-standing and relatively complex forms of 'ecosystem governance' (Vasseur et al., 2017), rooted in much broader cultural and spiritual beliefs and practices than those specifically focused on biodiversity. Individuals assessing potential OECMs will be *prima facie* interested in cultural and spiritual values and practices that lead to positive biodiversity outcomes (Dudley, 2008; IUCN-WCPA, 2017b). Yet for the reasons set out above, the social-ecological integrity of ICCAs could benefit from respect and support for Indigenous peoples' and local communities' broader cultural and spiritual systems, within which the more directly biodiversity-relevant aspects are nested. Actors involved in recognising ICCAs as OECMs must work outside the single issue silos to develop holistic, integrated and appropriate forms of support with the respective Indigenous peoples and local communities, subject to their free, prior and informed consent. It is hoped that funders also adopt progressive approaches to these needs, including through the Global Environment Facility under its proposed Operational Phase 7 impact programme on 'inclusive conservation' (Global Environment Facility, 2017). The alternative – provision of selective, externally-defined support – could have negative impacts, including on the governance and management of biodiversity.

Upholding FPIC

Extrapolating from existing international conservation policy, the external 'recognition' of an OECM must fully respect the rights of the Indigenous peoples and local communities (including their authorities and organisations responsible for such areas) and be based on their free, prior and informed consent (FPIC), and the governance of an OECM must reflect internationally-, regionally- and nationally-recognised human rights. This

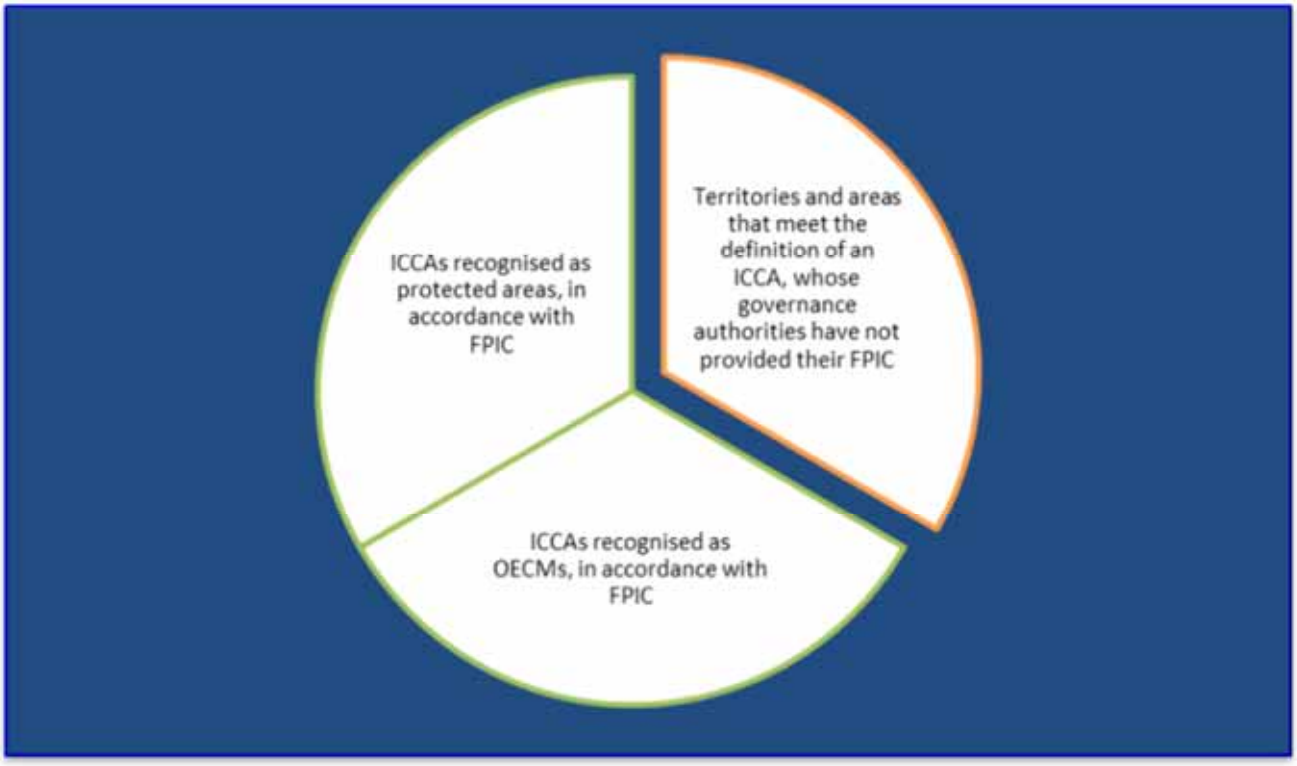


Figure 1: Recognition and reporting of ICCAs as protected areas or OECMs should be in accordance with the respective governance authorities' right to provide or withhold FPIC. The equal size of each segment is for illustration only.

includes respecting ICCA governing authorities' decisions in two key situations. First, when the governing authorities of ICCAs that meet either the definition of a protected area or an OECM and who decide against the recognition of their territories or areas as either designation. Second, when the governing authorities of an ICCA that meets the definition of a protected area prefers the area to be recognised as an OECM. This may be an important option for some Indigenous peoples and local communities living in contexts where recognition of an area as a protected area might lead to negative consequences for the area or its governance, but where they still wish to have some recognition under the (sub-) national or international level framework for biodiversity conservation.

Upholding FPIC is critical to ensuring that injustices perpetrated against Indigenous peoples and local communities under protected area-related regulatory frameworks are not repeated in the context of OECMs (see Figure 1). This is especially important in the run up to 2020 (the deadline for CBD Parties to achieve the Strategic Plan and Aichi Targets), when state agencies will be under pressure to boost their area-based coverage to meet Target 11 and may be tempted to report ICCAs as OECMs without due process.

As a corollary, in order to recognise ICCAs as OECMs, states must develop dedicated legal and policy frameworks with the full and effective participation of Indigenous peoples and local communities. They are advised to ensure that such frameworks form constituent parts of broader legal and institutional frameworks that recognise and support the full spectrum of Indigenous peoples' and local communities' cultures, customary laws and institutions, rights and responsibilities (i.e., as above, not just the aspects associated *directly* with the conservation of biodiversity) (Rights and Resources Initiative, 2015). Thus, legal, policy and institutional reforms necessary to recognise OECMs at the (sub-) national level may provide an opportunity to advocate for other and possibly more systemic reforms to recognise and support Indigenous peoples' rights.

There is growing recognition in Canada at the Federal level that conservation by Indigenous peoples could contribute to Canada's Biodiversity Target 1 to protect or conserve 17% terrestrial and 10% marine areas by 2020 (in line with Aichi Target 11).[9] Three ministries are actively engaged in the designation, recognition and management of protected and conserved areas: Environment and Climate Change Canada (ECCC), Indigenous and Northern Affairs Canada and Fisheries and Oceans Canada. Each uses different approaches to reach the targets and while the OECM-related work of each ministry and of several other Canadian bodies (MacKinnon et al., 2015 is notable. The example below focuses on the ECCC.

View towards Meares Island Tribal Park, governed by the Tla-o-qui-aht First Nation, with Ahousant village in the foreground, British Colombia, Canada. © Eli Enns

Example 2. Biodiversity Target 1, Canada:

The ECCC has created a National Steering Committee and process called *Pathway to Target 1*. The Steering Committee has set up an Indigenous Protected and Conservation Areas (IPCA) Indigenous Circle of Experts (ICE) to help inform ECCC on how IPCAs will help Canada meet its Biodiversity Targets. In 2016, the ECCC Parks Agency's Vice -President said, "other effective area-based conservation measures and Indigenous protected areas could contribute significantly to achieving the 17% [terrestrial] target and a national network of conservation" and added that the Pathway to Target 1 process will "support a renewed nation-to-nation relationship with Indigenous peoples based on respect, co-operation, partnership, and the recognition of rights".[10]

However, members of the ICE feel that it would be inappropriate to set up IPCAs only as a way to meet Aichi Targets. The work ahead is seen as too critical to be rushed in order to meet 2020 targets. They have called for effective and meaningful solutions around jurisdictional issues, and have said that the government (at various levels) will need to be prepared to mobilise substantial and effective financial support for issues that currently stand in the way of being able to effectively recognise and support IPCAs. They believe that a deeper process of reconciliation will result in positive outcomes for both the Indigenous peoples and biodiversity. Exactly how this issue is resolved, and the way in which OECMs support the Pathway to Target 1's aims, will contribute to the discussion of a range of the issues raised in this paper.

Indigenous territories in Vaupés, Colombia, Amazon Basin © Ignacio Giraldo

Addressing procedural challenges (and opportunities)

One potential challenge is that governance authorities of potential OECMs will be called upon to demonstrate, among other things: the identification of the full range of key biodiversity attributes for which the site qualifies; effective and enduring *in-situ* conservation of biodiversity (Stolton & Dudley, 2006; Geldmann et al., 2013; Nolte et al., 2013; Carranza et al., 2014; Watson et al., 2015); a direct causal link between the area's long-term management and the conservation outcomes; and effective means of control over activities that could impact biodiversity. These requirements raise conceptual and practical questions. Focusing on the practical aspects, and as reflected above, Indigenous peoples' and local communities' worldviews, knowledge, innovations and practices (CBD, 1992) have in many instances been denied, ignored and/or undermined by Western forms of science and conservation (IUCN, 2016c). Many Indigenous peoples and local communities have a deep understanding of their territories' and areas' biodiversity, natural resources and ecological functions and govern and manage them according to customary laws (Tobin, 2014), traditional ecological knowledge (Berkes, 1999) and spiritual and religious beliefs (Verschuuren et al., 2010). Yet they may also be at a significant disadvantage in attempting to demonstrate achievement of the above criteria using imposed languages and externally-developed methodologies. The concern is whether all Indigenous peoples and local communities who want their territories and areas to be recognised as OECMs would be able to present, for example, the area's key biodiversity attributes and values in the format that may be required by national or international bodies. The potential for these criteria to be a procedural challenge underscores the importance of Indigenous peoples and local communities themselves – including custodians of ICCAs – being centrally involved in the development and implementation of (sub-)national OECM-related laws, policies, procedures and institutional arrangements.

Whatever the final formulation of these specific criteria and related procedures, there is an increased urgency to improve the collective understanding of Indigenous peoples' and community-based governance, management, monitoring and reporting systems, as well as the broader linkages between culture and biodiversity (Boedhihartono, 2017). In contrast, the absence of these conditions will likely discriminate against culturally specific, locally rooted approaches to the governance of ICCAs. Doing so will be challenging for many conservation actors, but may provide a significant opportunity to co-develop innovative approaches to the conservation of social-ecological landscapes and seascapes. Collective thinking and integrated solutions will be especially important as the effects of biodiversity loss and other anthropogenic phenomena such as climate change intensify.

Example 3, Indigenous Reserves, Colombia: Some Indigenous territories in Colombia are recognised as Indigenous reserves under national law, implying also the recognition of the respective governing authorities' management approaches and related instruments such as '*planes de vida*' (life plans). Currently 696 Indigenous reserves are recognised, which comprise 32 million hectares including at least 21 million hectares of forests. The recognition of these territories has not been without challenges. For example, issues around consideration of cultural practices and the ancestral concept of territory has resulted in cases of divided traditional areas and the creation of new structures of political representation that do not necessarily coincide with cultural realities (Rodriguez et al., 2014).

Notwithstanding these issues, Indigenous peoples are working to maintain their traditional knowledge and vision of their territories, including through this framework. In the Colombian Amazon, for example, ethnic groups such as *Yucunas* and *Matapis*, are working with NGOs such as Tropenbos Colombia on the documentation of their knowledge of their territories and management to develop ancestral maps in order to avoid losing practices that are based mainly on shamanic concepts, including traditional approaches to forest management, and which demonstrate how indigenous people contribute to the conservation of tropical rainforests (Rodriguez et al., 2014; Matapí & Yucuna, 2012). Such cases illustrate the importance of recognition of community-based governance and traditional knowledge systems based on and permitting existence in equilibrium with nature.

CONCLUSIONS AND RECOMMENDATIONS

Protected areas are one important means by which many ICCAs can gain greater recognition for their contributions to conservation, subject to important caveats. The ongoing process of international and (sub-) national reform of protected areas law and policy – including recognising Indigenous peoples' and communities' rights and governance capacities – has the potential to increase the number of ICCAs whose governing authorities propose or consent to such recognition.

In parallel, mindful crafting of international and (sub-) national guidelines, laws and institutional arrangements on OECMs and their rights-based implementation may represent an important new inflection point in the evolution of conservation policy and practice. It may also lead to the improved recognition of conservation contributions of Indigenous peoples and local communities and increase support for the biodiversity that exists – whether thriving or under threat – outside protected areas. Recognition of particular ICCAs as OECMs may also provide increased security and visibility and lead to greater recognition and support for the territory or area, though this is subject to government agencies and private actors providing 'teeth' to this designation. A progressive approach to OECMs may also lead, in some instances, to a form of 'restorative ecology', whereby recognising and supporting individual ICCAs as OECMs catalyses a healing and transformative process for all parties involved.

However, such transformative processes and outcomes are by no means guaranteed. OECM-related frameworks could instead further entrench dichotomous approaches to 'science', 'culture' and 'nature' that deny the value of the interconnectedness of Indigenous peoples' and local communities' worldviews, knowledges and forms of governance and management. Governments and other agencies could focus their support too narrowly on biodiversity-related elements of Indigenous peoples' and local communities' cultures and governance structures. States could develop national OECM frameworks without the full and effective participation of Indigenous peoples and local communities. Government agencies could rush to meet their international commitments under Target 11 in ways that do not uphold the FPIC of Indigenous peoples and local communities. OECM-related recognition and reporting procedures could be perceived by Indigenous peoples and local communities as discriminating against community governance authorities that are less equipped to comply with them. More broadly, dedicated processes are required to resolve continuing issues with ICCAs overlapped by protected areas and may also be required if ICCAs are overlapped by OECMs without their FPIC. Under conditions such as these, the governance authorities of ICCAs may at best be disinterested in engaging with the framework. At worst, OECMs may be used – whether inadvertently or not – to further undermine the social-ecological integrity of ICCAs.

In making the case for the development of technical guidelines on OECMs, Jonas et al. (2014) invoked the *Inaugural Poem* by Maya Angelou to make the point that international law and policy can, under the right circumstances, offer "space to place new steps of change" (Angelou, 1993). In this context, the advent of OECMs provides a new means of recognising – among other things – very old forms of conservation; namely, those occurring as the outcome of Indigenous peoples' and local communities' relationships with their

territories and areas. An increase in the appropriate recognition of these previously under-appreciated systems will have many potential benefits for their governance authorities and broader communities, and the biodiversity within them. The question is, in which direction will things develop under this 'new' initiative?

Finally, two practical recommendations are as follows. First, to ensure that the unique and valuable characteristics of ICCAs are fully considered in the implementation of the IUCN Guidelines on OECMs, it is proposed that the WCPA undertake a process immediately following the publication of the guidelines on OECMs, in partnership with Indigenous peoples, local communities and relevant support organisations, to develop supplementary guidelines (for example, Day et al., 2012) on ICCAs and OECMs. This will provide an opportunity to co-develop a deeper understanding of the nuances of how the guidelines apply to ICCAs and to set out clear and tailored guidance for a range of rights-holders and stakeholders.

Second, there is a notable recent increase in the number of references to 'conserved areas' without specifying whether it is as shorthand for ICCAs, OECMs or something else. For example, the Promise of Sydney and the New Social Compact both make extensive reference to 'protected and conserved areas' (IUCN, 2014a, 2014b), and the term is also found in the names of the IUCN 'Green List of Protected and Conserved Areas' and the WCPA 'Specialist Group on the Governance of Protected and Conserved Areas'. It is therefore recommended that a wide range of interested parties discuss the pros and cons of referring to 'OECMs' as 'conserved areas' to promote a common language across policy makers and practitioners, including in the context of the CBD and IUCN.

ENDNOTES

[1] OECMs were referenced in eight CBD decisions, namely: Progress towards the achievement of Aichi Biodiversity Targets 11 and 12 (Decision XIII/2); Strategic actions to enhance implementation of the Convention and the Strategic Plan for Biodiversity 2011-2020 and the achievement of the Aichi Biodiversity Targets, including the mainstreaming of biodiversity within and across sectors (Decision XIII/3); Biodiversity and climate change (Decision XIII/4); Marine spatial planning and training initiatives (Decision XIII/9); Voluntary specific workplan on biodiversity in cold water areas within the jurisdictional scope of the Convention (Decision XIII/11); Resource mobilisation (Decision XIII/20); Capacity-building, technical and scientific cooperation, technology transfer and the clearing-house mechanism (Decision XIII/23); Indicators for the Strategic Plan for Biodiversity 2011-2020 and the Aichi Biodiversity Targets (Decision XIII/28).

[2] IUCN-WCPA (2015) For further information on the Task Force, see: https://www.iucn.org/theme/protected-areas/wcpa/what-we-do/other-effective-area-based-conservation-measures-oecms

[3] The IUCN definition of a protected area is: "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" (Dudley, 2008).

[4] The examples assume that the governance authorities have provided free, prior and informed consent to being recognized as such.

[5] Some protected areas, such as those that are proposed rather than designated, have been removed from these figures. For more information on how statistics are calculated using the WDPA, consult https://protectedplanet.net/c/calculating-protected-area-coverage

[6] Local governance arrangements are often more complex than a term such as 'governing authority' can convey. The paper acknowledges these local realities, but uses the simplified 'governing authority/authorities' to retain the focus on the other core arguments. More discussion of the governance-related issues relevant to ICCAs and OECMs is warranted.

[7] www.padddtracker.org

[8] Tasmanian Aboriginal language is written in italics and capital letters are only used for peoples' names.

[9] See: http://www.conservation2020canada.ca/. The example was written by Eli Enns, who is a member of the Indigenous Circle of Experts.

[10] 4 October 2016 meeting of the Standing Committee on Environment and Sustainable Development transcript: https://www.ourcommons.ca/DocumentViewer/en/42-1/ENVI/meeting-27/minutes

[11] Proving the area's management is a long-term measure may be difficult for some Indigenous peoples and local communities in the absence of written management plans. A track record of the way an area has been managed should be one way in which this criterion can be met. Using case studies from a range of ICCAs and locally managed marine areas (LMMAs) to better understand and articulate the complex relationships between different types of measures, livelihoods and biodiversity will likely improve the guidance and its implementation in the context of a range of areas governed by Indigenous peoples and local communities.

[12] 'Restorative justice' is a system of criminal justice that focuses on the rehabilitation of offenders through reconciliation with victims and the community at large. In the same vein, 'restorative ecology' may be one way to describe forms of ecology that encapsulate forms of restitution and reconciliation between various rights-holders and stakeholders.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the work of the Task Force on OECMs and the additional individuals who have invested time in providing inputs and case studies. We also thank the following individuals who have provided inputs to this paper: Heather Bingham, Grazia Borrini-Feyerabend, Nigel Dudley, Stephen Garnett, Brent Mitchell, Stan Stevens and Bas Verschuuren, as well as to the editors at PARKS and two anonymous reviewers.

ABOUT THE AUTHORS

Harry Jonas, based in Sabah (Malaysia), is an international environmental and human rights lawyer, co-founded Natural Justice and supports the ICCA Consortium and Forever Sabah. Harry co-chairs the IUCN World Commission on Protected Areas' Task Force on Other Effective Area-based Conservation Measures. His publications include: a novel, Tyranny of the Masses (www.tyranny-of-the-masses.com), The Right to Responsibility, The Living Convention and Conservation Standards. He is an Ashoka Fellow.

Emma Lee is a trawlwulway woman of Tasmania and Research Fellow at the Centre for Marine Socioecology, University of Tasmania. She has written extensively on protected areas and Aboriginal people and has had a senior role in developing the first joint management agreement for Aboriginal people in the Tasmanian Wilderness World Heritage Area. Emma is a member of the Australian World Heritage Indigenous Network (AWHIN) and an Honorary Member of the ICCA Consortium.

Holly Jonas, based in Sabah (Malaysia), is the International Policy Coordinator for the ICCA Consortium and works with other non-profit organisations in Sabah and internationally to support Indigenous peoples' and local communities' territories and ways of life. Her background is in international environmental and human rights law, zoology and cultural anthropology and she is a member of several volunteer networks and working groups, including in IUCN. She has co-authored and edited a number of articles, reports and volumes on issues related to law, conservation and human rights.

Clara Matallana-Tobon, based in Bogota (Colombia), is an ecologist from Colombia, with a Master's degree on Biological Conservation from California State University. She is currently the leader of the protected areas and other conservation measures research team of the Humboldt Institute, the official organisation in Colombia for biodiversity research. She works with regional and national authorities in order to enhance the protected areas networks, setting priorities for new protected areas, reviewing proposals for the establishment of regional protected areas, and nomination of Important Bird Areas. She is a member of the Green List reference group for Colombia.

Kim Sander Wright, based in British Columbia (Canada), has spent 20 years working on multi-cultural and multi-stakeholder processes to ensure adequate representation of all rights holders and stakeholders in the governance of land and coastal environments. She studied natural environmental sciences and international human conflict and has been involved as an advisor and facilitator in many land and marine use planning processes with Indigenous rights holders. She is currently the Senior Marine Planning Strategist at the David Suzuki Foundation and the Strategic Advisor on Marine, Coastal and Island Environments to the ICCA Consortium.

Fred Nelson, based in Vermont (USA), is the founder and Executive Director of Maliasili Initiatives. He has worked on natural resource management and sustainable development in East Africa since 1998, serving as both director and board member of leading conservation organisations in Tanzania, and has worked with a wide range of groups to design and facilitate community-based conservation initiatives with local communities in northern Tanzania. He has been published in journals such as Development and Change, Conservation Biology, Oryx, and Biodiversity & Conservation, and is the editor of: Community Rights, Conservation and Contested Land: The Politics of Natural Resource Governance in Africa, Earthscan, 2010.

Eli Enns, based in British Columbia (Canada) is a Nuu-chah-nulth Canadian political scientist focused on Constitutional Law, International Dispute Resolution and Ecological Governance. He is the co-founder of the Ha'uukmin Tribal Park in Clayoquot Sound on the west coast of Vancouver Island, holds a range of posts, including: Indigenous Circle of Experts (as part of the Pathway to Target 1), Member; Canadian Commission for UNESCO Man and the Biosphere National Committee, Committee Member; and Plenty Canada, Nation Building Program Director. With Ecotrust Canada, Eli helped develop an Indigenous Watershed Management Area Program offering services to First Nations across Canada. Eli was a recipient of the 20th Anniversary Canadian Model Forest Achievement Award in 2012.

REFERENCES

Adams, W. and Mulligan M. (eds.) (2004). *Decolonizing Nature: Strategies for Conservation in a Post-colonial Era*. London, UK: Earthscan. doi.org/10.4324/9781849770927

AIPP (2013). *Research on the Roles and Contributions of Indigenous Women in Sustainable Forest Management in Mekong Countries/Asia.* Chiang Mai, Thailand: AIPP.

Angelou, M. (1993). *On the Pulse of Morning*. http://www.nytimes.com/1993/01/21/us/the-inauguration-maya-angelou-on-the-pulse-of-morning.html.

Bennett, N., Govan, H. and Satterfield, T. (2015). 'Ocean grabbing.' *Marine Policy* 57: 61–68. doi.org/10.1016/j.marpol.2015.03.026

Berkes, F. (1999). *Sacred Ecology: Traditional Ecological Knowledge and Resource Management*, 2nd ed. Routledge.

Berkes, F., Colding, J. and Folke, C. (eds.) (2003). *Navigating Social-ecological Systems: Building Resilience for Complexity and Change.* Cambridge, UK: Cambridge University Press. doi.org/10.1017/cbo9780511541957

Bhatt, S., Pathak, N., Kothari, A. and Balasinorwala, T. (eds.) (2012). *Community Conserved Areas in South Asia: Case studies and Analyses from Bangladesh, India, Nepal, Pakistan, and Sri Lanka.* Pune, India: Kalpavriksh.

Bingham, H., Fitzsimons, J., Redford, K., Mitchell, B., Bezaury-Creel, J. and Cumming T. (2017). 'Privately Protected Areas: Advances and Challenges in Guidance, Policy and Documentation.' *PARKS* 23(1). doi.org/10.2305/iucn.ch.2017.parks-23-1hb.en

Boedhihartono, A. (2017). 'Can Community Forests be Compatible with Biodiversity in Indonesia?' *Land* 6:21. doi.org/10.3390/land6010021

Borrini-Feyerabend, G. (ed.) (2010). *Strengthening What Works: Recognising and Supporting the Conservation Achievements of Indigenous Peoples & Local Communities*. IUCN-CEESP Briefing Note No. 10. Tehran: CENESTA.

Borrini-Feyerabend, G., Dudley, N., Jaeger, T., Lassen, B., Pathak Broome, N., Phillips, A. and Sandwith, T. (2013). *Governance of Protected Areas: From understanding to action*. Best Practice Protected Area Guidelines Series No. 20, Gland, Switzerland: IUCN. p. 5.

Borrini-Feyerabend, G., Bueno, P., Hay-Edie, T., Lang, B., Rastogi, A. and Sandwith, T. (2014). *A Primer on Governance for Protected and Conserved Areas, Stream on Enhancing Diversity and Quality of Governance*. IUCN World Parks Congress. Gland, Switzerland: IUCN.

Borrini-Feyerabend, G. (2016). 'Mothers or lesser sisters? The strange case of "conserved areas"'. *CBD Square Brackets*. Montreal, Canada: CBD.

Bray, D., Duran, E., Ramos, E., Mas, J-F, Velazquez, A., McNab, R., Barry, D., and Radachowsky, J. (2008). 'Tropical deforestation, community forests, and protected areas in the Maya Forest'. *Ecology and Society* 13(2): 56. doi.org/10.5751/es-02593-130256

Brockington, D. and Igoe, J. (2006). 'Eviction for Conservation: A Global Overview'. *Conservation and Society* 4:424–470.

Brown, J. and Kothari, A. (2011). 'Traditional Agricultural Landscapes and Community Conserved Areas: An Overview.' 22(2) *Management of Environmental Quality: An International Journal* 139. doi.org/10.1108/14777831111113347

Burnham, P. (2000). *Indian Country, God's Country: Native Americans and the National Parks*. Washington, DC: Island Press. doi.org/10.5860/choice.38-1733

Butchart, S., Clarke, M., Smith, R., Sykes, R., Scharlemann, J., Harfoot, M., Buchanan, G., Angulo, A., Balmford, A., Bertzky, B., Brooks, T., Carpenter, K., Comeros-Raynal, M., Cornell, J., Ficetola, G., Fishpool, L., Fuller, R., Geldmann, J., Harwell, H., Hilton-Taylor, C., Hoffmann, M., Joolia, A., Joppa, L., Kingston, N., May, I., Milam, A., Polidoro, B., Ralph, G., Richman, N., Rondinini, C., Segan, D., Skolnik, B., Spalding, M., Stuart, S., Symes, A., Taylor, J., Visconti, P., Watson, J., Wood, L. and Burgess, N. (2015). 'Shortfalls and Solutions for Meeting National and Global Conservation Area Targets.' *Conservation Letters*, September/October 2015, 8(5), 329–337. doi.org/10.1111/conl.12158

CAPAD (2014). *Collaborative Australian Protected Area Database,* Department of the Environment, Australian Government, viewed 23 March 2016.

Carranza, T., Manica, A., Kapos, V. and Balmford, A. (2014). 'Mismatches between conservation outcomes and management evaluation in protected areas: A case study in the Brazilian Cerrado', *Biological Conservation*, 173. doi.org/10.1016/j.biocon.2014.03.004

CBD (1992). Convention on Biological Diversity. Secretariat of the CBD: Montreal.

CBD (2010). 'Decision X/2: Strategic Plan for Biodiversity 2011-2020.' Adopted by the Conference of the Parties to the Convention on Biological Diversity at its Tenth Meeting.

CBD (2013). Item 3 of the Provisional Agenda of the 17th Meeting of the Subsidiary Body on Scientific, Technical and Technological Advice, 'The Identification of Scientific and Technical Needs for the Attainment of the Targets Under Strategic Goal C of the Strategic Plan for Biodiversity 2011-2020' UNEP/CBD/SBSTTA/17/2/Add.3.

CBD (2014). Report of the 17th Meeting of the Subsidiary Body on Scientific, Technical and Technological Advice on the Work of its Seventeenth Meeting. UNEP/CBD/COP/12/2.

CBD (2016). Progress in the implementation of the Convention and the Strategic Plan for Biodiversity 2011-2020 and towards the achievement of the Aichi Biodiversity Targets (CBD/COP/DEC/XIII/2).Ceballos, G., Ehrlich, P. and Dirzo, R. (2017). 'Biological annihilation via the ongoing sixth mass extinction signaled by vertebrate population losses and declines.' *Proceedings of the National Academy of Sciences*. PNAS 2017. doi.org/10.1073/pnas.1704949114

CIPTA & WCS (Tacana Indigenous People's Council and Wildlife Conservation Society) (2013). *Deforestation Scenarios in the Greater Madidi-Tambopata Landscape*. Bogota: WCS-Bolivia.

Coalition Against Land Grabbing (2015). *The Repression of Defenders of Commons and ICCAs in Caraga Region, Mindanao–Philippines.* Philippines: Coalition Against Land Grabbing.

Cohen, G.A. (1978). *Karl Marx's Theory of History: a Defence*. Princeton University Press: Princeton. doi.org/10.1093/oxfordhb/9780198717133.013.57

Colchester, M. (2003). *Salvaging Nature: Indigenous Peoples, Protected Areas and Biodiversity Conservation*. UK: World Rainforest Movement and Forest Peoples Programme.

Day, J., Dudley, N., Hocking, M., Holmes, G., Lafolley, D., Stolton, S., and Wells, S. (2012). *Guidelines for Applying the IUCN Protected Areas Management Categories to Marine Protected Areas*. Gland, Switzerland: IUCN.

Diz, D., Johnson, D., Riddell, M., Rees, S., Battle, J., Gjerde K., Hennige, S. and Roberts, M.R., (2017). 'Mainstreaming marine biodiversity into the SDGs: The role of other effective area-based conservation measures (SDG 14.5)'. *Marine Policy*. doi.org/10.1016/j.marpol.2017.08.019

Dowie, M. (2009). *Conservation Refugees: The Hundred-year Conflict between Global Conservation and Native Peoples.* Massachusetts: MIT Press. doi.org/10.1111/j.1548-1433.2010.01239_5.x

Dudley, N. (ed.) (2008). *Guidelines for Applying Protected Area Management Categories.* Gland, Switzerland: IUCN.

Folke, C., Hahn, T., Olsson, P. and Norberg, J. (2005). 'Adaptive Governance of Social-ecological Systems.' *Annual Review of Environment and Resources* 30: 441.

Geldmann, J., Barnes, M., Coad, L., Craigie, I.D., Hockings, M. and Burgess, N.D. (2013). 'Effectiveness of terrestrial protected areas in reducing habitat loss and population declines' *Biological Conservation* 161: 230–238. doi.org/10.1016/j.biocon.2013.02.018

Gibbs, L.M. (2006). 'Valuing water: variability and the Lake Eyre Basin, central Australia', *Australian Geographer*, 37 (1), 73–85. doi.org/10.1080/00049180500511988

Global Environment Facility (2017). *Report of the First Meeting for the Seventh Replenishment of the GEF Trust Fund* (GEF/R.7/02). Washington, DC: Global Environment Facility.

Global Witness (2017). *Defenders of the Earth*. London, UK: Global Witness.

Greiber, T., Janki, M., Orellana, M., Savaresi, A. and Shelton, D. (2009). *Conservation with Justice. A Rights-based Approach*. Gland, Switzerland: IUCN. doi.org/10.2305/iucn.ch.2009.eplp.71.en

Hayes, T. and Ostrom, E. (2005). 'Conserving the World's Forests: Are Protected Areas the Only Way?' *Indiana Law Review* 38: 595.

Healey, G. and Tagak, A. (2014). 'PILIRIQATIGIINNIQ "Working in a collaborative way for the common good": A perspective on the space where health research methodology and Inuit epistemology come together', *International Journal of Critical Indigenous Studies*, 7 (1): 1–14.

IDMC (Internal Displacement Monitoring Centre). *Global Report on Internal Displacement* (2017). Geneva: IDMC.

Indian Law Resource Centre and IUCN (2015). *Conservation and Indigenous Peoples in Mesoamerica: A Guide.* Gland: Indian Law Resource Centre and IUCN-CEESP.

International Work Group for Indigenous Affairs (2017). Hansen K.B., Jepsen K., P.L. Jacquelin (eds.). *The Indigenous World 2017*. Netherlands: IWGIA.

IUCN (2003). *The Durban Accord: Our Global Commitment for People and Earth's Protected Areas*. Gland: IUCN.

IUCN (2012a). 'Facilitating conservation through the establishment of protected areas as a basis for achieving Target 11 of the Strategic Plan for Biodiversity 2011–2020' (WCC-2012-Res-035-EN) in IUCN, *Resolutions and Recommendations.* Gland, Switzerland: IUCN.

IUCN (2012b). 'Position Paper on Protected areas', Agenda Item 13.4. Submitted to the eleventh meeting of the Conference of the Parties to the Convention on Biological Diversity.

IUCN (2014a). *Promise of Sydney*. Gland, Switzerland: IUCN.

IUCN (2014b). *New Social Compact*. Gland, Switzerland: IUCN.

IUCN-WCPA (2015). Jonas H. and K. MacKinnon, *Discussion Paper on OECMs: framing the issues*. Gland, Switzerland: IUCN-WCPA.

IUCN-WCPA (2016a). Jonas H and K. Mackinnon (eds.) *Co-Chairs' Reports of the First Meeting of the IUCN-WCPA Task Force on Other Effective Area-based Conservation Measures*. Gland, Switzerland: IUCN-WCPA.

IUCN-WCPA 2016b. Jonas H. and K. MacKinnon (eds.). *Advancing Guidance on Other Effective Area-based Conservation Measures: Report of the Second Meeting of the IUCN-WCPA Task Force on Other Effective Area-based Conservation Measures*. Gland, Switzerland and Bonn, Germany: IUCN and Bundesamt für Naturschutz.

IUCN-WCPA (2016c). *Guidance for Recognizing and Reporting of Other Effective Area-based Conservation Measures under Target 11: Consultation Document*. Gland, Switzerland: IUCN.

IUCN-WCPA (2017a). *(Draft) Guidelines for Recognizing and Reporting Other Effective Area-based Conservation Measures: First Version*. Gland, Switzerland: IUCN.

IUCN-WCPA (2017b). Jonas H. and K. MacKinnon (eds.) *Using Case Studies to Enhance Guidance on Other Effective Area-based Conservation Measures: Report of the Third Meeting of the IUCN-WCPA Task Force on Other Effective Area-based Conservation Measures*. Gland, Switzerland: IUCN.

Johnson, J.J., Cant, G., Howitt, R. and Peters, E. (2007). 'Guest editorial. Creating anti-colonial geographies: embracing Indigenous peoples' knowledge and rights', *Geographical Research* 45(2), 117–120.

Johnson, J.T. and Murton B. (2007). 'Re/placing native science: Indigenous voices in contemporary constructions of nature', *Geographical Research* 45 (2), 121–129. doi.org/10.1111/j.1745-5871.2007.00442.x

Jonas, H.C. (2016). 'Indigenous peoples' and community conserved territories and areas (ICCAs): evolution in international biodiversity law', in Morgera E. and J. Razzaque (eds.) *Elgar Encyclopedia of Environmental Law: Biodiversity and Nature Protection Law*. UK: Elgar. doi.org/10.4337/9781783474257.iii.10

Jonas, H. D. (2012). *Legal and Institutional Aspects of Recognizing and Supporting Conservation by Indigenous Peoples and Local Communities: An Analysis of International Law, National Legislation, Judgements and Institutions as they Interrelate with Territories and Areas Conserved by Indigenous Peoples and Local Communities*. Bangalore and Pune, India: Natural Justice and Kalpavriksh.

Jonas, H.D., Barbuto, V., Jonas, H.C., Kothari, A. and Nelson F. (2014). 'New Steps of Change: Looking Beyond Protected Areas to Consider Other Effective Area-based Conservation Measures.' *PARKS* 20.2. Gland, Switzerland: IUCN. doi.org/10.2305/iucn.ch.2014.parks-20-2.hdj.en

Juffe-Bignoli, D., Harrison, I., Butchart, S., Flitcroft, R., Virgilio, H., Jonas, H., Lucasiewicz, A., Thieme, M., Turak, E., Bingham, H., Dalton, J., Darwall, W., Deguignet, M., Dudley, N., Gardner, R., Higgins, J., Kumar, R., Linke, S., Milton, G.R., Pittock, J., Smith, K., and van Soesbergen, A. (2016). 'Achieving Aichi Biodiversity Target 11 to Improve the Performance of Protected Areas and Conserve Freshwater Biodiversity.' *Aquatic Conservation*. 26 (Suppl. 1): 133–151. doi.org/10.1002/aqc.2638

Kashwan, P. (2013). 'The Politics of Rights-based Approaches in Conservation' (2013). *Land Use Policy* 31: 613. doi.org/10.1016/j.landusepol.2012.09.009

Knox, J. (2017) *Report of the Special Rapporteur on the issue of human rights obligations relating to the enjoyment of a safe, clean, healthy and sustainable environment* (A/HRC/34/49). Submitted to the 34th Session of the Human Rights Council.

Kothari, A., Pathak, N. and Vania, F. (2000). *Where Communities Care: Community Based Wildlife and Ecosystem Management in South Asia.* Pune, India: Kalpavriksh and IIED.

Kothari, A., Corrigan C., Jonas H.D., Neumann A. and Shrumm H. (eds.) (2012). *Recognising and Supporting Territories and Areas Conserved by Indigenous Peoples and Local Communities: Global Overview and National Case Studies*

(CBD Technical Series No. 64, Secretariat of the Convention on Biological Diversity, ICCA Consortium . Pune, India and Montreal, Canada: Kalpavriksh and Natural Justice..

Kothari, A. and Neumann A. (2014). *ICCAs and Aichi Targets: The Contribution of Indigenous Peoples' and Local Community Conserved Territories and Areas to the Strategic Plan for Biodiversity 2011-20*. Policy Brief of the ICCA Consortium, no. 1, co-produced with CBD Alliance, Kalpavriksh and CENESTA and in collaboration with the IUCN Global Protected Areas Programme.Laffoley, D., Dudley, N., Jonas, H.D., MacKinnon, D., MacKinnon, K., Hockings, M. and Woodley S. (2017). 'An introduction to "other effective area-based conservation measures" under Aichi Target 11 of the Convention on Biological Diversity: origin, interpretation and some emerging ocean issues.' *Aquatic Conservation: Marine and Freshwater Ecosystems*. 1–8 doi.org/10.1002/aqc.2783

Lee, E. (2015), 'Talking Point: honouring history's promise', *The Mercury,* 31 October, viewed 25 June 2017, < http://www.themercury.com.au/news/opinion/honouring-historys-promise/news-story/914dfdf14ba46c9f58d6b358447d0968>.

Lee, E. (2016a). 'Protected areas, country and value: the nature-culture tyranny of the IUCN's protected area guidelines for Indigenous Australians', *Antipode*, 48 (2), 355–374. doi.org/10.1111/anti.12180

Lee, E. (2016b). 'Talking Point: wilderness plan benchmark to renew relations', *The Mercury*, 8 January, viewed 24 June 2017, < http://www.themercury.com.au/news/opinion/talking-point-wilderness-plan-benchmark-to-renew-relations/news-story/b6b316bce3756d2d064760cf36d82110>.

Lopoukhine, N. and de Souza Dias, B. F. (2012). 'Editorial: What does Target 11 really mean?' *PARKS* 18(1): 5.

Lovgren, S., (2003). 'Map Links Healthier Ecosystems, Indigenous Peoples'. *National Geographic News*. Available online at: http://bit.ly/1kENKxB.

MacKinnon, D., Lemieux, C., Beazley, K., Woodley, S., Helie, R., Perron, J., Elliott, J., Haas, C., Langlois, J., Lazaruk, H., Beechey, T. and Gray, P. (2015). 'Canada and Aichi Biodiversity Target 11: understanding "other effective area-based conservation measures" in the context of the broader target.' *Biodiversity Conservation* 24. doi.org/10.1007/s10531-015-1018-1

Matapi, U. and Yucuna, R. (2012). *Cartografía ancestral yucuna-matapí: conocimiento y manejo tradicional del territorio*. Proyecto Cartografía Cultural del Noreste mazónico. Ministerio de Cultura, Patrimonio Natural. Bogotá, Colombia: Fondo para la Biodiversidad y Áreas Protegidas en alianza con Tropenbos Internacional.

Minority Rights Group (2012). *State of the World's Minorities and Indigenous Peoples: Focus on Land Rights and Natural Resources*. London, UK: Minority Rights Group.

Molnar, A., Scherr, S. and Khare, A. (2004). *Who conserves the world's forests: community driven strategies to protect forests and respect rights.* Washington, DC, USA: Forest Trends and Eco-agriculture Partners.

Morel, C. (2010). 'Conservation and Indigenous Peoples' Rights: Must One Necessarily Come at the Expense of the Other?' in Shrumm H (ed.) *Exploring the Right to Diversity in Conservation Law, Policy, and Practice*, (pp. 174–180) Policy Matters 17, Malaysia: IUCN.

Nagendra, H. (2008). 'Do Parks Work? Impact of Protected Areas on Land Cover Clearing' *AMBIO: A Journal of the Human Environment* 37(5): 330. doi.org/10.1579/06-r-184.1

Nelson, A. and Chomitz K.M. (2011). 'Effectiveness of Strict vs. Multiple Use Protected Areas in Reducing Tropical Forest Fires: A Global Analysis Using Matching Methods'. *PLoS ONE*, 6(8): e22722. doi:10.1371/journal.pone.0022722. doi.org/10.1371/journal.pone.0022722

Nepstad, D., Schwartzman, S., Bamberger, B., Santilli, M., Ray, D., Schlesinger, P., Lefebvre, P., Alencar, A., Prinz, E., Fiske, G. and Rolla, A. (2006). 'Inhibition of Amazon Deforestation and Fire by Parks and Indigenous Lands'. *Conservation Biology*, 20(1): 65–73. doi.org/10.1111/j.1523-1739.2006.00351.x

Nolte, C., Agrawal, A., Silvius, K.M., and Soares-Filho, B.S. (2013). 'Governance Regime and Location Influence Avoided Deforestation Success of Protected Areas in the Brazilian Amazon'. *Proceedings of the National Academy of Sciences*, 110(13): 4956–4961. doi.org/10.1073/pnas.1214786110

Ostrom, E. (1990). *Governing the Commons: The Evolution of Institutions for Collective Action.* Cambridge, UK: Cambridge University Press. doi.org/10.1017/cbo9780511807763.002

Ostrom, E. (2000). 'Collective Action and the Evolution of Social Norms.' *The Journal of Economic Perspectives* 14(3): 137. doi.org/10.1080/19390459.2014.935173

Pathak, N. (ed.) (2009). *Community Conserved Areas in India—A Directory.* Pune, India: Kalpavriksh.Phillips, A. (2004). 'Turning Ideas on their Head: The New Paradigm for Protected Areas.' *Environmental History,* 9(1) 173.

Phyälä, A., Orozco A., and Counsell, S. (2016). *Protected Areas in the Congo Basin: Failing both People and Biodiversity?* London, UK: Rainforest Foundation UK.

Poirier, R. and Ostergren, D. (2002). 'Evicting People from Nature: Indigenous Land Rights and National Parks in Australia, Russia, and United States'. *Natural Resources Journal* 42 (2), Spring 2002.

Porter-Bolland, L., Ellis, E.A., Guariguata, M.R., Ruiz-Mallén I., Negrete-Yankelovich, S. and Reyes-García, V. (2011). 'Community managed forests and forest protected areas: An assessment of their conservation effectiveness across the tropics.' *Forest Ecology and Management* 268, 2–17. doi.org/10.1016/j.foreco.2011.05.034

Rights and Resources Initiative (2012). *What rights? A Comparative Analysis of Developing Countries' National Legislation on Community and Indigenous Peoples' Forest Tenure Rights*. Washington, DC: Rights and Resources Initiative.

Rights and Resources Initiative (2015). *Protected Areas and the Land Rights of Indigenous Peoples and Local Communities: Current Issues and Future Agenda*. Washington, DC: RRI.

Robson, J.P. and Berkes, F. (2010). 'Sacred Nature and Community Conserved Areas' in S. Pilgrim and J. Pretty (eds.), *Nature and Culture: Rebuilding Lost Connections.* Earthscan.

Rodriguez, C., van der Hammen, M.C., Matapi, U., Yucuna, R. and Vargas, C. (2014). 'Environmental governance in the Colombian Amazon,' in Chavez-Tafur J. and R.J. Zagt (eds.) *Towards Productive Landscapes*. Wageningen, the Netherlands: Tropenbos International.

Shahabuddin, G. and Rao, M. (2010). 'Do community conserved areas effectively conserve biodiversity? Global insights and the Indian context.' *Biological Conservation* 12:3. doi.org/10.1016/j.biocon.2010.04.040

Stevens, S. (ed.) (1997). *Conservation Through Cultural Survival: Indigenous Peoples and Protected Areas*. Washington, DC: Island Press. doi.org/10.2307/215879

Stevens, S. (2010). 'Implementing the UN Declaration on the Rights of Indigenous Peoples and International Human Rights Law Through the Recognition of ICCAs' *IUCN-CEESP Policy Matters* 17: 181.

Stevens, S. (ed.) (2014). *Indigenous Peoples, National Parks and Protected Areas: A New Paradigm Linking Conservation, Culture and Rights*. Tucson AZ: University of Arizona Press.

Stevens, S., Jaeger T. and Pathak Broome, N. with Borrini-Feyerabend, G., Eghenter, C., Jonas, H.C. and Reyes G. (2016a). *ICCAs and Overlapping Protected Areas Fostering Conservation Synergies and Social Reconciliation*. Policy Brief of the ICCA Consortium, Issue No. 4. Teheran, Iran: ICC Consortium.

Stevens, S., Jaeger, T., and Pathak Broome, N., with Aylwin, J., Azhdari, G., Bibaka, D., Borrini-Feyerabend, G., Colchester, M., Dudley, D., Eghenter, C., Eleazar, F., Farvar, M., Frascaroli, F., Govan, H, Jonas, H.C., Kothari, A., Reyes, G., Singh, A., and Vaziri, L. (2016b). *Recognising and Respecting ICCAs Overlapped by Protected Areas*, Report for the ICCA Consortium.

Stolton, S. and Dudley, N. (2006). *Measuring Sustainable Use: A method to assess the conservation benefits from sustainable management outside protected areas and to include this information in ecoregional planning*. UK: Equilibrium Research.

Tauli-Corpuz, V. (2016). Conservation and Indigenous Peoples' Rights (A/71/150). Report to the 71st Session of the UN General Assembly.

Tobin, B. (2014). *Indigenous Peoples, Customary Law and Human Rights: Why Living Law Matters*. Routledge. doi.org/10.4324/9781315778792

United Nations (2009). State of the World's Indigenous Peoples. New York, NY: UN.

UNEP-WCMC and IUCN (2016). Protected Planet Report 2016. Cambridge UK and Gland, Switzerland: UNEP-WCMC and IUCN.

UNEP-WCMC and IUCN (2017). Protected Planet: The World Database on Protected Areas (WDPA) On-line, July 2017, Cambridge, UK: UNEP-WCMC and IUCN. Available at: www.protectedplanet.net.

Vasseur, L., Horning, D., Thornbush, M., Cohen-Shacham, E., Andrade, A., Barrow, E., Edwards, S., Wit, P. and Jones, M. (2017). Complex problems and unchallenged solutions: Bringing ecosystem governance to the forefront of the UN sustainable development goals. *Royal Swedish Academy of Sciences*. doi.org/10.1007/s13280-017-0918-6 doi.org/10.1038/sdata.2016.67

Verschuuren, B., Wild, R., McNeely, J., and Oviedo, G. (2010). *Sacred Natural Sites: Conserving Nature and Culture*. London, UK: Earth Scan. doi.org/10.4324/9781849776639

Watson, J., Darling, E., Venter, O., Maron, M., Walston, J., Possingham, H., Dudley, N., Hockings, M., Barnes, M. and Brooks, T. (2015). 'Bolder Science Needed Now for Protected Areas.' *Conservation Biology* doi.org/10.1111/cobi.12645

White, A., Molnar A., and Khare, A. (2004). *Who Owns, Who Conserves, and Why it Matters.* Washington D.C: Forest Trends.

Wilk, R. (1995). 'Learning to be local in Belize: global systems of common difference' in Miller, D (ed.), *Worlds apart:*

RESUMEN

Este artículo refleja los progresos en curso de la UICN en lo tocante al desarrollo de una guía técnica sobre "otras medidas eficaces de conservación basadas en áreas" (OECM, por sus siglas en inglés) y comienza a explorar bajo qué condiciones las OECM –como una nueva forma de reconocimiento– podrían contribuir positivamente a los territorios y áreas conservadas por pueblos indígenas y comunidades locales (ICCA, por sus siglas en inglés). En él se argumenta que, si bien el marco de áreas protegidas es un medio potencialmente útil para reconocer las contribuciones a la biodiversidad de algunos ICCA, no es universalmente válido. En este contexto, y sujeto a importantes advertencias, los marcos relacionados con las OECM ofrecen una buena oportunidad para aumentar el reconocimiento y el apoyo para los ICCA. El artículo concluye con dos recomendaciones prácticas: en primer lugar, para la elaboración de orientaciones complementarias sobre las OECM y los ICCA; y, en segundo lugar, para un debate más amplio entre las diversas partes interesadas con respecto a si las "OECM" deberían denominarse "áreas conservadas".

RÉSUMÉ

Ce document reflète les progrès continus de l'UICN pour élaborer des directives techniques concernant les 'autres mesures de conservation efficaces par zone' (OECM, selon le sigle en anglais) et commence à explorer dans quelles conditions les OECM - en tant que nouvelle forme de reconnaissance - pourraient apporter une contribution positive aux territoires et aires conservées par les peuples autochtones et les communautés locales (APAC). Il fait valoir que si les aires protégées présentent un cadre potentiellement utile pour reconnaître les contributions de certaines APAC en matière de biodiversité, ce cadre n'est pas universellement approprié. Dans ce contexte, et sous réserve de mises en garde importantes, la structure des OECM offre une opportunité importante d'accroître la reconnaissance et le soutien aux APAC. Le document se termine par deux recommandations pratiques : d'abord l'élaboration d'orientations supplémentaires pour les OECM et les APAC; et deuxièmement, la poursuite de discussions par un large éventail de parties intéressées sur la question de savoir si les 'OECM' pourraient être qualifiées d' 'aires protégées'.

NORTH AMERICAN PARK AGENCIES' EVOLVING USE OF TWITTER: A CONTENT ANALYSIS OF 2014 AND 2017 TWEETS

Elizabeth A. Halpenny[1,*] and Clara-Jane Blye[1]

Corresponding author: elizabeth.halpenny@ualberta.ca

[1] Faculty of Physical Education and Recreation, 2-130G University Hall, Van Vliet Complex, University of Alberta
Edmonton, Alberta, Canada, T6G 2H9

ABSTRACT

With a goal of improved social media communication by park agencies, the content from seven English-language North American park agencies' Twitter accounts were counted, interpreted, coded and compared. Trends in usage of Twitter by park agencies were examined by comparing tweets from 2014 (n=764) and 2017 (n=1,395). Special attention was directed to how park agencies address natural heritage conservation and park visitation in their Twitter feeds. Findings support a call for increased bottom-up, less controlled forms of information exchange on official park agency Twitter accounts to enhance interactivity, innovation and stakeholder input.

Key words: social media, Twitter, communications, parks, protected areas, engagement, conservation, tourism

INTRODUCTION

Social media (SM) has produced important changes in how users search, assess, produce, purchase and consume information, services and products. One of the most widely used SM is Twitter, with over 328 million monthly active users and more than 500 million tweets being sent every day (Statista.com, 2017; Forbes.com, 2017). Twitter is a microblogging medium that allows users to share 140-character texts accompanied by pictures, video and links to other external content such as other SM feeds or websites. It's a cost-effective way to broadcast one-way communications, and it enables users to interact with each other. Twitter is used as an engagement tool for marketing and building a customer base, and as a daily source for news and emergency updates, entertainment and communication (Ronsenstiel et al., 2015; Hoffman & Novak, 2012).

Government and non-government organisations (NGOs), including conservation agencies, have begun to harness the opportunities afforded by SM (Briones et al., 2011; Fletcher & Lee, 2012; Waters et al., 2009). Some park organisations and agencies have begun incorporating SM into their communications, education, marketing, visitor experience provision and stakeholder outreach efforts. This study highlights variations in this adoption among park agencies and the need for better understanding of how SM such as Twitter are being used, and makes recommendations for improving future use. More specifically, this study examined the Twitter feeds of seven North American park agencies in 2014 and 2017, analysing and critiquing their content. The lens for this analysis incorporated the key mandates of many protected area agencies, natural heritage conservation and visitor enjoyment. As conservation communications experts Jacobson, McDuff and Monroe (2015) suggest "from wilderness parks to urban refuges, natural resource managers must engage a variety of publics in understanding and practicing conservation actions" (p. 1). SM is an essential tool for reaching these diverse audiences.

LITERATURE REVIEW

Social media is "a group of internet-based applications that build on the ideological and technological foundations of Web 2.0, and that allow the creation and exchange of user-generated content" (Kaplan & Haenlein, 2010, p.61). Recent research reviews of SM literature suggest SM research priorities. While Zeng and Gerritsen (2014) identified 65 articles related to tourism and SM research, they also suggested that this research topic is still in its infancy, and needs attention due to its significant role in society. Similar observations have been made in other SM-related reviews in tourism (Lee et al., 2015; Leung et al., 2013) and marketing (Alalwan et al., 2017) as well as specific case studies of non-tourism organisations such as NGOs (Briones et al., 2011; Curtis et al., 2010; Seo et al., 2009; Waters et al., 2009), education institutions (Fletcher & Lee, 2012) and government (Lee & Kwak, 2012).

Empirical research exploring the use of SM to advance conservation is elusive and published works appear limited to "how to use" advice (Dosemagen, 2017) or cautionary lists of the pros and cons (Arts et al., 2015) regarding park agencies' SM use.

As for tourism, North American park agencies are significant tourism providers, hosting over 350,000,000 visits annually (Parks Canada 2016; National Parks Service, 2016), yet no research that documents park agencies' use of SM to engage visitors could be located. Lessons instead are drawn from other tourism providers. Studies suggest that tourism operators and destination marketing organisations (DMOs) (Sevin, 2013; Hays et al., 2013; Gibbs & Dancs, 2013) have not taken full advantage of the communication opportunities offered by Twitter and other SM tools. For example, Sevin (2013) studied 20 major American city DMOs, and found SM used for five major functions: providing information, questions and answers to and from followers, announcing deals and promotions, retweeting and acting as an organisational information hub. However, most tweets did not mention or converse with other users (Sevin, 2013).

Use of social media such as Twitter can more readily create interactive relationships among users than can traditional marketing tools or strategies. Engagement via SM can result in an increase in park visitors as well as repeat visits, attracting new park visitors and fostering park advocates. Hvass and Munar (2012) suggest that engaging followers through conversational content can increase customer loyalty and their feeling of connectedness to the organisation. Yang et al. (2010) found that dialogic communication, the "negotiated exchange of ideas and opinions" (Kent & Taylor, 1998, p. 235) in SM campaigns led to more favourable public attitudes toward the organisation.

While engagement and conversation are pillars of Twitter, tone of voice can also influence engagement with users. SM outlets such as Twitter pose a challenge to park

Figure 1: An example of a user-generated tweet

agencies, in that the traditional corporate/government communication tone may conflict with the new informal tone of SM (Hvass & Munar, 2012; Zeng & Garristen, 2014). The tone used in SM communication resembles face-to-face communication and attempts to imitate that of friends or colleagues (Hvass & Munar, 2012).

As SM and related information communication technologies become ubiquitous, it is relevant and timely to study the use of SM best practices by park agencies. To assist protected area agencies in their missions, content analysis of high- and low-activity park agency Twitter accounts was conducted, and compared over time to document trends and evaluate use. Twitter accounts' efficacy was assessed by comparing data with best practice recommendations from SM researchers and practitioners. The goal of this study is to improve park agencies' use of SM as a communication outlet.

METHODS

It is challenging to measure the impact, significance or success of a Twitter feed, as there are multiple influencers and variables that can be analysed (Effing & Spil, 2016; Alboqami et al., 2015; Antoniadis et al., 2015; Aladwani, 2015). This exploratory study engaged in SM-specific mixed methods (Altheide & Schneider, 2013; Hart & Taylor, 2014).

The study sample was determined through a two-step process. First, an inventory of all English-language, official North American park agency Twitter feeds was created and organised by frequency of posts, date of establishment and number of followers. As of April 2014, thirty US state park agencies and two Canadian provincial park agencies had established Twitter accounts. Park agencies that shared an account with sister agencies such as tourism or resource management were excluded. For agencies with multiple Twitter feeds, only the main account was considered (e.g. @NatlParksService and not @PacificNPS). Second, state, provincial and federal agencies were selected for inclusion from two tweet frequency groupings (after Hvass & Munar, 2012). Alberta, Ontario and Vermont were selected from the high Twitter activity group, and California and Utah from the low activity group. Virginia State Parks was excluded as its tweet frequency was extremely high and appeared to be automated, making it an outlier. Parks Canada, characterised by the highest levels of tweet rates, and the US National Parks Service, characterised by moderate to low tweet frequencies, were also included due to their federal status and large potential audiences.

To establish a content analysis protocol, three sources of information were used. First, during Phase 1 of the sampling process, feeds from all North American park agencies' official Twitter sites were monitored for a two-month period to determine general categories for coding tweet content. These general categories were then compared with content analysis from the SM literature (Dann, 2010; Gibbs & Dancs, 2013; Hvass & Munar, 2012; Hays et al., 2013; MacKay et al., 2017). Finally, conservation and enjoyment, mandates common to most park agencies, were added as coding categories. Park agency tweets were coded according to the following categories: type of tweet, purpose of tweet, conservation and tourism orientation, audience (local or external park stakeholders), and authorship. Authorship was sub-coded as agency-generated or user-generated (see example Figure 1). Frequency and character of tweets as well as the presence of external links (e.g. web links, pictures, video), mentions and hashtags were also recorded. These latter elements are discussed in a companion paper.

Lake Astontin, Elk Island National Park - Parks Canada
© Elizabeth Halpenny

Tweets were gathered for one month (4 June 2014 to 5 July 2014) using NCapture for NVivo (v. 11). A one-month period (after Gibbs & Dancs, 2013) generated a manageable number of tweets, while also capturing tweets typical of both low and high tourist seasons. A national holiday also occurred in each country during the time period. A total of 764 tweets was collected in the 2014 sample. To examine changes in practice, the same park agency Twitter feeds were captured again between 4 June 2017 and 5 July 2017, with 1,395 tweets collected.
Deductive analysis of tweets by three coders was compared until inter-coder consensus was achieved; a single analyst then used the refined methodology to complete tweet categorisations (Creswell, 2014). Table 1 presents the final coding categories. Categories were not mutually exclusive and some tweets were assigned to more than one *Type* and *Purpose* category.

RESULTS

Table 2 outlines tweet and follower numbers for the month-long data collection periods in 2014 and 2017, as well as the overall number of tweets for each year. In this

Table 1 Tweet Coding Categories

Category		Definition	Example tweet
Type	Conversational	Tweet directly addresses another user(s); asks/ answers a question, involves them in the Tweet or uses @_____	@Vermont State Parks: @jayfurr How was the trip to Maidstone?
	Promotional	Tweet markets/promotes an event, activity, contest, website, artist, etc. and urges users to take action	@OntarioParks: Become the outdoorsy person you always wanted to be! #LearntoCamp with #OntarioParks! http://t.co/4AN5QeWckJ
	Information	Tweet presents an update or live discussion of an event, reports news or provides information; does not urge users to take action	@ParksCanada: The Bill to establish #RougeNUP, once passed, establishes a unique type of protected area in Canada http://t.co/iKKcdDETaC #ConservationPlan
	Status	Answers the Twitter question "What are you doing now?"	@AlbertaParks: RT @RonCantiveros: Pitstop at Dinosaur Provincial @Albertaparks on our way to Calgary! Amazing place! #ExploreAB @TravelAlberta http://t.co…
	Phatic	Tweet contains greetings to the Twitter community, text soliloquies/monologues, undirected statements of opinion, or establishes sociability rather than communicating information or ideas	@Parks Canada: Thank you to everyone who visited us this year at the @TOwaterfest – We hope to see you in a national park or historic site soon!
Purpose: Conservation	Education	Tweet outlines the importance of cultural or natural heritage, and/or educates the audience about how preservation and conservation are conducted. Tweets that describe the park's role in conservation efforts fit in this category, but also in the Promotions section	@NatlParkService: Learn about how sea level rise is affecting parks like @AssateagueNPS: http://t.co/ GKhxq6NanK #ActOnClimate http://t.co/ cJYlnKOQLu
	Behaviour	Tweet encourages pro-park, pro-conservation behaviour (e.g. donate to Friends Group, drive carefully on parkway to protect animals, stay on trails) In addition to information about conservation in the park, provides direction from the park or others to behave in a pro-park manner	@UtahStateParks: Please do your part to keep our waterways clean! http://t.co/ eqd7FnTyZL
Purpose: Tourism	Promotional	Tweet provides information, enhances visitor experiences or encourages tourism	@ParksCanada: So many fun activities to do this summer! What's first on your list? http://t.co/x0chaGA7fg @RogersTVToronto #daytimeTO
	Tourist info (how to travel)	Tweet provides information or enhances visitor experiences; directed specifically to those who are in the park or planning to visit	@CAStateParks: The holiday weekend brings extra traffic. Be extra cautious esp. if traveling with a trailer. Check conditions at http://t.co/4CqbeL2oEO
Purpose: Local	Local-specific info	Information relevant to anyone located inside or just outside the park	@JasperNP: #rockscaling is underway on #hwy16 East for the next few weeks. Expect 20mins delays/ 7 days a week. Info: http://511.alberta.ca
	Local emergency	Information relevant to anyone located inside or just outside the park, who may be impacted by a current hazardous condition in the park	@AlbertaParks: Advisory: Livingstone Falls PRA is now closed due to road washouts.

period, park agencies' combined tweets and number of followers grew 220 per cent and 235 per cent, respectively. In comparison, Twitter followers worldwide grew 77 per cent between 2014 and 2017 (Statista.com, 2017). From 2015 to 2017, Twitter's growth slowed at first but now appears to be accelerating, particularly the number of users (Oreskovic, 2015; Gallagher, 2017). Park agencies adoption of Twitter appears to be growing at an even faster pace, catching up with other sectors.

The US National Park Service (NPS) had many more followers than both Ontario and Vermont State Parks but not as many tweets. Lower Twitter activity on the US NPS site may be explained, in part, by the existence of multiple specialised NPS Twitter accounts (e.g. @MidwestNPS) that serve as unique communication channels to specific audiences, separate from the main NPS account. In 2014, Ontario and Vermont, on the other hand, each had one primary Twitter account. Differences may also be explained by variances in how each agency prioritises resources for communication, including policies regarding staff engagement in SM. Cultures in some NGO (Curtis et al., 2010; Munar, 2012) and government organisations (Lee & Kwak, 2012) embrace new communication technologies faster than others. Parks Canada, with the highest tweet and follower growth, appears to be prioritising SM engagement. Likely, higher numbers of followers on the NPS account are also due to its brand recognition, as well as the size of the US population relative to Canada, Ontario and Vermont. According to Linvill et al. (2012) the size and prominence of organisations matters when it comes to SM exposure.

Table 2: Number and growth of agency tweets and followers – 2014 and 2017 (Highest values are highlighted purple)

		Number of tweets (4 Jun–5 Jul)		Tweets per day (4 Jun–5 Jul)		Total annual tweets		Change in number of tweets	Number of followers		Change in number of followers
Park Agency	**Member Since**	**2014**	**2017**	**2014**	**2017**	**2014**	**2017**		**2014**	**2017**	
Alberta Parks @Albertaparks	April 2009	126	109	4.06	3.5	2,402	3,971	65%	2,616	6,758	158%
California State Parks @CAStateParks	May 2009	61	77	1.97	2.4	2,737	5,112	87%	15,403	26,500	72%
NPS @NatlParkService	April 2009	35	129	1.10	4.1	2,103	7,725	267%	123,394	428,000	247%
Ontario Parks @OntarioParks	Feb 2009	145	646	6.68	20.8	3,678	15,900	332%	25,965	51,800	99%
Parks Canada @ParksCanada	August 2009	239	212	7.65	6.8	8,894	68,603	671%	16,100	153,000	850%
Utah State Parks @UtahStateParks	Sept 2008	20	24	0.65	0.8	1,248	2,218	78%	5,620	10,900	94%
Vermont State Parks @VTStateParks	April 2009	138	198	4.45	6.4	5,850	8,328	42%	9,877	22,800	131%

Only four of the seven park agency's Twitter accounts had higher numbers of tweets during the 31-day sample period in 2017 compared with 2014. However, for all park agencies, the number of tweets over 12 months for 2017 was greater than in 2014. Parks Canada led the way in annual number of tweets in both 2014 and 2017; its Twitter account also experienced the greatest growth in tweet rates and followers. The NPS consistently had the greatest number of followers.

The low tweets per day rates for Utah and California during the 30-day sample periods are concerning, as experts suggest frequency is an important factor in maintaining audience interest (Ellering, 2017; Houghes, 2016; Patel, 2017). This could be driven by a lack of staff resources, or it could be a quality over quantity strategy. Conversely, 20 tweets per day from Ontario Parks in 2017 may be excessive, causing followers to unfollow or ignore the agency's messaging. However, high tweet rates may also increase the number of new followers – for every one that unfollows, five new followers could be generated. A tension exists in this approach – high tweet rates may lessen agency messaging impact, but at the same time grow its follower numbers.

In 2014, only 13 per cent of the tweets examined in this study engaged followers in a conversation and 44 per cent focused on sharing information. In 2017, 65 per cent of tweets provided information as one-way communication, and only 7 per cent appeared to be conversational. Similar one-way communication approaches, characterised by information provision and promotion, were documented by Sevin's (2013) and Gibbs and Dancs' (2013) studies of US and Canadian destination marketing organisations. In Sevin's (2013) study only 20 per cent of all tweets enabled organisations/agencies to engage in direct conversation with Twitter followers. Reduced conversation efforts in 2017 is concerning, as it reflects a lost opportunity for park agencies to engage their Twitter community in dialogic communication. Dialogic communication can build relationships with the public, and shares the quality of an individual's interpersonal dialogues (Pang et al., 2016).

Twitter account content is generated by the park agency or other Twitter users and retweeted by the agency. In general, status and conversational content was more commonly generated by other Twitter users, and retweeted by the respective park agencies (see Table 3). Agency-generated content was most often informational, followed by promotional and phatic. Information provision ranked as the most common type of content in both 2014 and 2017. Twitter is an important vehicle for rapid bursts of time-sensitive information. It is also a good vehicle for reminding. Both the 2014 and 2017 feeds were dominated by tweets that excelled at this. For example: "Next Saturday is National Aboriginal Day and we're celebrating with a special event at #WritingonStone. Don't miss it http://t.co/gK48jMvGjK".

Table 3 Twitter Activity Type – Frequency of tweet types and percentage of total agency tweets 4 June–5 July, 2014 and 2017 (Highest values are highlighted purple)

Park Agency	Conversational # (%)*		Promotional # (%)		Information # (%)		Status # (%)		Phatic # (%)	
	2014	2017	2014	2017	2014	2017	2014	2017	2014	2017
Alberta Parks @Albertaparks	30 (24)	17 (16)	17 (13)	26 (24)	85 (67)	65 (59)	5(4)	1 (0.1)	21 (17)	16 (14)
California State Parks @CAStateParks	31 (51)	0	18 (30)	8 (10)	12 (20)	49 (64)	5(8)	0	17 (28)	21 (26)
National Parks Service @NatlParkService	0	0	17 (13)	20 (16)	22 (63)	74 (58)	0	3 (2)	5 (14)	30 (24)
Ontario Parks @OntarioParks	19 (13)	13 (2)	58 (40)	109 (17)	74 (51)	379 (59)	6(4)	16 (2)	28 (19)	154 (24)
Parks Canada @ParksCanada	28 (12)	0	79 (49)	80 (38)	119 (48)	105 (49)	7(3)	0	29 (12)	33 (16)
Utah State Parks @UtahStateParks	0	4 (17)	8 (40)	1 (17)	11 (55)	9 (37)	0	0	3 (5)	10 (42)
Vermont State Parks @VTStateParks	15 (11)	0	29 (21)	8 (8)	81 (59)	53 (55)	0	5 (5)	42 (30)	31 (32)
Total across all tweets	13%	7%	26%	15%	44%	65%	2%	2%	15%	36%

*Percentage of total agency tweets 4 June–5 July. Categories are not mutually exclusive

Table 4: Tweet Purpose (Highest values are highlighted purple)

	Tourism (promo info) # (%)*		Tourist (specific 'how to' info) # (%)		Local-specific info # (%)		Local emergency # (%)		Conservation Behaviour # (%)		Conservation Education # (%)	
Park Agency	**2014**	**2017**	**2014**	**2017**	**2014**	**2017**	**2014**	**2017**	**2014**	**2017**	**2014**	**2017**
Alberta Parks @Albertaparks	13 (10)	50 (46)	30 (24)	26 (24)	4 (3)	18 (16)	26 (21)	13 (12)	1 (0.7)	8 (7)	3 (2)	12 (11)
California State Parks @CAStateParks	3 (5)	16 (21)	1 (2)	1 (1)	0	1 (1)	0	0	7 (12)	4 (5)	0	8 (10)
National Parks Service @NatlParkService	0	16 (12)	0	7 (5)	0	5 (4)	0	0	0	2 (2)	9 (26)	21 (16)
Ontario Parks @OntarioParks	53 (37)	183 (28)	5 (3)	38 (6)	2 (1)	2 (.3)	1 (1)	0	1 (0.6)	32 (5)	1 (0.6)	65 (10)
Parks Canada @ParksCanada	31 (13)	69 (32)	50 (21)	0	11 (5)	0	0	0	12 (5)	3 (1)	31 (13)	9 (4)
Utah State Parks @UtahStateParks	8 (4)	7 (29)	2 (10)	2 (8)	2 (10)	0	0	0	2 (1)	3 (1)	0	0
Vermont State Parks @VTStateParks	29 (21)	20 (20)	1 (1)	5 (5)	1 (1)	4 (4)	0	0	1 (0.7)	2 (2)	0	9 (9)
Total tweets per purpose (%)**	137 (18)	361 (47)	89 (12)	79 (12)	20 (3)	30 (4)	27 (4)	13 (2)	24 (3)	54 (7)	44 (6)	129 (16)

Feedback was an initial coding category to determine if park agencies asked their Twitter followers for feedback on park management performance. The number of tweets that solicited or replied to user-generated feedback was so small that this category was dropped. An example, retweeted by California State Parks, was first posted by California State Parks' advocacy group: "RT @calparks: "The type of feedback you've been providing informs our work and tells us what you need" @CAStateParks director Lisa." Lack of feedback solicitation is a significant failure on the part of park agencies. Experts suggest microblogging and other forms of SM provide an invaluable opportunity for park agencies to have conversations with stakeholders about the agency's performance and improvement (Sotiriadis & Van Zyls, 2015).

Conservation, tourism and local stakeholder messaging

The Twitter accounts for Ontario Parks and Alberta Parks produced the most tourism promotion tweets such as reminders to make campsite reservations online, and tweets intended to facilitate travel such as safe food storage. These agencies have extensive tourism infrastructure including well-established, sophisticated online camping registration systems that integrate well with an online promotional tool such as Twitter. Tourism plays an important role in generating revenue for these agencies (Eagles, 2014) hence it is not surprising to see tourism promotion and facilitation emphasised. For all agencies, between 2014 and 2017 there appears to have been an overall increase in the number of tweets providing tourism advice and promotion (see Table 4).

Twitter facilitates visits by linking to services such as wayfinding and reservation resources. Visitor satisfaction can be increased through enhanced management of visitors' experiences and expectations. Twitter can also encourage visitors to recall memorable and meaningful park experiences through post-visit dialogue utilising SM (MacKay et al., 2017). This can serve to elevate park loyalty practices such as donations, return visits and positive word-of-mouth.

Twitter excels at broadcasting emergency information; saving lives during wildfire emergencies and related disaster events is well documented (Alexander, 2014; Cooper et al., 2015; Panagiotopoulos et al., 2016). The higher rates of local emergency tweets for Alberta Parks in 2014 were related to a major flood. Reporting time-

sensitive activities such as bear sightings in campgrounds and prescribed burns made up the bulk of content related to local emergencies and location-specific information provision.

Conservation messaging was disappointingly low for park agencies, making up only 4.5 per cent and 12 per cent of combined agency tweets in 2014 and 2017, respectively. Tweets promoting pro-conservation behaviours were especially low; a combined average of 5 per cent pro-park behaviour-related tweets in 2014 and 2017 was documented. Alberta Parks and California State Parks led the way with pro-conservation behaviour tweets such as "News Release: Managing Boat Sewage the Environmental Way: There's an App for that! https://t.co/A8WvcNltnN". Conservation education tweets, highlighting the importance of cultural or natural heritage values in each park, were also scarce; an average of 11 per cent of tweets in 2014 and 2017 contained this type of information. The NPS led the way in generating and retweeting heritage values education messages, such as "RT @FortPulaskiNPS: Our park protects acres of tidal saltmarsh, a critical ecosystem that filters runoff before it reaches nearby Atlantic…"

Overall, the content of these conservation messages appeared well crafted; it was their lack of frequency that was surprising. SM can provide park visitors with information or access to mobile tools for donating to parks or identifying invasive species. SM can also reinforce park visitors' awareness of natural and cultural heritage post-visit with reminders about key conservation facts and how to engage in nature-protective behaviours at home (Bueddefeld & Van Winkle, 2017; Hofman & Hughes, 2017; Wheaton et al., 2016).

Authority, tone and anonymity

A review of the SM literature suggests that organisations communicating with their stakeholders and customers through SM must engage in communication approaches that differ from traditional mediums such as advertising or annual reports. Communication style on SM tends to be more informal, interactive and transparent. This study assessed tweets using three style categories (Hvass & Munar, 2012). *Tone*, coded as formal or informal, refers to the style of language in the tweet. Informal tone resembles face-to-face conversations, and as such can be more engaging. Vermont State Parks excelled at fostering this style of communication through their own tweets and retweeting user-generated content. A decline in informal tweets was documented between 2014 and 2017 (see Table 5).

The second style category, *Authority,* is the level of content control exhibited by the agency. In this study, the majority of tweets were top-down, also known as command-and-control communication style. This style of controlling message is still common in many sectors (DiStaso et al., 2011; Seo et al., 2009). Experts suggest greater interactivity on Twitter feeds is fostered through the use of bottom-up communication style to foster

Lake Louise, Banff National Park - Parks Canada © Elizabeth Halpenny

follower engagement (Kaplan & Haenlein, 2010). An example of this less authoritative style of Twitter message is provided in Figure 2.

Anonymity, the third style of communication, refers to the level of transparency in the agency's tweet author. When a poster's identity is known, experts suggest he or she can generate loyal followers and create stronger organisational ties (Israel, 2009). Hvass and Munar (2012) caution that a personal connection can be hard to replace if a transparent poster can no longer post. Coded as opaque or transparent, opaque tweets were much more common, and almost always the case for agency-generated tweets. This opacity did not change between 2014 and 2017. Baym (2015) suggests that transparent strategies increase followers' feelings of interacting with an authentic person through virtual communication (cited in Hvass & Munar, 2012). If park agencies wish to evoke more authentic interactions with their followers, they may wish to engage more frequently in transparent authorship.

Limitations

This paper focused on analysis of the tweet content of seven park agency Twitter accounts over time. There are many other factors that shape the effectiveness of a Twitter account. Elements such as links to outside content (e.g. websites, blogs, video), use of hashtags, mentions and followers' characteristics all combine to increase the influence of a Twitter account and its overall impact in the Twitter universe. All approaches to measuring effectiveness could not be addressed here, however several of these aspects were analysed for the same seven park agency accounts and are reported in a parallel article. Additionally between 2014 and 2017, Twitter introduced new services to its platform such as "Likes" and the function of copying and pasting a link to another tweet and responding to the tweet. The latter option is used by posters who want their response, and the tweet they are responding to, to be more public, rather than a reply thread. As these functions were not offered in 2014, we did not collect and perform an analysis of their use in 2017.

Future SM and parks research efforts should compare the use and effectiveness of different SM platforms. In depth case studies of park agencies' culture, resourcing and practice as they relate to SM and its integration with marketing and business planning efforts would also reveal important insights needed to encourage park agency communication innovation and efficacy. In short, there are many ways to analyse the trends in and effective use of SM tools such as Twitter; identifying organisational priorities, as in this study with a

Table 5 Style of Tweet (Highest values are highlighted purple)

	Tone: Formal # (%)*		Tone: Informal # (%)		Authority: Top Down # (%)		Authority: Bottom Up # (%)		Anonymity: Opaque # (%)		Anonymity: Transparent # (%)	
	2014	2017	2014	2017	2014	2017	2014	2017	2014	2017	2014	2017
Alberta Parks @Albertaparks	63 (50)	67 (61)	63 (50)	42 (38)	102 (81)	105 (96)	24 (19)	4 (4)	102 (81)	105 (96)	24 (19)	4 (4)
California State Parks @CAStateParks	23 (38)	59 (77)	38 (62)	18 (23)	51 (84)	77 (100)	10 (16)	0	51 (84)	77 (100)	10 (16)	0
National Parks Service @NatlParkService	26 (74)	61 (48)	9 (26)	66 (52)	35 (100)	122 (96)	0	4 (3)	34 (97)	122 (96)	1 (3)	4 (3)
Ontario Parks @OntarioParks	54 (37)	276 (43)	91 (63)	370 (57)	143 (99)	586 (91)	2 (1)	60 (9)	143 (99)	586 (91)	2 (1)	60 (9)
Parks Canada @ParksCanada	106 (44)	81 (38)	133 (56)	131 (62)	224 (94)	206 (97)	15 (6)	6 (3)	224 (94)	206 (97)	15 (6)	6 (3)
Utah State Parks @UtahStateParks	13 (65)	14 (58)	7 (35)	10 (42)	20 (100)	20 (83)	0	4 (17)	20 (100)	20 (83)	0	4 (17)
Vermont State Parks @VTStateParks	5 (4)	19 (20)	133 (96)	77 (79)	113 (85)	80 (82)	25 (15)	18 (18)	113 (85)	80 (82)	25 (15)	18 (18)
Total tweets per style (%)**	260 (34)	577 (45)	474 (62)	714 (55)	688 (90)	1196 (93)	76 (10)	96 (7)	687 (90)	1196 (92)	76 (10)	96 (7)

*percentage of total agency tweets
**percentage of total tweets by all agencies 4 June–5 July

Figure 2. Bottom-up tweet shared by Vermont State Parks

specialised focus on conservation and tourism messaging, is an important first step when embarking on assessing SM practice.

CONCLUSION

Conservation communications specialists Jacobson, McDuff and Monroe sum up SM best practice by stating that "resource agencies must determine how they want a message to be received, and understand how the message is spread by SM, encoded by media gatekeepers, or decoded and interpreted by the receiver" (McDuff & Monroe, 2015, p. 1). This study identified the current state-of-the-art in North American park agency tweet content. Six best practice suggestions arise from this paper:

1. Take greater advantage of Twitter's ability to facilitate two-way communication and relationship building.
2. Increase transparency of authorship or assign a "persona" to interact with Twitter users on a committed basis.
3. Decrease formal tone of communication.
4. Revise communications policies to reduce the dampening effect on SM's utility for genuine co-creation opportunities with conservation and park tourism stakeholders and partners.
5. Reply promptly to complaints or direct queries, and use these as opportunities to engage in conversation and obtain feedback.
6. Post frequently, but not overwhelmingly; relevancy and timeliness are essential.

ACKNOWLEDGEMENTS

This research was supported by the Canadian Social Science and Humanities Research Council. Special thanks to Maureen Shenher for her contributions to the foundations of this paper and research process.

ABOUT THE AUTHORS

Elizabeth Halpenny , PhD, teaches and conducts research in the areas of tourism, marketing, environmental psychology and protected areas management. Elizabeth's research focuses on individual's interactions with nature environments, tourism experience, and environmental stewardship. Current research projects include: (a) the effect of mobile digital technologies on visitors' experiences: (b) the impact of World Heritage designation and other park-related brands on travel decision making; (c) individuals' attitudes towards and stewardship of natural areas; and (d) children, health and nature.

Clara-Jane Blye is a doctoral student in the Faculty of Kinesiology, Sport, and Recreation at the University of Alberta. Her research focuses on environmental psychology theories and how humans connect and interact with the natural environment. Through her doctoral research Clara-Jane seeks to understand the lived experiences of new Canadians participating in environmental engagement programs developed to facilitate access and understanding of Canadian national parks and culturally relevant outdoor recreation practices.

REFERENCES

Aladwani, A.M. (2015). Facilitators, characteristics, and impacts of Twitter use: Theoretical analysis and empirical illustration. *International Journal of Information Management*, 35(1): 15–25. doi.org/10.1016/j.ijinfomgt.2014.09.003

Alalwan, A.A., Rana, N.P., Dwivedi, Y.K. and Algharabat, R. (2017). Social Media in Marketing: A Review and Analysis of the Existing Literature. *Telematics and Informatics*. doi.org/10.1016/j.tele.2017.05.008

Hoodoos at Writing on Stone Provincial Park, Alberta Parks © Elizabeth Halpenny

Alboqami, H., Al-Karaghouli, W., Baeshen, Y., Erkan, I., Evans, C. and Ghoneim, A. (2015). Electronic word of mouth in social media: the common characteristics of retweeted and favourited marketer-generated content posted on Twitter. *International Journal of Internet Marketing and Advertising*, 9(4): 338–358. doi.org/10.1504/IJIMA.2015.072886

Alexander, D.E. (2014). Social media in disaster risk reduction and crisis management. *Science and Engineering Ethics*, 20 (3): 717–733. doi.org/10.1007/s11948-013-9502-z

Altheide, D. and Schneider, C.J. (2013). Plugged-in research. In: *Qualitative Media Analysis, 2nd ed*, pp. 2–22. Newbury Park: Sage. doi.org/10.4135/9781452270043.n1

Antoniadis, K., Zafiropoulos, K. and Vrana, V. (2015). Locating Active Followers in Governmental Twitter Accounts: The Case of Greece. In *ECSM2015-Proceedings of the 2nd European Conference on Social Media 2015: ECSM 2015* (p. 28). Academic Conferences Limited.

Arts, K., van der Wal, R. and Adams, W.M. (2015). Digital technology and the conservation of nature. *Ambio*, 44(4): 661–673. doi.org/10.1007/s13280-015-0705-1

Baym, N.K. (2015). *Personal Connections in the Digital Age*. John Wiley & Sons.

Briones, R.L., Kuch, B., Liu, B.F. and Jin, Y. (2011). Keeping up with the digital age: How the American Red Cross uses social media to build relationships. *Public Relations Review*, 37(1): 37–43. DOI:10.1016/j.pubrev.2010.12.006

Bueddefeld, J.N. and Van Winkle, C.M. (2017). Exploring the effect of zoo post-visit action resources on sustainable behavior change. *Journal of Sustainable Tourism*, 25(9): 1205–1221. doi.org/10.1080/09669582.2016.1257629

Cooper Jr, G.P., Yeager, V., Burkle Jr, F.M. and Subbarao, I. (2015). Twitter as a potential disaster risk reduction tool. Part I: introduction, terminology, research and operational applications. *PLoS Currents*, 7. doi.org/10.1371/currents.dis.a7657429d6f25f02bb5253e551015f0f

Creswell, J.W. (2014). *A Concise Introduction to Mixed Methods Research*. Sage Publications.

Curtis, L., Edwards, C., Fraser, K.L., Gudelsky, S., Holmquist, J., Thornton, K. and Sweetser, K.D., (2010). Adoption of social media for public relations by nonprofit organizations. *Public Relations Review*, *36*(1): 90–92. doi.org/10.1016/j.pubrev.2009.10.003

Dann, S. (2010). Twitter content classification. *First Monday*, 15(12): 1–12. doi.org/10.5210/fm.v15i12.2745

DiStaso, M.W., McCorkindale, T. and Wright, D.K. (2011). How public relations executives perceive and measure the impact of social media in their organizations. *Public Relations Review*, *37*(3): 325–328. doi.org/10.1016/j.pubrev.2011.06.005

Dosemagen, S. (2017). Social Media and Saving the Environment: Clicktivism or Real Change? [online] *HuffPost*. Available at: http://www.huffingtonpost.com/shannon-dosemagen-/social-media-and-saving-t_b_9100362.html [Accessed 26 July 2017].

Bison at Elk Island National Park, Parks Canada © Elizabeth Halpenny

Eagles, P.F. (2014). Fiscal implications of moving to tourism finance for parks: Ontario provincial parks. *Managing Leisure*, 19(1): 1–17. DOI:10.1080/13606719.2013.849503

Effing, R. and Spil, T.A. (2016). The social strategy cone: Towards a framework for evaluating social media strategies. *International Journal of Information Management*, 36(1): 1–8. doi.org/10.1016/j.ijinfomgt.2015.07.009

Ellering, N. (2017). How often to post on social media [Proven research from 14 studies]. coschedule.com/blog/how-often-to-post-on-social-media/. [Accessed 25 July 2017].

Fletcher, A. and Lee, M.J. (2012). Current social media uses and evaluations in American museums. *Museum Management and Curatorship*, 27(5): 505–521. doi.org/10.1080/09647775.2012.738136

Forbes.com. (2017). Twitter's surprising user growth bodes well for 2017. www.forbes.com/sites/greatspeculations/2017/04/27/twitters-surprising-user-growth-bodes-well-for-2017/#5accdc9e2e11. [Accessed 26 July 2017].

Gallagher, K. (2017). Twitter sees best user growth in over a year. Business Insider. www.businessinsider.com/twitter-sees-best-user-growth-in-over-a-year-2017-4 [Accessed 20 July 2017].

Gibbs, C. and Dancs, A. (2013). Understanding destination management organizations' use of Twitter: A content analysis of tweets. In: *Tourism and Travel Research Association: Canada Chapter Annual Conference Proceedings,* pp.14. www.ttracanada.ca/sites/default/files/uploads/2013_academic_papers_proceedings.pdf#page=14. [Accessed 5 March 2014].

Hart, W.B. and Taylor, E.C. (2014). How to Do Communication Research Using Social Media Data. In: K. Langmia et al., (eds.) *Social Media: Pedagogy and Practice*, (pp. 73–84). New York, NY: University Press of America.

Hays, S., Page, S.J. and Buhalis, D. (2013). Social media as a destination marketing tool: its use by national tourism organisations. *Current Issues in Tourism*, 16(3): 211–239. doi.org/10.1080/13683500.2012.662215

Hoffman, D.L. and Novak, T.P. (2012). Social media strategy. In: V. Shankar (ed.) *Handbook of Marketing Strategy*, (p.198). doi.org/10.4337/9781781005224

Hofman, K. and Hughes, K. (2017). Protecting the Great Barrier Reef: analysing the impact of a conservation documentary and post-viewing strategies on long-term conservation behaviour. *Environmental Education Research*. 1–16. doi.org/10.1080/13504622.2017.1303820

Houghes, B. (2016) How to optimize your social media posting frequency. socialmediaweek.org/blog/2016/03/optimize-social-media-time/. [Accessed 25 July 2017].

Hvass, K.A. and Munar, A.M. (2012). The takeoff of social media in tourism. *Journal of Vacation Marketing*, 18(2): 93–103. doi.org/10.1177/1356766711435978

Israel, S. (2009). *Twitterville: How businesses can thrive in the new global neighborhoods*. Penguin.

Jacobson, S.K., McDuff, M.D. and Monroe, M.C. (2015). Effective communications for conservation. OUPblog: Oxford University Press's Academic Insights for the Thinking World. blog.oup.com/2015/10/communications-conservation/. [Accessed 15 July 2017].

Kaplan, A.M. and Haenlein, M. (2010). Users of the world, unite! The challenges and opportunities of Social Media. *Business Horizons*, *53*(1): 59–68.

Kent, M.L and Taylor, M. (1998). Building dialogic relationship through the World Wide Web. *Public Relation Review*, 24: 321–334. doi.org/10.1016/S0363-8111(99)80143-X

Lee, G. and Kwak, Y.H., (2012). An open government maturity model for social media-based public engagement. *Government Information Quarterly*, *29*(4): 492–503. doi.org/10.1016/j.giq.2012.06.001

Lee, M., Lowry, L.L. and Delconte, J.D. (2015). Social media in tourism research: A literature review. Tourism Travel and Research Association: Advancing Tourism Research Globally. 21. scholarworks.umass.edu/ttra/ttra2015/Academic_Papers_Visual/21 [Accessed 15 July 2017].

Leung, D., Law, R., Van Hoof, H. and Buhalis, D. (2013). Social media in tourism and hospitality: A literature review. *Journal of Travel & Tourism Marketing*, 30(1-2): 3–22. doi.org/10.1080/10548408.2013.750919

Linvill, D.L., McGee, S.E. and Hicks, L.K. (2012). Colleges' and universities' use of Twitter: A content analysis. *Public Relations Review*, 38(4): 636–638. doi.org/10.1016/j.pubrev.2012.05.010

MacKay, K., Barbe, D., Van Winkle, C.M. and Halpenny, E. (2017). Social media activity in a festival context: temporal and content analysis. *International Journal of Contemporary Hospitality Management*, 29(2): 669–689. doi.org/10.1108/IJCHM-10-2015-0618

Munar, A.M. (2012). Social media strategies and destination management. *Scandinavian Journal of Hospitality and Tourism*, *12*(2): 101–120. doi.org/10.1080/15022250.2012.679047

National Parks Service (NPS). (2016). Visitation History and Highlights. www.nps.gov/subjects/socialscience/upload/visitation-historic-and-top-10-sites-2016_508compliant.pdf [Accessed 15 April 2017].

Oreskovic, A. (2015). Here's another area where Twitter appears to have stalled: tweets per day. [online] *Business Insider*. www.businessinsider.com/twitter-tweets-per-day-appears-to-have-stalled-2015-6 [Accessed 26 July 2017].

Panagiotopoulos, P., Barnett, J., Bigdeli, A.Z. and Sams, S. (2016). Social media in emergency management: Twitter as a tool for communicating risks to the public. *Technological Forecasting and Social Change*, 111: 86–96. doi.org/10.1016/j.techfore.2016.06.010

Pang, A., Shin, W., Lew, Z. and Walther, J.B. (2016). Building relationships through dialogic communication: organizations, stakeholders, and computer-mediated communication. *Journal of Marketing Communications*, 1–15. doi.org/10.1080/13527266.2016.1269019

Parks Canada (2016). State of Canada's natural and culture heritage places 2016. (No. R61-63/2016E-PDF). Parks Canada.

Patel, N. (2017). Forbes: How frequently should you post to social media according to the pros? IBM Think Marketing blog. www.ibm.com/think/marketing/how-frequently-you-should-post-on-social-media-according-to-the-pros/. [Accessed 25 July 2017].

Rosenstiel, T., Sonderman, J., Loker, K., Ivancin, M. and Kjarval, N. (2015). Twitter and News: How people use Twitter to get news. American Press Institute. www.americanpressinstitute.org/publications/reports/survey-research/how-people-use-twitter-news/ [Accessed 26 July 2017].

Seo, H., Kim, J.Y. and Yang, S.U. (2009). Global activism and new media: A study of transnational NGOs' online public relations. *Public Relations Review*, 35(2): 123–126. doi.org/10.1016/j.pubrev.2009.02.002

Sevin, E. (2013). Places going viral: Twitter usage patterns in destination marketing and place branding. *Journal of Place Management and Development*, 6(3): 227–239. doi.org/10.1108/JPMD-10-2012-0037

Sotiriadis, M.D. and Van Zyls, C. (2015). Tourism Services, Micro-Blogging, and Customer Feedback: A Tourism Provider Perspective. In: *Maximizing commerce and marketing strategies through micro-blogging*, (pp. 154–173). IGI Global. doi.org/10.4018/978-1-4666-8408-9.ch007

Statista.com (2017). Twitter: number of active users 2010-2017 | Statista. www.statista.com/statistics/282087/number-of-monthly-active-twitter-users/ [Accessed 26 July 2017].

Waters, R.D., Burnett, E., Lamm, A. and Lucas, J. (2009). Engaging stakeholders through social networking: How nonprofit organizations are using Facebook. *Public Relations Review*, 35(2): 102–106. doi.org/10.1016/j.pubrev.2009.01.006

Wheaton, M., Ardoin, N.M., Hunt, C., Schuh, J.S., Kresse, M., Menke, C. and Durham, W. (2016). Using web and mobile technology to motivate pro-environmental action after a nature-based tourism experience. *Journal of Sustainable Tourism*, 24(4): 594–615. doi.org/10.1080/09669582.2015.1081600

Yang, S. U., Kang, M., and Johnson, P. (2010). Effects of narratives, openness to dialogic communication, and credibility on engagement in crisis communication through organizational blogs. *Communication Research*, *37*(4), 473–497. doi.org/10.1177/0093650210362682

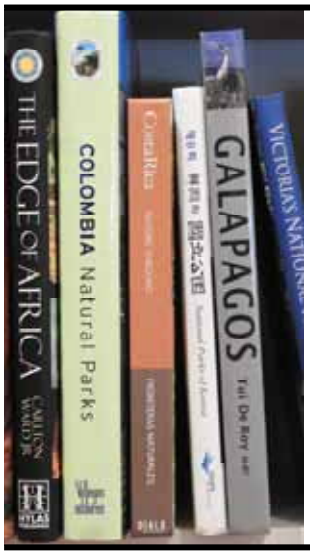
Zeng, B. and Gerritsen, R. (2014). What do we know about social media in tourism? A review. *Tourism Management Perspectives*, 10: 27–36. doi.org/10.1016/j.tmp.2014.01.001

RESUMEN

Con el objetivo de mejorar la comunicación en las redes sociales por parte de las agencias encargadas de la gestión de parques, se contó, interpretó, codificó y comparó el contenido de las cuentas de Twitter en inglés de siete agencias del Servicio de Parques Nacionales de los Estados Unidos. Se examinó las tendencias en el uso de Twitter por parte de las agencias encargadas de los parques mediante la comparación de los *tweets* de 2014 (n=764) y 2017 (n=1,395). Se prestó especial atención a cómo abordan dichas agencias la conservación del patrimonio natural y las visitas a los parques en sus mensajes vía Twitter. Las conclusiones apoyan un llamado para aumentar el uso de formas menos controladas de intercambio de información de abajo hacia arriba en las cuentas de Twitter de las agencias oficiales de parques para mejorar la interactividad, la innovación y las aportaciones de las partes interesadas.

RÉSUMÉ

Dans un but d'améliorer la communication des agences de parcs sur les réseaux sociaux, le contenu des comptes Twitter en langue anglaise de sept agences de parcs nord-américains a été compté, interprété, codé et comparé. Les tendances d'utilisation de Twitter par ces agences ont été examinées en comparant leurs tweets de 2014 (764 tweets) et 2017 (395 tweets). Une attention particulière a été portée à la façon dont les agences de parc abordent la conservation du patrimoine naturel et la fréquentation du parc dans leurs tweets. Les résultats viennent appuyer un appel en faveur de formes d'échange d'information ascendantes et moins contrôlées sur les comptes Twitter officiels des parcs afin d'améliorer l'interactivité, l'innovation et la contribution des intervenants.



BOOK REVIEWS

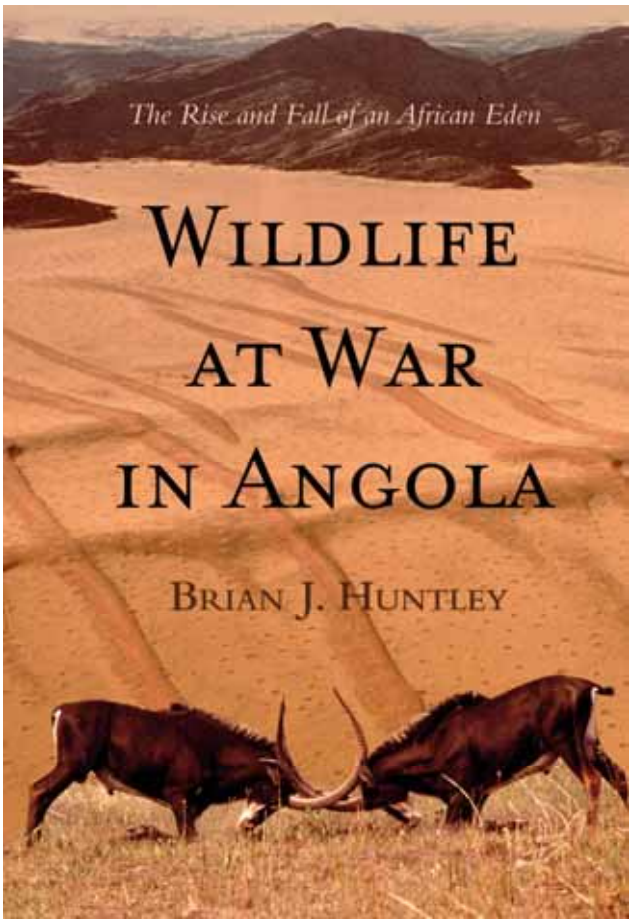
Wildlife at War in Angola: The Rise and Fall of an African Eden by Brian J. Huntley, (2017), Pretoria, South Africa, Protea Book House, 432pp., ZAR350 (soft cover), ISBN 978-1-4853-0611-5. Reviewed by Marc Hockings.

T*he Magnificent Nahanni: The Struggle to Protect a Wild Place* by Gordon Nelson, (2017), Regina, Saskatchewan, Canada, University of Regina Press, 304pp., C$34.95 (soft cover), ISBN 9780889774605. Reviewed by Stephen Woodley.

The Daintree Blockade: the Battle for Australia's Tropical Rainforests by Bill Wilkie, (2017), Mossman, Queensland, Australia, Four Mile Books, 344pp., A$39.95 (soft cover), ISBN:9780994631800. Reviewed by Bill Sokolich.

Protected Areas: Are They Safeguarding Biodiversity Edited by Lucas, N. Joppa, Jonathan E.MM Bailie and John G. Robinson (2016), Chichester, UK, John Wiley & Sons, 269pp., Reviewed by Marc Hockings

WILDLIFE AT WAR IN ANGOLA: THE RISE AND FALL OF AN AFRICAN EDEN BY BRIAN J. HUNTLEY



Few people would know more about Angola's wildlife and natural environments than Emeritus Professor Brian Huntley. Few then could better appreciate what was the splendour of the natural environment and wildlife in Angola, and the losses to this natural heritage that decades of war, corruption and mismanagement have wrought. This book, *Wildlife at War in Angola*, is one man's odyssey of a decades-long commitment to wildlife conservation in one of the lesser known countries in Africa. Sub-titled "The rise and fall of an African Eden", the book covers Brian Huntley's early years of exploration when, together with his wife Merle, he accepted a position as ecologist in the country's six-million-hectare national park system. He remained in Angola for five years until civil war drove him back to his native South Africa. Over the next 40 years, as he established his eminent scientific career and served as Chief Executive Officer of the South African National Botanical Institute, he returned repeatedly to Angola in support of conservation in that country.

Professor Huntley starts with a biologist's portrayal of the habitats and wildlife of Angola's principal conservation areas, Parque Nacional da Quiçama, Luando and Parque Nacional de Iona as he discovered them in his role as ecologist. This is the African Eden in which he worked until his dramatic departure in 1975 in a refugee column from an Angola in the grip of civil war. I doubt that Brian Huntley would claim to be an historian, at least not a professional historian, but Huntley, the biologist, has set his story of wildlife conservation in Angola within the context of the history of the time. As he rightly says, "To understand Angola, one must understand its history". This history helps the reader to understand the root causes behind the fall of this African Eden. He pays respect to the all too few conservationists in the country who made heroic, although ultimately unsuccessful efforts to support national parks and wildlife conservation in the face of the "confusão" that dominated Angola through the civil war years and beyond.

This is, in many ways, a somewhat depressing read, documenting, as it does, the decline of a country's natural heritage in the face of civil war, corruption and mismanagement. The losses are significant; by one estimate, less than 10 per cent of large mammal populations remained by the early 1990s. The impact of civil war on wildlife conservation is at least understandable, if not acceptable. What Brian Huntley

questions is why there has continued to be no improvement, and arguably continued decline, in the 20 years since the civil war ended. His answer is that Angola has entered the "era of paper parks", so that despite claims of over 12 per cent of the country being in conserved areas and an official target of over 20 per cent coverage by 2020, little is actually conserved. The maps indicate increasing protection while the reality is just the opposite. He points to the absence of a committed and visionary leadership, poor governance, and the pervasive influence of corruption (what he calls the kleptocracy) as the causes.

The lessons here are not just for Angola. We need to focus on quality, not just quantity of parks; we need good governance, leadership and adequate resources if national parks and conservation areas are to deliver their benefits to nature and humankind. The book ends on a more hopeful note, although the last chapter's title asks ominously, "Will hope be the last thing to die?". The author is not promoting hope alone, as hope without action would be futile and the last chapter sets out his proposals to change the direction of conservation in Angola. One can only hope that the conservation leaders in Angola take note of these proposals.

Marc Hockings, IUCN WCPA, Australia

THE MAGNIFICENT NAHANNI: THE STRUGGLE TO PROTECT A WILD PLACE BY GORDON NELSON

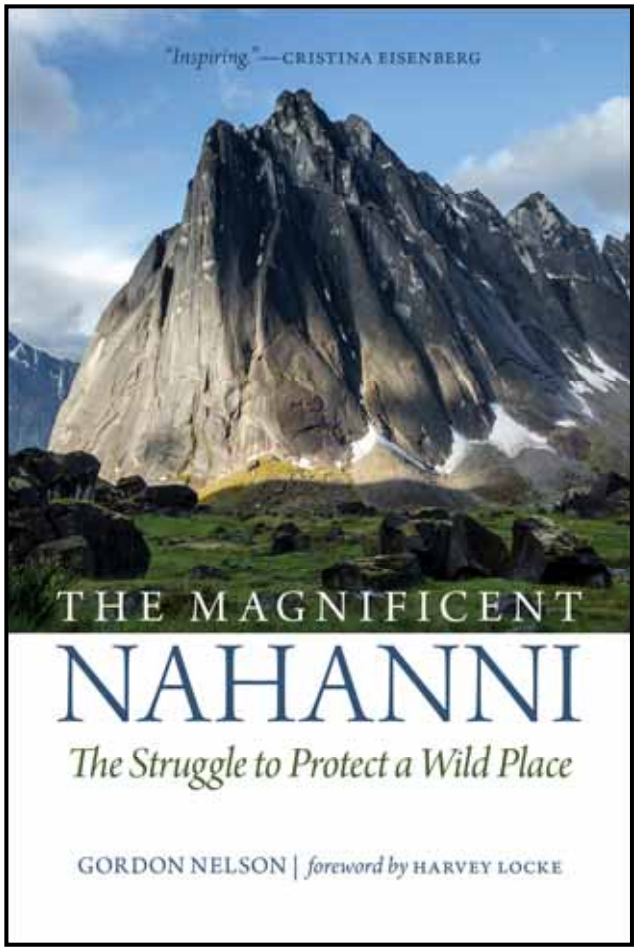
The Nahanni River watershed stands out in Canadian, and indeed global, conservation mythology as a place of unparalleled beauty, wildlife and wilderness. The book, The Magnificent Nahanni documents the place and the long history of conservation efforts, which finally resulted in a vast National Park and World Heritage Site.

The book has a fitting author. Like the Nahanni, Gordon Nelson is also a Canadian conservation legend. As professor at the Universities of Calgary and then Waterloo, Gordon trained a generation of conservation leaders. He was a leader in developing the precursor to the Canadian Parks and Wilderness Society, which played an instrumental role in getting the Nahanni protected. Gordon also started the Heritage Resources Centre at the University of Waterloo, which was the sole Canadian academic centre dedicated to natural and cultural conservation research. As a scholar, Dr Nelson has published hundreds of articles and received many awards. This books follows that scholarly tradition and documents the struggles by the Deh Cho First Nation, civil society, researchers and government officials to conserve a globally important place.

Nahanni National Park and World Heritage Site is 30,050 km². Along with the adjacent Nááts'ihch'oh National Park (adding another 4,850 km2), this protected area is large enough to protect viable populations of Dall sheep, grizzly bears and mountain caribou. The Nahanni River cuts through canyons as deep as the Grand Canyon, over a spectacular 100 m high waterfall and through a Karst landscape with caves and hot springs. It is truly World Heritage.

First Nations have lived with the Nahanni for at least 6,000 years and that relationship continues today. Europeans first arrived to harvest furs and then prospect for gold in the 1800s. There was a proposal in 1945 to study the area for a National Park. The modern era conservation struggle to protect the Nahanni took 40 years, from the first small park proposal in the early 1970s, to the final expanded park boundary in 2009. The area was seen as potentially valuable for minerals and hydroelectric power. Many forces opposed the creation of the Nahanni, decrying the locking up of such a big area from economic development. The struggle to conserve the Nahanni is a history of the evolution of land conservation, including ideas of wilderness, ecological integrity and relationships with indigenous peoples. The author examines these ideas with a scholar's eye, but keeps the book readable and well-paced.

In the fast-paced world of modern conservation, those working to conserve nature often forget they are also making history. The history of the modern conservation



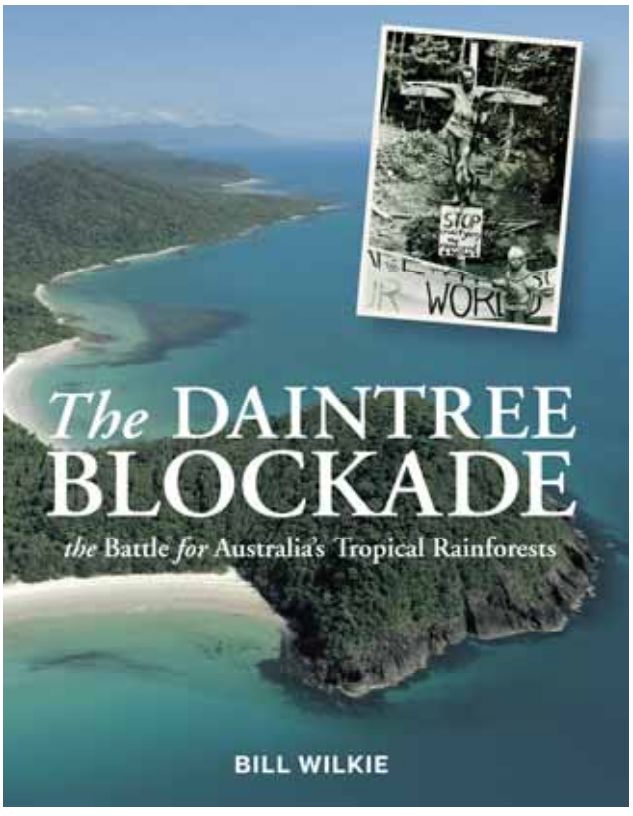
movement is not well documented and this book is a necessary and welcome addition. It reminds us how difficult it is to conserve nature, of the people that spend much of their working lives conserving special places, and of the changing ideas we use to define and defend conservation.

Stephen Woodley, IUCN World Commission on Protected Areas, Canada

THE DAINTREE BLOCKADE: THE BATTLE FOR AUSTRALIA'S TROPICAL RAINFORESTS BY BILL WILKIE

In late November 1983, the Douglas Shire Council crossed the Daintree River with two bulldozers, a caravan and work crew equipped with chainsaws to commence building a 34 km dirt track through lowland rainforest north of Cape Tribulation to the Bloomfield River. When they arrived they were met by a band of resolute locals, conservationists and individuals from all over Australia who took a stand to protect an area of overwhelming beauty and international scientific importance, which had recently been declared a National Park.

From a modest beginning where both sides battled each other to a relative stand still, the blockade grew to an epic struggle where the stakes grew ever higher by the day. As work progressed, there was greater determination by local blockaders, experienced "greenies" fresh from rainforest campaigns in the south, a "might is right" local council re-armed with bigger equipment, supported by a larger contingent of state police backed by an authoritarian state government. National and international media covered the story, eminent scientists raised their voices and politicians from all persuasions took positions – right up to the Queensland Premier and the Australian Prime Minister; a cast of thousands. Daintree became a household name.



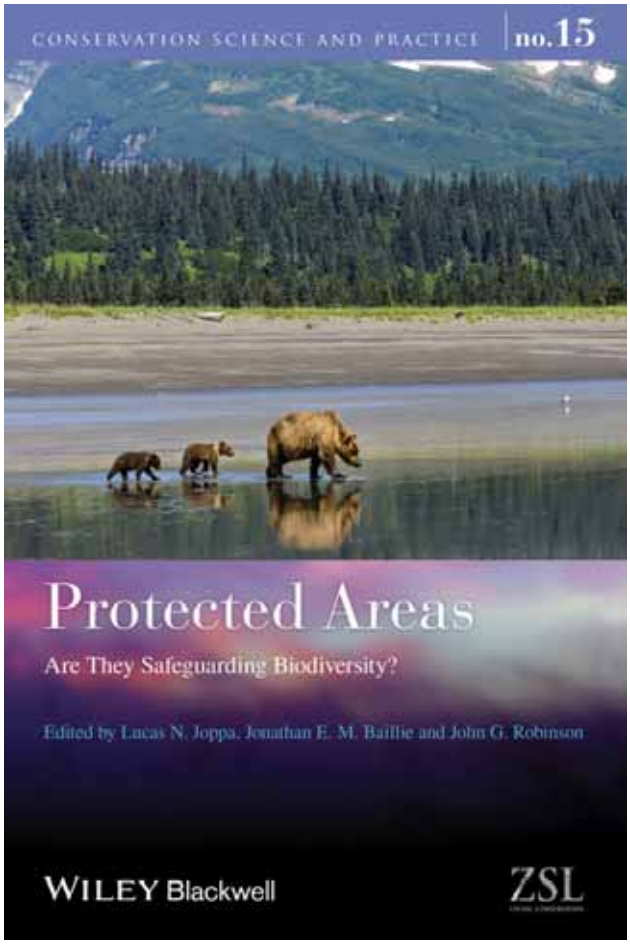
Bill Wilkie documents this historical event with carefully researched documents, hundreds of photos, and dozens of interviews. He takes us through the maze of opinion, actions, personal stories, historical backgrounds, high drama, passion, declarations, clashing ideologies and theatre with skill, providing an entertaining narrative along the winding trail to the blockade's final conclusion: completion of the Bloomfield track, closely followed by a national election with a Daintree plank, leading finally to World Heritage listing by the IUCN of the wet tropics region of North Queensland. One of the great Australian conservation campaigns. An inspiring read for all with a treasure of archive material and wonderful photos.

Bill Sokolich, Cairns, Australia

PROTECTED AREAS: ARE THEY SAFEGUARDING BIODIVERSITY EDITED BY LUCAS N. JOPPA, JONATHAN E.M.BAILLIE AND JOHN G. ROBINSON

This book examines the question "how protected areas are contributing to biodiversity conservation?". The editors point out in their introduction that even if we meet the area targets for declaration of terrestrial and marine protected areas established in the Convention on Biological Diversity through Aichi Target 11, that this will be insufficient to stem the loss of biodiversity. It is increasingly clear that while we will meet these coverage targets by 2020, biodiversity continues to decline.

The edited book contains 14 chapters contributed by 51 authors including many of the leading researchers on protected areas. The book is organised into four parts, with the first examining the nature and extent of the global protected area estate. Dudley and Stolton highlight the diversity of approaches to establishing protected area systems around the world from the diverse mix of government, private and community reserves in Colombia to the large protected landscapes of the United Kingdom that focus primarily on multiple use and lack the more extensive areas of strict protection characteristic of many other systems. They raise the question of how well networks of small reserves can protect biodiversity. Although an adequate answer to this question is not yet available, it is a critical issue given that small



protected areas dominate the records in the World Database on Protected Areas. James Watson and his co-authors call for an expansion of the protected area estate targeted on species protection and not on an arbitrary percentage target. They point out that, of the 4118 threatened species they examined, 17.4 per cent do not occur in any protected area and a large majority of the species lack sufficient area under protection to ensure their persistence over time.

In part two of the book, authors decry the poor state of knowledge of species population trends in protected areas and argue the need for greater monitoring in and around protected areas. They report both some successes and also failures of protected areas to conserve populations of species within their borders, but with very large regional differences. Protected areas can maintain species populations under the right circumstances but we cannot assume that this is the case in all or even many areas. Understanding the characteristics and attributes of protected areas that lead to effective species conservation is a question of great urgency and increased research focus.

What is clear, is that, for many species, protected areas alone will not be sufficient to ensure their conservation and they need to be managed within a supportive ecological and social matrix. Managing protected areas at system scale is the focus of part three of the book where protected area functioning is considered in the context of surrounding land uses, and environmental change. Hansen and colleagues examined the vulnerability of US National Parks to surrounding land use change and climate change and illustrate how understanding the diversity in vulnerability can help prioritise adaptation options. Rao and her co-authors examine the importance and effectiveness of community-based approaches to management of protected areas, highlighting the importance of effective and equitable governance in biodiversity conservation and proper recognition of the huge contribution made through indigenous and community conserved areas. The final chapter in this section looks at the importance of protected areas in Asia in conserving species subject to intense poaching pressure and impacted by habitat loss. They point to a consistent pattern where the majority of the remaining population of these species is now confined to protected areas. They point out that law enforcement is essential to the conservation of these species, and while examples of success can be pointed to, effective law enforcement is lacking in many places.

Part four of the book is devoted to monitoring of both protected area coverage and species populations. Better targeting of conservation efforts to ensure protected areas are located in the places of greatest importance to biodiversity. Monitoring both the performance of protected area management and the impacts of protected areas in conserving species is the basis for a properly adaptive approach to protected area management. Tools to support these efforts such as camera traps and various forms of remote sensing can make such data both more easily available and affordable.

This collected work, arising from a symposium held at the Zoological Society of London in 2012, does not pretend to answer the question “are protected areas safeguarding biodiversity?” in a definitive way. Rather it has set out the parameters of the debate, and raised the prominence of this critical question. The final answer will depend on the decisions we make, as a global community, about how much we protect, where we place that protection and how effectively we govern and manage those areas.

Marc Hockings, IUCN WCPA, Australia