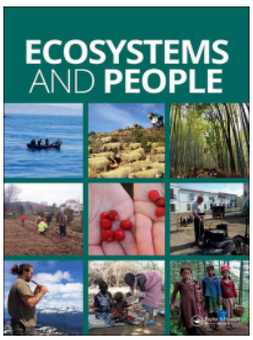

Ecosystems and People

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/tbsm22

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To cite this article: Amrita Neelakantan, Kishor Rithe, Gary Tabor & Ruth DeFries (2021) Pathways towards people-oriented conservation in a human-dominated landscape: the network for conserving Central India, Ecosystems and People, 17:1, 432-446, DOI: 10.1080/26395916.2021.1955745

To link to this article: https://doi.org/10.1080/26395916.2021.1955745

ECOSYSTEMS AND PEOPLE
2021, VOL. 17, NO. 1, 432–446
https://doi.org/10.1080/26395916.2021.1955745

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Pathways towards people-oriented conservation in a human-dominated landscape: the network for conserving Central India

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ABSTRACT

Landscape-level conservation that maintains biodiversity and livelihoods for local people requires long-term collaborations across local communities, scientists, practitioners and decision-makers. The Network for Conserving Central India (NCCI) provides a platform for such collaborations in a globally important tiger conservation region within a complex social-ecological system. Using the NCCI as an example, our study identifies indicators to track progress in collaborative landscape-level networks across four dimensions: the composition of the network; collaborative scientific output; dissemination of research outputs through social, electronic and print media; and participation in policy and decision-making bodies. The NCCI is primarily comprised of members of the scientific community, Non-Governmental Organizations (NGOs) and various levels of government. Since 2013, the NCCI members conducted research that predominantly addressed human-wildlife conflicts and human livelihood needs around protected areas (PAs), with less attention to forest ecology and climate. NGOs within the NCCI work closely with local communities and provide avenues for local engagement. Co-production of policies is an essential but challenging goal due to established hierarchies and top-down institutional structures. Our analyses highlight the NCCI's role as a knowledge platform and bridge among researchers, NGOs, and government, with significant opportunities for boundary work in the Science, Policy and Practice Interface (SPPI). A challenging and unfulfilled goal is the engagement of local communities to co-produce approaches that balance conservation, local livelihoods, and development. We suggest that other landscape-level networks in social-ecological systems can modify these dimensions as pertinent to their respective circumstances to track progress towards co-produced management to address livelihood and conservation needs.

ARTICLE HISTORY
Received 8 September 2020
Accepted 9 July 2021

EDITED BY
Odirilwe Selomane

KEYWORDS
Conservation; boundary work; India; science policy practice interface; governance; bridging organization; wildlife corridor

1. Introduction

Regions of the world with rapidly changing land-use and economies require transdisciplinary focus to adequately address today's challenges for conservation, local livelihoods, and development (Mace et al. 2012; DeFries and Nagendra 2017; Sterling et al. 2017). To this end, conservation scientists and practitioners are forming broader and more inclusive networks (Bawa et al. 2007; Ruth DeFries et al. 2010; Keeley et al. 2019; Nagendra et al. 2006; Sayles et al. 2018). The complexity of the interactions between conservation, local livelihoods, and development are particularly acute in regions with complex historically driven (for example – feudal and colonial) hierarchies with high resource dependence of vulnerable local communities (West and Brockington 2006; de Mello et al. 2020). Large scale, collaborative socio-ecological networks have the potential to marshal diverse human and financial capacities to achieve ambitious conservation goals (Jacobson and Robertson 2012; Chester 2015; Scarlett and McKinney 2016; Keeley et al. 2019).

Central India, similar to many other tropical areas of conservation importance, is a human dominated landscape that includes critical wildlife habitat refuges for globally endangered species (Dutta et al. 2015; Nayak et al. 2020). In this matrix, conservation often competes with infrastructure development, agriculture, and human needs. Collaborative landscape level conservation provides a path to address these multiple objectives (Bodin et al. 2017; Kettle et al. 2017). However, due to colonial legacies in the region, local human communities do not always enjoy equitable status within top-down conservation management for conservation goals (Spangenberg et al. 2014; Macura et al. 2016; Gavin et al. 2018). Thus, researchers working in many conservation landscapes have identified the need to focus on human well-being alongside conservation goals (Barlow et al. 2010; Peterson et al. 2010; Defries et al. 2012; Mace et al. 2012; Sterling et al. 2017).

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Supplemental data for this article can be accessed here.

The complexities of social-ecological processes challenge researchers and decision makers in such landscapes to delve into transdisciplinary issues beyond a single field of study (Young et al. 2014; Chester 2015).

1.1. The importance and utility of boundary work and bridging organizations

Collaborative social-ecological networks are able to achieve multiple interacting goals by conducting boundary work and by playing the role of bridging organizations in the SPPI (White et al. 2010; Baird et al. 2019). Boundary work in the context of complex social-ecological landscapes focuses on the boundaries between scientists of intersecting disciplines; scientists and decisionmakers; and scientists and practitioners including local communities. Participation and accountability are important enabling conditions (Clark et al. 2016). Co-production of knowledge and mainstreaming new findings remain challenging but rewarding work that can culminate in the existence of effective management via boundary objects – organizations that are set up to conduct boundary work (Turnhout 2009; Scarano et al. 2019). Such boundary work requires multiple bridging organizations that perform roles on either side of a disciplinary, organizational, or mission statement divide (Crona and Parker 2012; Goodrich et al. 2020). Actively structuring institutions to undertake boundary work for complex social-ecological landscapes requires Credibility, Relevance and Legitimacy (CRELE). SPPI researchers suggest that the process to co-produce actionable knowledge needs to be iterative (Sarkki et al. 2015; Leibenath et al. 2020; Tambe et al. 2020). However, there remain challenges to the CRELE framework when new scientific findings remain difficult to include in policy due to lack of timeliness or comprehensive consideration of all aspects of a decision (Dunn and Laing 2017; Tangney 2017). A balancing of scientific freedom to innovate and guide policy while also responding to demand-driven scientific enquiry from decision-makers or other actors within a social-ecological landscape is required to achieve ambitious and complex goals (Weichselgartner and Kasperson 2010; Sarkki et al. 2014; Kowalczewska and Behagel 2019). Collaborative social-ecological networks can build robust frameworks for boundary work, formalize the role of bridging organizations and iteratively measure effectiveness of co-produced knowledge for the management of multiple goals.

We characterize one network, the NCCI, formed in 2014 to provide science-based input to decisions for conservation, local livelihoods, and development. In this study, we discuss the institutional context under which the NCCI operates within the SPPI and indicators to assess the effectiveness of the network. We also identify remaining challenges and opportunities in fostering bottom-up engagement in decisions affecting the landscape.

2. The Central Indian Highlands

The Central Indian Highlands span across the Indian states of Madhya Pradesh, Chhattisgarh, and Maharashtra (Figure 1) encompassing more than 450,000 sq. kms. Agriculture is the main land cover

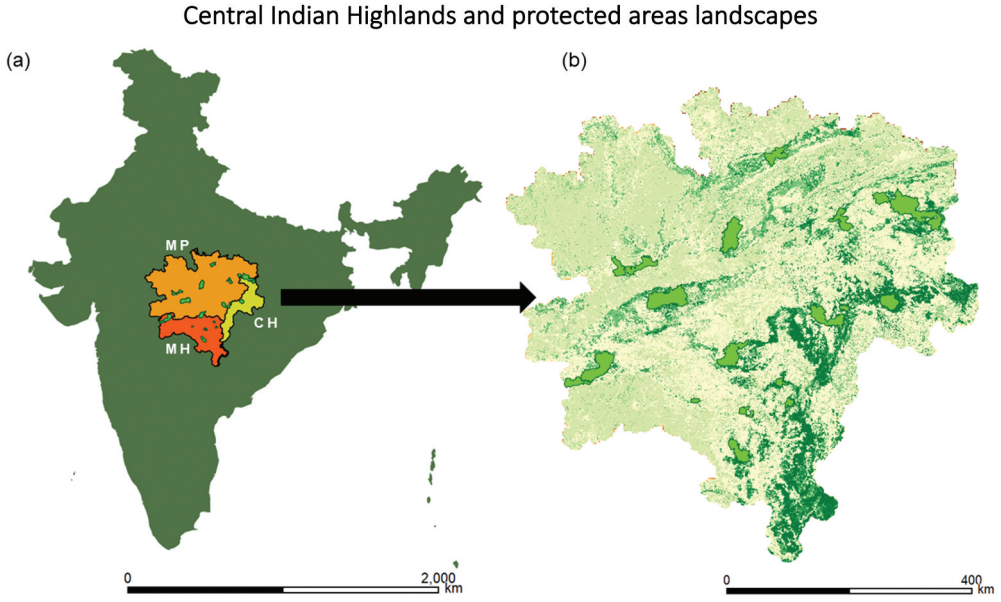

Figure 1. Central Indian Highlands and protected areas landscapes. (a) India and location of the Central Indian Highlands (CIH) region across three states (Yellow and orange polygons depicting parts Madhya Pradesh (MP), Chhattisgarh (CH) and Maharashtra (MH) states) as well as PAs (green polygons). (b) Forest cover (dark green) in the region with embedded PAs (lighter green polygons) show corridors between the PAs.

and forested areas composed of tropical deciduous forests cover approximately 29% of the land (Dutta et al. 2015). This landscape includes several embedded PAs and officially recognized Tiger Reserves (TRs) (e.g. Kanha, Satpuda, Pench (Madhya Pradesh), Pench (Maharashtra), Melghat, Tadoba, Navegaon-Nagzira, Bor, Kawal and Achanakmar) and forest corridors that are essential for wildlife movement and genetic continuity across the landscape (Dutta et al. 2015; Thatte et al. 2018). The Central Indian Highlands are particularly important for tiger (*Panthera tigris*) populations (they support 29% of the country's tiger population (Jhala et al. 2018)), as well as populations of leopard (*Panthera pardus*), wild dog (*Cuon alpinus*) sloth bear (*Melursus ursinus*), gaur (*Bos gaurus*), and swamp deer (*Cervus duvacelli*). National Parks, and especially TRs, have the highest protection and enforcement from the Indian government for conservation of endangered species. Central India is globally recognized for tiger tourism with a sharp increase in tourism around PAs over the last decade (DeFries et al. 2010; Karanth and DeFries 2010). Around PAs, local economies flourish and falter alongside the seasonality of ecotourism with livelihood options dwindling during off-season (Neelakantan et al. 2019).

The region also serves as the headwaters to several rivers, including the River Narmada and Tapti, which are among the seven major rivers in India, and are essential for meeting the irrigation, electricity, industrial and urban needs of the region. The forests in this region also support local livelihoods: 60% of the income of local people in non-protected areas is based on these forests. Important forest products include fodder for cattle, tendu (*Diospyros melanoxylon*), mahua (*Madhuca indica*), amla (*Phyllanthes emblica*) and other ingredients essential for the herbal medicine industry. There is a high density of historically disadvantaged indigenous communities (e.g. scheduled tribes) or *adivasis* that reside in the central Indian region (>25% of all inhabitants, see – Mohindra and Labonté 2010). The Indian government formally recognizes these communities as 'scheduled tribes' who rely on forest resources for their livelihoods (Revankar 1971; Lele et al. 2015).

The people of this landscape live and support themselves through a range of activities including agriculture, forest produce collection, tourism and urban activities. Simultaneously, studies suggest that this region will be highly vulnerable to climate change as higher temperatures and altered precipitation may disrupt the existing environmental and economic systems (Defries et al. 2016; Roxy et al. 2017; Mishra et al. 2020). The central Indian region is also rapidly changing with increasing urbanization and associated investments in infrastructure (Dutta et al. 2015; Gibson et al. 2017). Large dams (mainly for irrigation and power) have already consumed large sections of the remaining forests/wildlife habitats during 1980–2000 (P. Mondal and Southworth 2010). The region has been a source of coal-based energy for several states in central India, threatening the remaining forest connectivity between PAs (Javed and Khan 2012). In recent years, linear transportation infrastructure needs are threatening tiger connectivity and could have long-term impacts on conservation region-wide (Thatte et al. 2018).

3. The formation of the NCCI

The NCCI grew out of a small group of researchers working in the central India landscape. The group organized the first symposium in February 2014 at Kanha TR, with invitations to approximately 80 people from local and national NGOs, the Forest Department, and other researchers. A second and third symposium took place in December 2016 at Pench TR and in 2019 at Melghat TR respectively. In January 2021, the fourth symposium took place online due to the COVID-19 pandemic. The NCCI defines its mission as 'a network of researchers, NGOs, and managers dedicated to conserving biodiversity, improving livelihoods, and fostering sustainable development in the landscapes of the Central Indian Highlands through the application of science' (http://www.conservingcentralindia.org).

Members initially met to share their experiences and knowledge of conservation in central India and elsewhere. In the third meeting (2019), the members developed a set of themes to focus their work, which include inputs to crucial questions facing the landscape and its people: Where and how can the region accommodate India's needs for infrastructure? What approaches are effective to promote livelihoods that provide options for coexistence between people and wildlife in the landscape? How can Central Indian landscapes benefit the water supply for local people and downstream users? Since 2019, a dedicated coordinator (first author in this study) carries out the activities of the NCCI, including a newsletter, layperson summaries of research papers, facilitation of working group activities, a website with profiles of members in the NCCI and information about funding opportunities. In the last virtual symposium (2020), the NCCI launched a central and open access spatial data repository – the NCCI Data Collab. Many diverse disciplines and professionals participated in the last symposium – including landscape planners, architects, social science researchers, grassroots NGOs and activists in addition to ecology or conservation researchers and government officials. The NCCI seeks to break silos and foster science-based decisions to achieve positive outcomes for

conservation, local livelihoods, and development in the context of existing complex institutional structures.

Science-informed conservation networks such as the NCCI aim to achieve a balance among multiple objectives that serve both present and future conditions. For example, in the central Indian region, the NCCI works towards providing a knowledge-base and platform for collaborations that improve the well-being of local communities; conserve habitat for wildlife; protect watersheds; promote sustainable tourism; and accommodate development needs for improved infrastructure.

4. Existing institutional structure for decision-making on conservation and livelihoods in central India

Decision-making for conservation and livelihoods in India has a many storied past that includes the degradation of commons, feudalism and colonialism, the legacies of which continue to this day (Agrawal and Chhatre 2006; Sekar 2016). The Indian government typically solicits external expert opinion while setting the terms of reference for environmental clearances and during final drafting of policies (Ghosh 2013). Additionally, there are advisory bodies that could also influence the policies at the initial stages (Table 2, see Glossary – Table 1). Academic institutions and NGOs have previously advised the government on national and regional or state-wide policies. Typically, third-party experts have opportunities to advise the Indian Government at the national, state and local levels. Similarly, the government invites experts to be part of environmental/forest/wildlife clearance processes of several infrastructure projects across hierarchical levels (Table 2).

Decision-making for environmental issues in India largely falls under forest, wildlife and environmental clearance processed under the Forest (Conservation) Act (FCA 1980), the Wild Life Protection Act (WLPA 1972) and the Environment (Protection) Act (EPA 1986) respectively. Forest clearance is needed if a proposed project requires official forest land and wildlife clearance is needed if a proposed project location includes PA habitats or officially designated eco-sensitive areas (ESAs). The structural opportunities for third-party involvement are limited to expert appraisal committees (Table 2). These expert committees can give strong recommendations for additional terms to be met as well as recommend that no clearance be approved due to impact on environment, including forest and wildlife.

While similar expert appraisal opportunities exist during local planning and management, the level of involvement from NGOs varies across the country. In many places, lack of involvement allows PA management to take decisions without third-party involvement. PA landscapes that enjoy high involvement from both government and NGOs have more co-produced management plans (Agarwal et al. 2017). In addition, not all states have functioning Local Advisory Committees (instituted for TRs), Advisory Committees (for wildlife sanctuaries) that the Government of India legally mandates for bottom-up inputs (Table 2). Finally, for protection measures and anti-poaching operations, there exist state and district level Tiger Cells (government mandated protection and anti-poaching bodies) with inclusions of NGO representatives alongside forest officials and police.

Under the WLPA, NGO experts participate to delineate the boundaries of core (Critical Tiger Habitat) and buffer of TRs. Under the EPA, people and NGO experts can also send their suggestions or objections on the proposed boundaries of ESAs and PAs as well as participate in public hearings to submit their recommendations about proposed infrastructure projects. Once ESA notification for a PA is issued, management committees are constituted for every PA which includes NGO representatives, public representatives and experts. Under Forest Rights Act 2006 (FRA 2006), NGO experts participate to delineate the boundaries of critical wildlife habitat for every PA. Outside of PAs, there are Joint Forest Management (JFM) committees, Eco-Development Committees, Biodiversity Management Committees and Community Forest Resource (CFR) Management Committees.

Environmental and conservation decisions in Central India sit within the aforementioned national structure. While decision-making remains rigidly top-down in central India, there is a flourishing diversity of local governance that manages commons with varying degrees of effectiveness against external pressures (Agrawal and Chhatre 2006; Narain and Vij 2016). The legal provisions within the Forest Rights Act (FRA, 2006) and its interpretation remain fraught with contestations that are exacerbated by conflicting policy regarding land tenure and land use in the WLPA (Kashwan 2013; Sekar 2016). However, there

Table 1. Glossary of acronyms used.

Acronym	Full-Form
CFR	Community Forest Resource
CRELE	Credibility, Relevance and Legitimacy
EPA	Environment (Protection) Act, 1986
ESA	Eco-Sensitive Area
FCA	Forest (Conservation) Act, 1980
FRA	Forest Rights Act, 2006
JFM	Joint Forest Management
NGOs	Non-Governmental Organizations
PAs	Protected Areas
SPPI	Science, Policy, and Practice Interface
TRs	Tiger Reserves
WLPA	Wildlife (Protection) Act, 1972

Table 2. The top-down advisory and decision-making policy structure (solicited opportunities) for civic or stakeholder involvement. India also has a National Green Tribunal for cases within the environmental law-making jurisdiction.

Advisory	Wildlife Protection Act (WLPA)	National Board for Wildlife, National Tiger Conservation Authority (NTCA)	State Board for Wildlife and its subcommittees; Regional offices of the NTCA	Honorary Wildlife Wardens, PA Advisory management committee
	Biodiversity Act, 2002	National Biodiversity Authority	State Biodiversity Board	Village Biodiversity Management Committee
	Other Bodies under WLPA, FCA, EPA, FRA	Forest Advisory Committee	Regional Empowered Committee for forest clearance, State Expert Appraisal Committee for environmental clearance	Local Advisory Committees (eco-development, tourism etc.), Ecologically Sensitive Area Monitoring Committee, Local representation in declaring Critical Tiger Habitats and Critical Wildlife Habitats.
Environmental Clearance	Terms of Reference (with External Involvement)	Yes (limited in practicality as time is insufficient. See – (Ghosh 2013; Parikh 2017))	Yes	Yes
	Expert Appraisal Committee	Yes	Yes	Yes
	Legal	National Green Tribunal – jurisdiction limited to FCA, the Indian Biodiversity Act 2002 and does not include WLPA or FRA, Central Empowerment Committee, Supreme Court	High Court	District Courts

have been bottom-up approaches, fostered by NGOs as part of the FRA, that show promise for management by local communities with formalized spaces to create Conservation and Management Plans for CFR areas – especially in the state of Maharashtra pertaining to bamboo production and use (Tambe et al. 2021). Land acquisition by state-approved industrial activities in these areas is a threat to both conservation and local communities. The formal inclusion of local institutions in top-down management mechanisms could foster long-term and more holistic conservation success alongside local development (Ostrom 2012; Gavin et al. 2018; Baird et al. 2019). The integration of local institutions in decision-making is already taking place informally in some parts of the central India. Village involvement is key to restoration efforts or invasive management in the forests of central India (Agrawal and Chhatre 2006; Bawa et al. 2007; Beazley 2009; Agarwal et al. 2017). An example is the NCCI member organization the Foundation for Ecological Security, which is working on reclaiming commons to enhance local livelihoods while maintaining natural resources around Kanha National Park in south-eastern Madhya Pradesh (pers. comm. Ishan Agarwal, member of the NCCI and general manager – programmes, at NGO Foundation for Ecological Security). Restoration of commons or fallow lands are implemented both by officially recognized top-down policies that involve local communities – for example the JFM scheme, various eco-development committees and Dr. Shyamaprasad Mukharjee Jan Van scheme in Maharashtra. These efforts implemented by the Forest Department to involve local communities and stabilize their livelihoods have seen mixed success and elite capture of resources (Kumar 2002; Agarwal et al. 2016; Macura et al. 2016). Studies show that bottom-up approaches, where local communities autonomously manage resources enjoy greater success than those continuing to function in a top-down manner with regard to forest restoration (Ghate and Nagendra 2005). However, exploring the efficacy of Community Conserved Areas, a cornerstone of people-led conservation with many examples in central India, shows that understanding of the enabling conditions for conservation and resource management requires further enquiry (Shahabuddin and Rao 2010; UNDP 2012).

Finally, co-management of resources in central India is achieved through civil society groups and village government (*Panchayats*) providing a high institutional diversity that activates according to the requirement or decision to be made. An example is the focus on water in Maharashtra where local bodies came together to govern and manage water sources in arid regions facing debilitating droughts (Depinder et al. 2010; Samuel et al. 2015). NCCI

member NGO, Satpuda Foundation works with local communities in Pench TR to provide alternative livelihoods and other support to locals with the observation of reduced anthropogenic pressures on tiger habitat (reduction in forest fires, illegal fuelwood collection, poaching and illegal cattle grazing incidents, pers. comm. Kishor Rithe, NCCI member and president – Satpuda Foundation). Elsewhere, in the south and north-east of India, local governance has played a strong and positive role. In north-east India, where formal recognition and inclusion of traditional knowledge can inform on-ground systems for resource management and livelihood enhancement, evidence suggests that rural areas have better quality of governance compared to urban centers, likely due to local involvement (Singh et al. 2010; Basumatary and Panda 2019). In Karnataka state, studies highlight the importance of local institutions for sustainable management of forests and enhanced, diversified livelihoods (Bawa et al. 2007). There is also evidence of the dependence on local governance for the long-term success of co-management of resources from Himachal Pradesh in north India (Agrawal and Chhatre 2006). However, without strengthening local institutions the deregulation of resources does not provide local governance over natural resources. A modified but not reduced state control over resources after formal deregulation is common across the forests of the central Indian state of Madhya Pradesh (Véron and Fehr 2011).

4.1. Governance in central India for conservation and local resource use

The origins of conservation and the historical British administration of lands in India have limited most collaborative efforts with local communities to protection of forest or afforestation. More recently, in the early 1990s, the deregulation of forests via JFM committees and private actors that govern forestry in Madhya Pradesh have led to a further disconnection between local uses of forests, ownership and legal standing to exercise agency over historical forest lands. Government-recognized corporations and the forest department are the owners of forests and regulate forest use including forest produce extraction, thus modifying control over de-regulation but not ceding it. In JFM and other schemes of the government to foster bottom-up management of resources, elite-capture (a form of corruption where resources are controlled by few individuals or entities with higher social standing) has at least partially negated the co-management gains that the government envisioned for these schemes in rural India (Kumar 2002; Agarwal et al. 2016). Local communities have had little incentive to manage historical commons or non-commercial forest produce. Local communities in many places now relate to forests as state owned entities which could provide employment that ranges from daily wage work to tourism. In the Indian context, multiple studies document the need for local governance and strengthened local institutions for long-term resource management and wildlife conservation (Narayan et al. 2009; Shahabuddin and Rao 2010).

NGOs in the region also work closely with local communities and provide a bridge between them and the hierarchical decision-making process (Table 3). At the local level, village committees add to biodiversity registers or provide inputs on PA village policy implementation. The NTCA adopted the policy to help voluntary relocation of villages to make the core of TRs inviolate. NGOs work with locals in some cases to resettle. The village eco-development committees prepare the village micro-plans which become part of the Tiger Conservation Plan for a TR. In India, NGOs work on livelihood options near PAs and efforts to minimize human-wildlife conflict (Karanth et al. 2012; Harihar et al. 2014). Local Advisory Committees for TRs include representatives of public/local communities, ecotourism industry, PA managers, NGOs and district government to decide/regulate/manage the tourism, development, economic practices in core and buffer of TRs. For example, NGOs sometimes aid Local Advisory Committee members in producing recommendations for Tiger Conservation Plans (mandated for TR management). NGOs, in part, continue to represent local community interests as well as forest department mandates to form a bridge between local communities and local management of PAs.

5. Indicators for effectiveness of the network for Conserving Central India

Within the complex milieu of local, state, and national institutional and governance structures, the NCCI provides a platform for all stakeholders and promotes science-based decisions. We identify the following characteristics of the network that affect its ability for input into policy and decision-making: the composition of the network and affiliations of its members; collaborations among members; dissemination of research outputs through social media and coverage in the press. The NCCI is evolving into a bridge institution to address the difficult challenge of fostering bottom-up involvement of local communities to further democratize the top-down decision-making structure.

5.1. Participation in NCCI

For the purposes of our study, we consider NCCI members to be those individuals who attended at least two of the three symposia, voluntarily joined as a member as of November 2018, or participate in a working group. We assigned each member a main affiliation categorized as academic institutions, government institutions (including the Forest Department and government scientific institutions), non-governmental-organizations, and other (e.g. private sector).

NCCI membership numbered 67 as of November 2018. Membership is predominantly composed of researchers (n = 27, 40%) and individuals affiliated with NGOs (n = 26, 39%), with a fewer number of individuals affiliated with government institutions (n = 10, 15% – see Figure 2). We find members have preliminary engagement with local governance or communities surrounding PAs. Many members of the NCCI produce published scientific output (62 peer reviewed articles, see Appendix 1).

5.2. Research collaboration, outreach, and topics

To identify papers authored by NCCI members, we performed a search in 2019 using Google Scholar for each member for papers published in the peer review literature since 2013. We screened the papers to select those which are relevant for central India. For each paper, we identified the co-authors who are also NCCI members. Using the tool from altimetrics (www.altimetrics.com), we recorded for each paper the numbers of mentions on Twitter, policy sources, blogs, and number of times receiving media coverage. We combined Twitter and blog mentions into a total social media score. A drawback of this method is the likely underestimation of media mentions in local and/or non-English outlets. We also categorized each paper into main categories: livelihoods/governance, connectivity and corridors, forest ecology, wildlife ecology, human wildlife conflict, and climate/water/agriculture.

Published research from the NCCI heavily focuses on wildlife (connectivity, wildlife ecology and wildlife conflict). An additional focus is on livelihood studies (Figure 3(a)). Forest ecology is not well represented in the NCCI publications, nor are agriculture and climate change. Only 19 of the members produce 40 such peer-reviewed publications with co-authors from within the network (Figure 3(b)). Authors are primarily researchers and from NGOs (Figure 3(b)). Published authors from NGOs have most co-authors from NGOs (46%). Researchers also have more co-author links among themselves (28%). Only 10% of co-author links between researcher and NGOs members in NCCI. NCCI members published 24 papers with no other NCCI members as co-authors. NCCI as a research platform highlights place-based research from central India within broader research on how local context influences conservation and development. Moreover, place-based research in central India is an example of how conservation and development interact in a human-dominated region. Published research from NCCI highlights the credibility of the network with 57 of the 62 articles with primarily Indian authors.

NCCI members are also producing scientific research that enjoys some press and social media exposure (Figure 4). People share NCCI members' published studies more often on social media than in regular news channels or written press. Certain themes of interest to the general public (for example – human-wildlife conflict or wildlife protection) and novel or controversial results garner more media and social media exposure (Smith et al. 2010). Studies that are pertinent to managers and practitioners can often fall out of news cycles and social-media interest and remain difficult to find. Moreover, there is a time lag between research to publication and outreach. NCCI members can share their findings and accounts of on-ground conditions with managers faster and more effectively than the time-

Table 3. The NCCI (members and on-going work) provides a neutral-ground knowledge-sharing platform that creates bridges among diverse stakeholders from actors of policy to the local governance level (Potential Inputs column). The decision-making is currently top-down and NCCI could foster informed bottom-up approaches as well as allow for informed implementation of top-down policies.

Level of governance	Mandate	Implementation of mandate	Potential input from NGO's and advisors
Central government	Creates and amends laws and policies	Forest, Wildlife and Environmental and social clearances	Influence policy, third-party reviews, public scrutiny of clearances, legal casework
State government	Creates state rules, Implements laws and policies and government schemes	Forest, Wildlife and Environmental and social clearances	Influence policy, third-party reviews, public scrutiny of clearances, legal casework
Local government managers	Prepares plans, implements management actions	Implements laws, policies and government schemes at village level	Influence management plans, liaise with local communities
Formally Recognized Village institutions	Prepare village micro-plans, implements directives at village level	Village committees	Strengthen capacity of communities, communicate ground realities

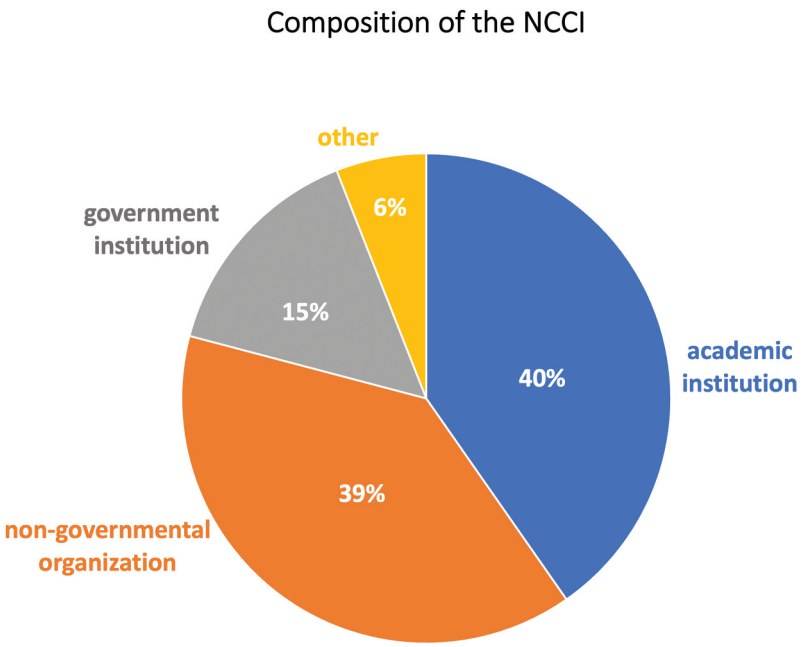

Figure 2. Composition of the NCCI. The Network for Conserving Central India (NCCI) is prominently made of academic institutions (blue) and non governmental organizations (orange). There is representation from government institutions (grey) and other stakeholders (yellow) but in fewer numbers.

consuming publication process (Cook et al. 2013). To date, NCCI members are identifying actionable science for connectivity of wildlife, and there is a growing interest in documenting bottom-up approaches to restoration for livelihoods and wildlife. Such outputs are difficult to measure currently, but indicators will be iteratively added as on-ground interventions take place.

5.3. Participation in policy-setting and top-down decision-making

We identified policy-setting bodies that advise the government at the national, state and local levels by talking to NCCI members who are integrated into these bodies. The policy-setting bodies are primarily advisory in nature and do not have decision-making capacities. We then identified the main mechanism of environmental decision-making as that of forest, wildlife and environmental clearances for developmental projects, in line with India's agenda to further economic growth over the last few decades. The opportunities for third-party involvement within the forest, wildlife and environmental clearances are predominantly through participation in Expert Committees. The expert committees are sometimes also involved in decision-making appraisals within PAs (including TRs), ESAs, critical wildlife/tiger habitats and PA multi-use buffers. We then identified eight members of the NCCI that have been part of these policy-setting and decision-making bodies by two open calls on social media and a few follow-up conversations with the eight members who responded to ascertain their level of engagement.

In the central Indian region, the opportunities for NCCI members to influence policy and decisions are predominantly reactive through expert opinions of already existing clearance documents (Table 3). Some of these expert appraisals at the district level occur prior to on-ground surveys or construction of infrastructural projects and could influence planning at the landscape level. NCCI members are part of decision-making in the environment, forest and wildlife clearance committees and engage at both the national and state level. However, only a few (8) NCCI members are involved across the chain of third-party or expert appraisal for clearances (Figure 5).

To utilize the information gathered on the NCCI thus far, we formulate a preliminary set of indicators to guide priorities for NCCI and track progress in our efforts to foster bottom-up approaches for long-term place-based goals. Additionally, we provide the current assessment of our indicators (Table 4).

6. NCCI's role in boundary work and as a bridging organization

In central India, local communities are rarely part of the decision-making process and are more likely to be involved in providing consent for decisions that managers and authorities have made for them (Agrawal and Gibson 1999; Agarwal et al. 2016). The NCCI struggles with the top-down reality while fully acknowledging, as do many officials in government, that without local communities as equal and leading actors the success of any policies is likely to be short-lived at best and

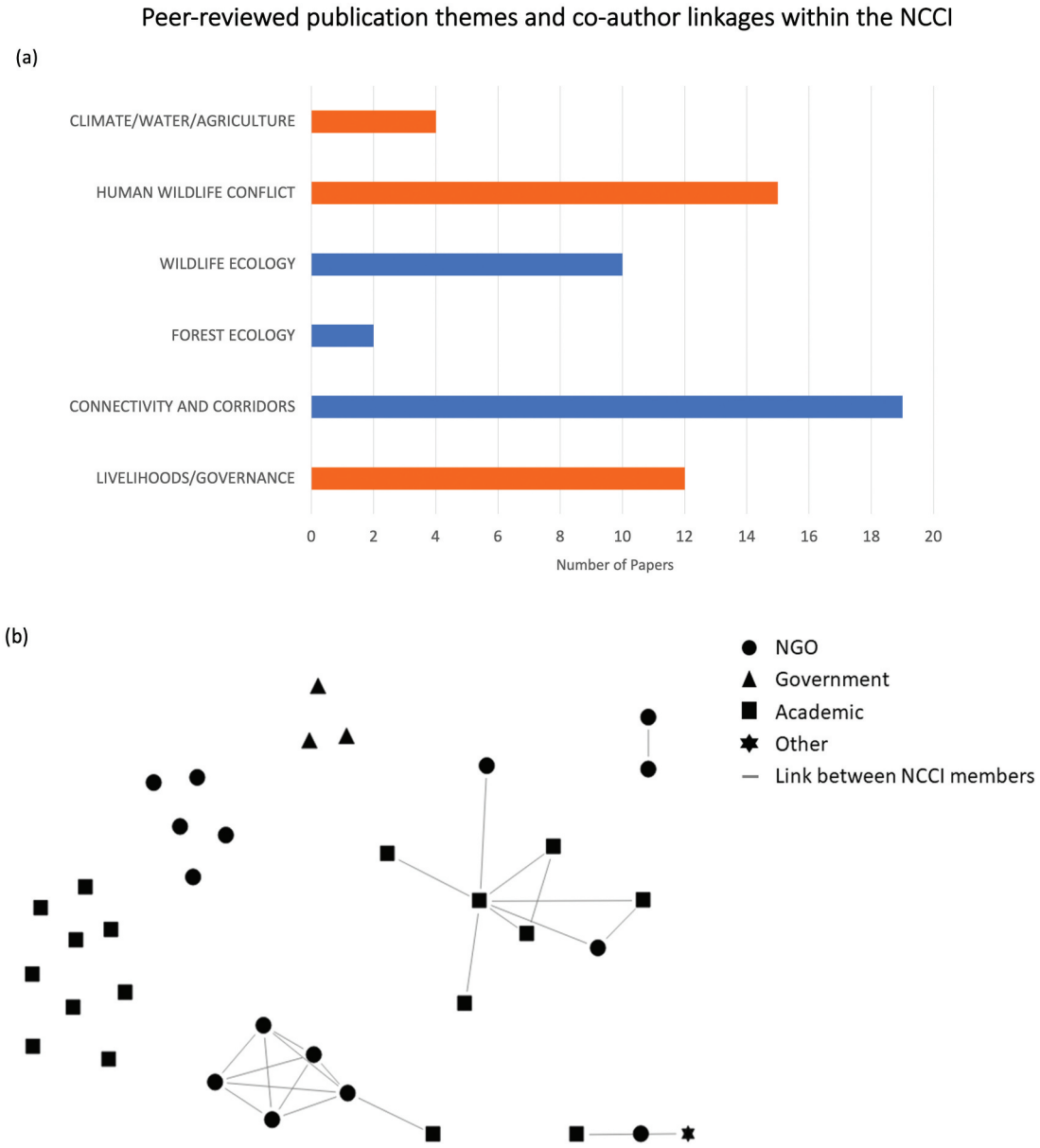

Figure 3. Peer-reviewed publication themes and co-author linkages within the NCCI. (a) Peer reviewed publications (n = 62) from members of the NCCI are wildlife centric (blue) with an applied science focus on livelihoods (orange) as well. Publications on climate change, agriculture and forest ecology are not as many. (b) Scientific outputs (62 peer reviewed publications) from 36 members of the NCCI mirror the stakeholders most represented in the NCCI: Some researchers and NGO members are highly linked with each other as co-authors, whereas many members are publishing with co-authors outside of the NCCI. 19 members of the NCCI are co-authors on publications relevant to central India. For (b) co-authors from NCCI network map: circle = NGO, triangle = government, square = academic, star = other, grey lines = link between NCCI members. We used Social Network Visualizer to produce the graphic.

wholly inadequate as well as unjust at worst. The key contribution from NCCI so far has been to provide an equal platform for all to share knowledge and plan for goals within a social-ecological framework, within a reality where not all actors are able to access such a platform. The NCCI platform allows researchers from separate disciplines to come together on multi-disciplinary issues that are pertinent to the work of NGOs and decision makers – spanning multiple boundaries and with multiple NCCI members performing bridging roles. Indicators described above do not assess the need for institutions that enable local communities to participate fully in decision-making processes. Based on the importance of multiple institutions and the need to strengthen local institutions, more attention to engagement in bottom-up policy and decision-making is a priority for NCCI (Ostrom 2012; Baird et al. 2019). Collaborations with NGOs within the NCCI are providing valuable inputs and forming bridges for local communities to be involved in local management of resources as well as interactions with government bodies. Most wildlife and resource-centered NGOs actively seek and build relationships with a diverse group of stakeholders (including local

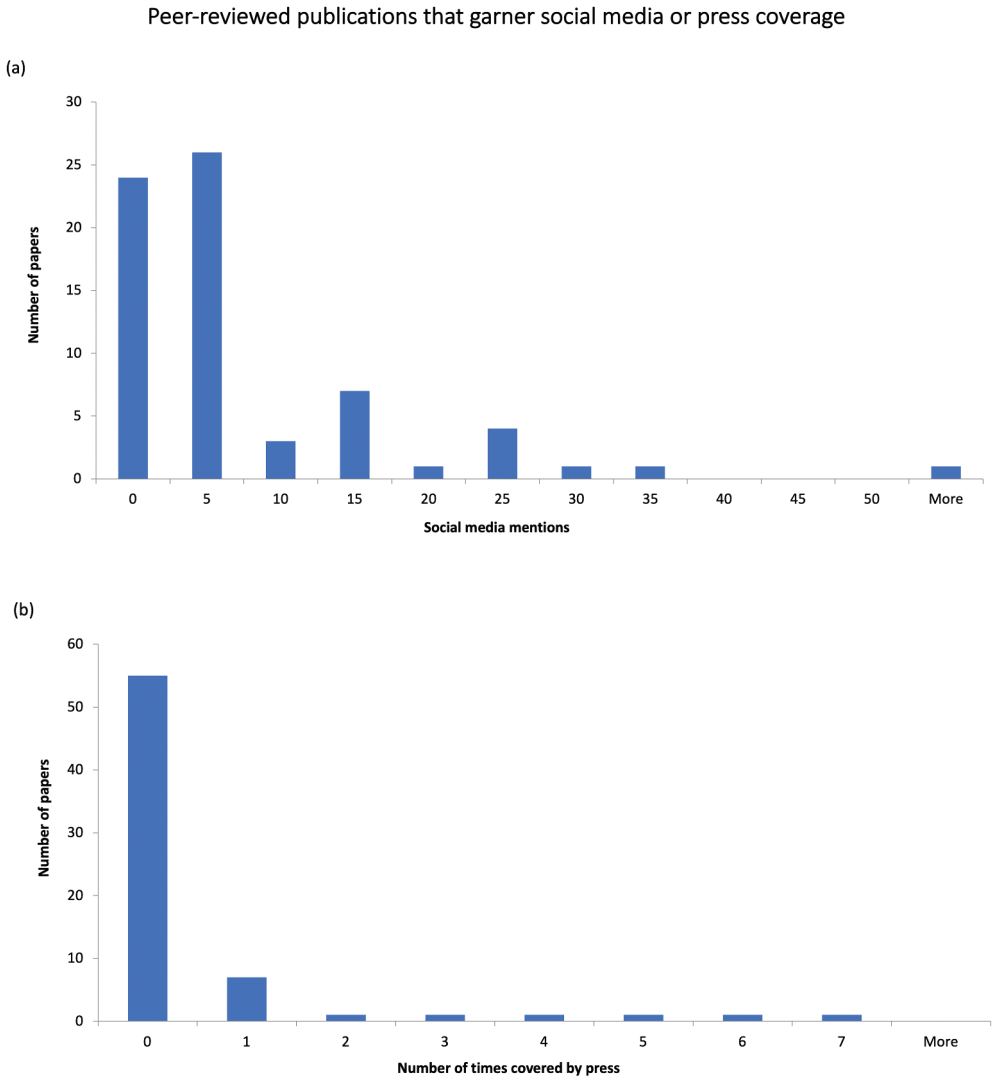

Figure 4. Peer-reviewed publications that garner social media or press coverage. (a) 65% of papers enjoy some social media mentions; and (b) 19% of papers enjoy some press coverage.

communities as well as industry and land managers) to set long-term goals.

Our results highlight that almost all avenues to interact with environmental policy and decision-making are in response to threats through clearance processes of already planned infrastructure. The lack of proactive avenues is a critical feature of the nation-wide institutional structure that restricts NCCI members from engaging with and anticipating decisions that lead to threats to wildlife and local community well-being. A particular challenge is the frequency of changes in government officials and staff at NGOs (Agarwal et al. 2017). Future work within the network might be to build trust and collaboration that would enable involvement in proactive planning. The reactive opportunities in policy and decision-making also adversely affect landscape level planning. For example, in the central Indian region, the primary focus for conservation remains maintaining populations of tigers (*Panthera tigris*) and scientists working in the region have provided a wealth of information on spatial and genetic requirements for tiger conservation. In addition to the inter- and intra-protected area dynamics of genetics, the science is clear on the importance of habitat connectivity for tigers in the region (Dutta et al. 2015; Krishnamurthy et al. 2016; I. Mondal et al. 2016; Reddy et al. 2017; Thatte et al. 2018; Yumnam et al. 2014). India is recognized as pivotal to tiger conservation as more than 70% of the world's tigers reside in the country. Central India remains a crucial region for the continued well-being of India's tiger population and there remains tremendous pressure on these PAs for natural resource while also providing for local economies via eco-tourism (including wildlife tourism). A proactive opportunity for the science to inform infrastructure planning for the region would have enabled an environment for landscape or regional planning for multiple goals for the long term. Additionally, we recommend that co-production among local communities, NGOs, researchers, and government officials would recognize the need for

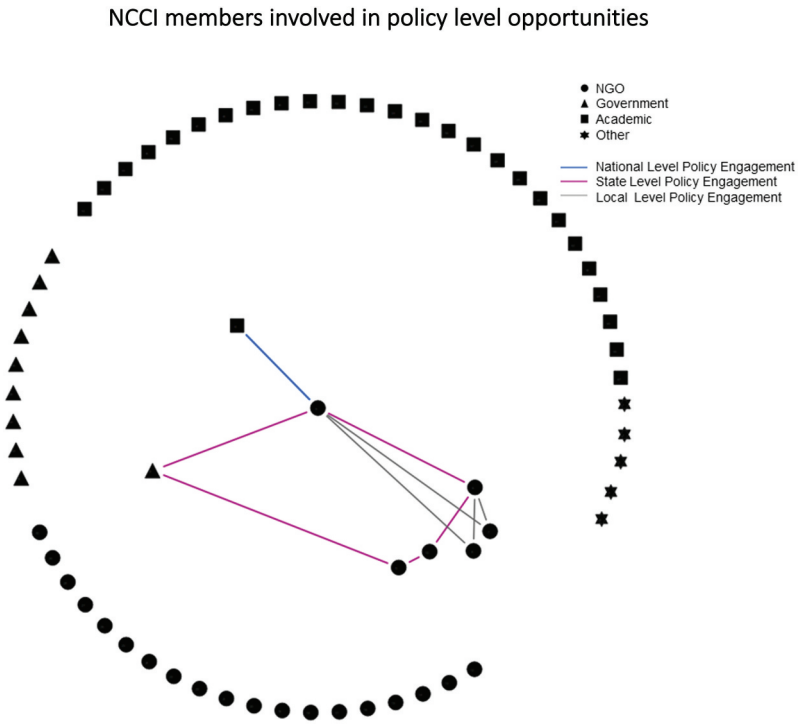

Figure 5. NCCI members involved in policy level opportunities. NCCI has a few individual members (8) that are involved at national (blue interaction), state (pink interaction) and local (grey interaction) level policy opportunities. Only one academic (square) and one governmental (triangle) NCCI member were involved in policy opportunities, with all other members involved in the policy sphere from the NGO category (circle). NCCI members that are not part of government, academia or NGOs are depicted by stars. We used Social Network Visualizer to represent these relationships.

Table 4. Indicators and preliminary assessment to guide NCCI priorities. NCCI will use indicator assessment to track progress and foster bottom-up approaches for place-based conservation that includes local development.

Indicator	Assessment
Diversity of affiliations in NCCI	Good representation from academic (40%) and NGOs (39%); Relatively low membership (15%) from government institutions
Co-authorship on papers	61% of paper published co-authored with NCCI members. No co-authorship with members from government institutions.
Breadth of research topics	Most (30%) papers on corridors and connectivity; and human wildlife conflict 24%); least on climate/water/agriculture (6.5%) and forest ecology (3%)
Outreach from research	19% of paper received press attention and 65% of papers received social media mentions
Participation in policy and decisions	12% of members engaged in decision-making bodies; few opportunities for participation in top-down policy setting; engagement with local communities through NGOs

landscape planning in a multidisciplinary way. So far, NGOs that are part of the NCCI perform bridging roles between local communities and other actors in the landscape. Moreover, NGOs operate within the boundary between local community concerns and decision makers – a boundary that remains challenging due to top-down hierarchy in decision-making. Two examples of topics that would benefit from a process of co-production are eco-tourism for local economies to benefit and linear infrastructure for conservation and development of the region.

Currently, co-production is entirely dependent on the abilities and capacity of government officials to solicit guidance from interested and present NGOs and academic researchers. Specific co-production planning opportunities at the national or state level are not common. Some inputs are solicited by the Biodiversity Management, JFM and Eco-Development Committees around PAs at the local level but these are used to enhance local biodiversity registers, village micro-plans and other local conservation and resource management plans (pers. comm. Mandar Pingale, member of the NCCI and assistant director at NGO Satpuda Foundation). Governmental initiatives such as the Local Advisory Committees and Biodiversity Management Committees can aid in co-production at the landscape level.

Tightly woven conservation and human-needs in human-dominated landscape require multidisciplinary and action-oriented networks, realized as the NCCI for central India (Keough and Blahna 2006; DeFries et al. 2010). Networks of NGOs alongside other stakeholders are especially important for local communities who have few avenues to engage in policy and decision-making even at the local scale. NGOs perform a crucial role in providing a bridge

for local wildlife and people related concerns to researchers and government officials who make decisions on policy implementation. NGOs working with local communities are a priority in the NCCI. Researchers now recognize that conservation is a people-centric field and conservation cannot achieve its goals in the absence of enhancing well-being of the most vulnerable peoples within PA landscapes (West and Brockington 2006; Oldekop et al. 2016).

7. Conclusions

We explore collaboration within the NCCI and characterize the main actors from a landscape management perspective. Our analyses specifically capture the conservation issues that are most often the focus of work within the NCCI – livelihoods, human-wildlife conflict and ecological science on vulnerable species. We also explore how we are translating these scientific outputs for wider audiences via press and social media. Additionally, given the top-down reality of central India, we assess the potential for NCCI to leverage existing structures to co-produce landscape and region pertinent science, management and advocacy support. However, only with tracking all of these aspects of the network and documenting outcomes of policies will we be in a position to recognize the long-term effectiveness of the NCCI for conservation in central India (Keough and Blahna 2006; Poocharoen and Wong 2016). In our final recommendations, we stress that formalizing opportunities for co-production while including local communities is key to long-term conservation and development in regions such as central India. Our results from this analysis show that NCCI effectiveness can benefit from lessons learned from other multi-level networks with varied goals – such as the ecosystem-based management of the national pilot project by the Swedish Environmental Protection Agency (Bodin et al. 2017) and the growing body of social-ecological networks to address on-the-ground challenges (Sayles et al. 2019).

In assigning a network coordinator and forming thematic working groups, perhaps a coordinated heterogeneity approach could be effective for the goals within the central Indian region (Bodin et al. 2017; Kettle et al. 2017). NCCI's effectiveness as an evolving landscape collaborative grew from initial discussions, time spent collaborating to create trust and a testing ground for future science as well as management (Poocharoen and Wong 2016). NCCI also mirrors networks elsewhere in the world with the realization of the importance of stakeholders including industry and multi-role network members (Brody 2003; Turnhout 2009; Kettle et al. 2017; Scarano et al. 2019). The continued efforts of the NCCI on-the-ground as well as in measuring our effectiveness contribute to place-based conservation and our understanding of how such networks might be successful in the long term.

Conservation landscapes in heavily human-dominated landscapes with legacies of top-down management, such as central India, present challenges for co-production processes that might not be present in less human-dominated landscapes with more established institutions for local engagement. We suggest that measures such as the ones identified in our study can track the long-term progress of landscape collaboratives in similar realities.

Acknowledgments

We thank the two anonymous reviewers for their very helpful and clear feedback. We thank Neeraj Vagholikar (Kalpavriksh) for explanations of overall environmental decision-making structures in India and Mandar Pingle (Satpuda Foundation) for specific inputs on the local decision-making bodies for biodiversity and management. We also thank Ishan Agrawal (Foundation for Ecological Security) for his valuable input on village level institutional diversity and understanding of commons in central India. The Network for Conserving Central India is funded by the DeFries Bajpai Foundation with 501C(3) status. The source of the funds in the DeFries Bajpai Foundation is the unrestricted award from the MacArthur Foundation to Ruth DeFries in 2007.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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