



MONASH University

Private Land Initiatives for Biodiversity Conservation: The Case of Conservation Covenants

Julie Elizabeth Groce

BA Zoology
MSc Wildlife and Fisheries Sciences

A thesis submitted for the degree of Doctor of Philosophy at

Monash University in 2018

School of Biological Sciences

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Abstract

Conservation covenants are multi-party, permanent agreements with the goal of protecting biodiversity values on private lands. Landholders with conservation covenants are therefore making long-term commitments to maintain those values over time through on-going land stewardship. It is therefore essential to understand what factors support landholders to sustain management action within these perpetual agreements. Although the factors that influence pro-environmental decision-making with regards to initial program participation or adoption of management practices in production landscapes have often been studied, there is a gap in our understanding about what leads to sustained conservation action. To fill this gap, I used a mixed methods approach to investigate the perspectives and management activities of landholders with conservation covenants on their properties in Australia. Drawing on a conceptual framework that identifies key elements in sustained pro-environmental behavior in agricultural landscapes, I investigated the landholders' *willingness* to covenant and undertake management activities, their *ability* to do so, and their *engagement* with support networks. It is at the nexus of these elements – willingness, ability, and engagement – where sustained management action is most likely to occur. Additional insights gained through interviews with covenant provider staff, representing the authorizing party to the agreement, helped contextualize landholder perspectives. This study is the first to examine factors that influence the ongoing commitment of covenanted landholders across Australia to manage their land for conservation, based on their detailed perspectives of the benefits they derive and challenges they face.

My assessment of landholder positions within the conceptual framework reveals critical strengths and weaknesses of covenanting programs. The findings suggest that, despite wide diversity in landholder characteristics and contexts, most covenanted landholders remain committed to the program and are willing to continue with management activities. However, many landholders face barriers to their ability to manage, and desire greater engagement with sources of management support. Lack of willingness, ability, and engagement among the growing pool of successive owners, who did not have the opportunity to negotiate covenant terms, is more pronounced than for original signees. Differences between original and successive owners, and additional challenges faced by covenantors as they age or do not live on the property, suggest growing risks to the longevity of covenanting programs that will need to be managed into the future. My analysis of where landholders are positioned within the framework offers opportunities to design strategies that can move them towards a more sustainable position. With targeted support and

encouragement that removes barriers to their ability and engagement, many landholders can shift to where positive environmental outcomes are most likely to occur.

Covenant providers are best placed to support the landholders, given their involvement in the covenant and management plan development and landholders' desire for greater connection with them. Additional and consistent resources for the covenant providers – in line with the continued increase in covenanted properties – would increase their capacity to bolster the ability and engagement of landholders. With covenanting programs in Australia involving thousands of landholders and continuing to be promoted by federal and state governments, it is essential to continue assessing the landholders' willingness, ability, and engagement over time and find opportunities to empower the landholders in ways that facilitate positive environmental outcomes.

Declaration

This thesis contains no material which has been accepted for the award of any other degree or diploma at any university or equivalent institution and that, to the best of my knowledge and belief, this thesis contains no material previously published or written by another person, except where due reference is made in the text of the thesis.

Signature:

A solid black rectangular box used to redact the signature.

Print Name: Julie Elizabeth Groce

Date: 9 July 2018

Publications during enrolment

Chapter 6 Groce, J.E., M.A. Farrelly, B.S. Jorgensen, and C.N. Cook. 2018. Using social-network research to improve outcomes in natural resource management. *Conservation Biology*. In press.

Thesis including published works declaration

I hereby declare that this thesis contains no material which has been accepted for the award of any other degree or diploma at any university or equivalent institution and that, to the best of my knowledge and belief, this thesis contains no material previously published or written by another person, except where due reference is made in the text of the thesis.

This thesis includes one original paper in press in a peer reviewed journal and three unpublished papers intended for submission in peer reviewed journals. The core theme of the thesis is conservation management on private lands. The ideas, development and writing up of all the papers in the thesis were the principal responsibility of myself, the student, working within the School of Biological Sciences under the supervision of Dr. Carly Cook.

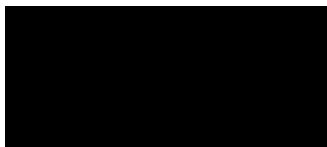
(The inclusion of co-authors reflects the fact that the work came from active collaboration between researchers and acknowledges input into team-based research.)

In the case of chapters 3, 4, 5, and 6, my contribution to the work involved the following:

Thesis Chapter	Publication Title	Status	Nature and % of student contribution	Co-author names Nature and % of Co-author's contribution	Co-authors, Monash student Y/N
3	Landholder motivations to secure and maintain conservation covenants	Not yet submitted	Design, data collection, data analysis, and writing of manuscript 80%	- Carly Cook: design, analysis, contributions to writing, 10% - Megan Farrelly: design, analysis, contributions to writing, 5% - Bradley Jorgensen: design, analysis, contributions to writing, 5%	No
4	Landholder ability to sustain management activities on private protected areas	Not yet submitted	Design, data collection, data analysis, and writing of manuscript 80%	- Carly Cook: design, analysis, contributions to writing, 10% - Megan Farrelly: design, analysis, contributions to writing, 7% - Bradley Jorgensen: design, contributions to writing, 3%	No
5	Engagement with information and support by landholders of private protected areas	Not yet submitted	Design, data collection, data analysis, and writing of manuscript 80%	- Carly Cook: design, analysis, contributions to writing, 10% - Megan Farrelly: design, contributions to writing, 3% - Bradley Jorgensen: design, analysis, contributions to writing, 7%	No
6	Using social-network research to improve outcomes in natural resource management	In press	Design, data collection, data analysis, and writing of manuscript 80%	- Carly Cook: design, analysis, contributions to writing, 10% - Megan Farrelly: contributions to writing, 5% - Bradley Jorgensen: contributions to writing, 5%	No

I have renumbered sections of submitted or published papers in order to generate a consistent presentation within the thesis.

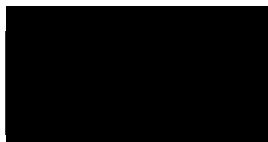
Student signature:



Date: 9 July 2018

The undersigned hereby certify that the above declaration correctly reflects the nature and extent of the student's and co-authors' contributions to this work. In instances where I am not the responsible author I have consulted with the responsible author to agree on the respective contributions of the authors.

Main Supervisor signature:



Date: 9 July 2018

Acknowledgements

This research was supported by an Australian Government Research Training Program Scholarship.

After 15 years in wildlife research, I thought “wouldn’t it be interesting” to shift my focus from birds and mammals and mussels to the human side of conservation. I wanted to gain a better understanding about the decisions people make with regards to conserving biodiversity and about the people making those decisions. Doing so required exiting my comfort zone of quantitative data collection and analysis and entering qualitative research, and I am thankful for this opportunity to view the amazing complexities of language and behavior in a new light.

I am equally thankful to the people who encouraged me along the way. To Carly, for seeing the potential in me as a student and showing endless enthusiasm for my research. To Megan and Brad, for helping to teach me about – and developing in me a huge appreciation for – social research. To my family, for always being on side with my pursuits, although perhaps never fully understanding what I’m up to. To my friends back in the US, for not letting distance get in the way of good conversations. To Jayne, for making sure I keep things in perspective, and sharing ‘the sis’.

Daily support, in so many forms, came through the incredible friendships made in the past four years. Georgia, sharing home life with you has been a saving grace and made my transition to Australia and into PhD life all the more easy. You’ve known when to let me cry or make me laugh or break out the wine. Stef, you’ve been a source of encouragement since day one and a great influence on me as an individual. Em, your abundance of smiles and positivity, and early morning drive-to-campus venting sessions, have been invaluable. So many others have helped through laughs, distractions, dessert excursions, brunch excursions, bird watching, and conversations of anything not to do with work: Kelsey, Mel, Hayley, Qam, Steve, Rowan (also for the homemade standing desk!), Matthew, Anita, Keirnan, Yardenah, John/Stan, Shiv, Nancy, Sonia, Cathy, Toby, Fran, Cath, Helena, and Louise. Thanks Jess, for being excited about my project from the moment we met, and sharing your wisdom since then. Thanks Margreet, for commiserating over the struggles of delving into the social sciences, and doing so over cake. Andy, you appeared at the end but helped immensely in getting me through the final months with writing breaks, home-cooked meals, and giving me something to look forward to when this “phud” is finished. Thanks also to yoga classes, magpies and currawongs in the backyard, and sunny mornings on the back steps.

Finally, an enormous thank you to the landholders and staff, for being so generous with your time, your stories, and your cups of tea. I hope I’ve done justice to your words.

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CHAPTER 1: General introduction

“The disconnect between our biological knowledge and conservation success has led to a growing sense... that social factors are often the primary determinants of success or failure. Although it may seem counterintuitive that the foremost influences on the success of *environmental* policy could be *social*, conservation interventions are the product of *human* decision-making processes and require changes in *human* behavior to succeed. Thus, conservation policies and practices are inherently social phenomena, as are the intended and unintended changes in human behavior they induce.” (Mascia et al. 2003)

The conservation of biodiversity is an ongoing process, requiring long-term commitment from the level of national governments to individual people alike. At the individual level, influences on decision-making and behavioral change have long been a focus within social psychology research and have extensive application to understanding pro-environmental attitudes and behaviors (Harry et al. 1969; Kollmuss & Agyeman 2002; St. John et al. 2010). Studies of pro-environmental behavior have found that while initial change in behavior is important (e.g., a decision to participate in a conservation program), the behavior needs to be sustained long-term to achieve enduring conservation outcomes (St. John et al. 2010; Dayer et al. 2017). This is particularly apparent with regards to private working landscapes (e.g., farms, ranches, forest lands), where individuals are continually involved in decisions that can impact the short- and long-term outcomes of their property and neighboring areas (Knight 1999; Wilcove et al. 2004).

Based on a review of studies into pro-environmental behaviors of farmers, Mills et al. (2017) developed a conceptual framework of the factors that can influence “sustained and durable management action”, broadly categorized as: (1) willingness to adopt an action, (2) ability to do so, and (3) engagement with support networks to facilitate their activities. Mills et al. (2017) found that it is at the nexus of the three factors where sustained action is most likely to occur (Fig. 1.1). Other reviews, either of environmental management by landholders or of behavioral change in general, have arrived at the same fundamental concepts that can impact sustained action, described as: an individual’s attitudes, motivations, perceived abilities, and habits (all related to willingness), their resources (related to ability), and external influence or support (related to engagement) (e.g., St. John et al. 2010; Kwasnicka et al. 2016; Swann & Richards 2016; Dayer et al. 2017).

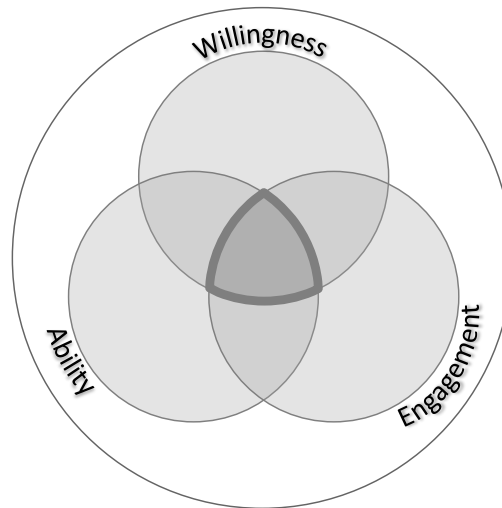


Figure 1.1. Three categories of factors influencing landholders' decisions about pro-environmental management of their properties, including willingness to act, ability to act, and engaging with information and advice. The central overlap of factors suggests circumstances where landholders are most likely to persist with pro-environmental management practices. Figure adapted from Mills et al. 2017.

In the context of land management, willingness may include attitudes about the concept of conservation or personal beliefs about the value of environmental action. An individual's willingness to act towards conservation goals is often examined through their motivations and associated attitudes (e.g., Theory of Planned Behavior [Ajzen 1991; Brain et al. 2014]), values, and norms (e.g., Value-Belief-Norm theory [Stern et al. 1999; Stroman & Kreuter 2015]). However, much of this research field has focused on initial participation (e.g., decision to enroll in a program or adopt a practice) rather than sustained action (reviewed in Dayer et al. 2017). Ability encompasses characteristics and resources of the landholder, property, or environment, such as having sufficient personal finances and physical capacity, the size of the property or bio-geographical conditions (e.g., terrain), any of which can facilitate or constrain the landholders' ability to manage the property (e.g., Jellinek et al. 2013; Meadows et al. 2014). Finally, landholder engagement includes their pursuit of information, advice, and who they connect within the process (e.g., covenant providers, other landholders). Social connections can open avenues for support and may help improve conservation outcomes (Rissman & Sayre 2012). The importance of social networks in facilitating or discouraging behavior has been well recognized and is gaining increasing attention in understanding the functioning of social-ecological systems (e.g., Guerrero et al. 2015).

As private lands have become more relevant in protected area networks for biodiversity conservation (Stolton et al. 2014), it is essential to understand the reasons for landholder involvement in conservation programs and their commitment to conservation outcomes. Protected areas provide for the long-term conservation of natural resources and aid significantly in slowing biodiversity declines (Taylor et al. 2011; Bertzky et al. 2012). Private land conservation initiatives are an essential element in reducing the loss of biodiversity, through complementing public protected areas and enabling landscape-scale conservation approaches that target important natural ecosystems (Bingham et al. 2017). To encourage private landowners to conserve biodiversity on their properties, mechanisms and programs have been developed that range from regulatory restrictions imposed on land use to voluntary strategies adopted by willing landowners (Kamal et al. 2015). Broadly, these initiatives aim to protect biodiversity and improve ecological conditions through promoting environmentally-friendly practices or disallowing damaging land uses (e.g., European Commission 2005; Cheever & McLaughlin 2015).

Conservation covenants (also known as conservation easements) are a popular mechanism for private land conservation and have become an essential component of expanding the global protected area network (Stolton et al. 2014). Conservation covenants (hereafter covenants) are a legal agreement between a willing landholder and a government agency or land trust, with the purpose of permanently protecting the natural or cultural values on the landholder's property (Kamal et al. 2015). They are increasingly common in countries with high proportions of private lands, such as Australia (Figgis 2004), Brazil (Chiavari & Lopes 2015), Canada (ECCC 2016), several Latin American countries (SEPA Project 2007a, b), New Zealand (Saunders 1996), and the USA (Pidot 2005). Covenants are typically binding on the property title such that the land use restrictions and any management obligations associated with the covenant apply to existing landholders and transfer to future owners (Saunders 1996; Figgis 2004; Cheever & McLaughlin 2015).

Using conservation covenants in Australia as a case study, I examine how the framework presented by Mills et al. (2017) applies to long-term conservation management by landholders responsible for covenanted properties. I assess where covenanted landholders are positioned within the framework (Fig. 1.1) in relation to their willingness, ability and engagement, and what actions may need to be taken to support landholders to move

toward the nexus of these elements, where ongoing management activities are facilitated and sustained.

The fact that covenants are binding agreements and involve a wider variety of landholders (e.g., lifestyle owners) and motivations for participation (e.g., Kabii & Horwitz 2006) make them different from farmer-focused programs and/or non-binding agreements that are typically the foci in previous work (e.g., see reviews by Dayer et al. 2017; Mills et al. 2017). Furthermore, although the covenant itself is permanent, it is unknown to what extent that permanency translates to ongoing, on-ground management. Active management (e.g., pest control, revegetation) is generally needed on covenanted properties to maintain remnant native vegetation or restore degraded areas (O’Connell and Noss 1992; Stroman & Kreuter 2015). These activities require ongoing commitments by current and future owners. Yet a large portion of research to-date has focused on initial landholder participation. Scant attention has been given to the long-term outcomes of covenants, such as whether covenanted landholders continue to be environmental stewards of their properties in accordance with their covenant agreements, or whether their perspectives about the covenants change over time or are the same as new (i.e., successive) owners (Farmer et al 2017). Through the use of qualitative and quantitative methods, my research explores several aspects of conservation covenants in Australia from the perspectives of landholders involved in covenanting programs (hereafter covenantors). Active stewardship depends on the covenantors, thus it is essential to understand their perspectives on the programs, the challenges they face, and how these relate to their ability to meet their management obligations.

Conservation covenants in Australia

Australia is home to a wide diversity of endemic and unique species, habitats, and landforms (Cresswell & Murphy 2017) but also has one of the highest rates of extinction in the world (Woinarski et al. 2015; Waldon et al. 2017). Loss of biodiversity is attributed to numerous, widespread threats, including predation by non-native species (e.g., feral cats [*Felis catus*] and red foxes [*Vulpes vulpes*]; Woinarski et al. 2015) and habitat loss via changes in land use or fire regimes (Evans et al. 2011; Allek et al. 2018). Investments by the Australian Government in natural resource management – to promote sustainable land management

practices and conserve biodiversity – increased notably at the national level in the early 1990s (Cresswell & Murphy 2017); investments of varying amounts have continued through to the present, although the focus and goals of the environmental programs shifts every few years (Hajkowicz 2009; Cresswell & Murphy 2017). The National Landcare Programme, Natural Heritage Trust, Caring for our Country, and most recently the Biodiversity Fund have been major funding mechanisms for the protection and management of natural resources on private lands, primarily administered at the state-, territory-, and regional-levels, with some funds specifically allocated to covenanting programs (Cresswell & Murphy 2017).

The primary strategy in Australia for biodiversity conservation has been through establishing parks, reserves, and protected areas within the National Reserve System (NRMMC 2009), currently covering nearly 20% of the country (Australian Government 2018a). It is recognized, however, that achieving a “comprehensive, adequate and representative system of protected areas” requires, in addition to public protected areas, the dedication of some private lands to biodiversity conservation (NRMMC 2009, p. 23), such as through conservation covenants. Approximately 60% of the land in Australia is privately owned (Cresswell & Murphy 2017), thus conservation covenants provide opportunities to protect species and ecological communities underrepresented or absent from the National Reserve System (Fitzsimons 2015).

Conservation covenants and easements have been part of the conservation landscape of Australia for decades (Figgis 2004) and continue to be promoted as an option to protect biodiversity (e.g., Australian Government 2018b). In Australia, a conservation covenant is

“a voluntary agreement made between a landholder and an authorised body (such as a Covenant Scheme Provider) that aims to protect and enhance the natural, cultural and/or scientific values of certain land. The owner continues to own, use and live on the land while the natural values of an area are conserved by the landholder in partnership with the Covenant Scheme Provider [which] can be not-for-profit organisations, government agencies or local Councils...” (Australian Government 2018b).

The major covenanting programs occur at the level of states and territories, with additional, smaller programs at national and local levels (e.g., administered by local government; Sunshine Coast Council 2017), and not all are accepted as part of the National Reserve System (Fitzsimons 2015). Each state and territory has different legislation for, approaches

to, and administration of conservation covenants (Table 1.1; Fitzsimons 2015). Specific details – restrictions and allowances – can vary by property but typically involve restrictions on certain land uses and development (Figgis 2004). Additional management obligations by the landholder may be agreed to but are only legally binding if written into the covenant (Fitzsimons and Carr 2014).

Covenants are registered on the land title and are intended to remain in place through successive property owners (Fitzsimons & Carr 2014). Although covenants can be removed, or “released”, it requires authorization by all parties to the agreement and has rarely occurred (Hardy et al. 2017). Along with the landholder, Covenant Scheme Providers (hereafter covenant providers) are one of the parties to the agreements, representing the environment Minister or government representative under the relevant legislation and administering the covenanting programs (Cowell & Williams 2006). The providers thus have an obligation to ensure the covenants are enforced and management takes place, necessitating their continued engagement with covenantors and their management plans (Cowell & Williams 2006).

Although the majority of conservation covenants have been entered into voluntarily in Australia (Cowell & Williams 2006), covenanting may also be required as a condition of subdivision or other development approval (i.e., conditional covenants), such as in South Australia (NVC 2017) and Western Australia (WA Planning Commission 2017), or as an offset for native vegetation clearance, such as in Victoria (DSE 2007), Tasmania [NCHD 2015], New South Wales [OEH 2017], and Queensland [DES 2018]). An additional and more recent approach to covenanting is through revolving fund programs, in which a nonprofit organization purchases a property with conservation value and resells with a covenant in place or on the condition that the new owner enter into a covenant (Hardy et al. 2018). These options, along with financial incentive payments (e.g., Iftekhhar et al. 2014) and the availability of rate and tax relief for covenanted properties (Figgis 2004; Smith et al. 2016), have encouraged participation in covenants by landholders with varying degrees of conservation-related motivations.

Table 1.1. Major covenanting programs¹ in Australia, including coverage, administration, and legislation. Number and area of covenants are from Fitzsimons 2015 for private individual covenants. Data in the Table pertain to the time when thesis research commenced; footnotes includes changes since that time.

State	Program	#	Area (ha)	Administered by	Legislation
New South Wales	Voluntary Conservation Agreements Program ²	367	143,050	Office of Environment & Heritage ³	National Parks and Wildlife Act 1974
New South Wales	Nature Conservation Trust covenants ²	73	16,687	Nature Conservation Trust ³	Nature Conservation Trust Act 2001 ⁴
New South Wales	Registered Property Agreements Program ²	237	44,150	Office of Environment & Heritage ³	Native Vegetation Act 2003 ⁴
Northern Territory	Voluntary conservation covenant program	2	640	Parks and Wildlife Commission NT	Land Title Act 2007; Territory Parks and Wildlife Conservation Act 2014
Queensland	Queensland Nature Refuge program	453	3,438,004	Department of Environment and Heritage Protection ⁵	Nature Conservation Act 1992
South Australia	Heritage Agreement Program	1,518	643,631	Department of Environment, Water and Natural Resources ⁶	Native Vegetation Act 1991
Tasmania	Private Land Conservation Program	703	83,644	Department of Primary Industries, Parks, Water and Environment	Nature Conservation Act 2002; Land Titles Act 1980
Victoria	Trust for Nature Conservation Covenants	1,242	53,370	Trust for Nature	Victorian Conservation Trust Act 1972
Western Australia	Nature Conservation Covenant Program	169	17,386	Department of Parks and Wildlife	Transfer of Land Act 1893; Conservation and Land Management Act 1984
Western Australia	National Trust of Australia (WA) Conservation Covenant Program	162	17,879 ⁷	National Trust	National Trust of Australia (WA) Act 1964
Total		4,926	4,458,441		

¹ Additional programs that offer(ed) in-perpetuity and fixed-term covenants include: New South Wales's Property Vegetation Plans administered by the Catchment Management Authority; Queensland's Voluntary conservation agreement programs administered by several southeast local councils (Gold Coast, Sunshine Coast, Moreton Bay, Brisbane City, Logan City, Cairns Regional); Victoria's Land Management Co-operative Agreements administered by Department of Environment, Land, Water & Planning; and Western Australia's Soil and Land Conservation Covenants administered by Department of Agriculture and Food.

² Renamed under the Biodiversity Conservation Act 2016; <https://www.bct.nsw.gov.au/i-have-an-existing-agreement>

³ Now administered by the Biodiversity Conservation Trust

⁴ Replaced with the Biodiversity Conservation Act 2016

⁵ Now Department of Environment and Science

⁶ Now Department for Environment and Water

⁷ Extent of bushland (natural habitat). Total area covenanted (included cleared land) is 64,381 ha.

At the time of data collection for this research, there were approximately 5,000 conservation covenants in Australia covering 4.5 million hectares and involving thousands of landholders and land managers (Fitzsimons 2015). Covenantors can include private individuals or groups of individuals, non-governmental organizations, and companies or corporations, but in this research I have focused on the individually-owned covenants established through the major, state-level covenanting programs (Table 1.1). The distribution of these covenants follows that of freehold land (Hajkowicz & Young 2002), with the majority in the east, south, and southwest of the continent (Fitzsimons 2015). The use of covenants continues to be promoted by the Australian Government (Cresswell & Murphy 2017) and the number of covenants continues to grow (e.g., there were 867 covenants in Tasmania as of June 2018; DPIPWE 2018).

Thesis objectives

Through a mixed methods inquiry of covenanted landholders and covenanting agencies in Australia, I explore the willingness, ability, and engagement with support networks of landholders and their commitment to long-term involvement in covenanting obligations and land management activities. Using Mills et al.'s (2017) framework for the covenanting context, I examine: (1) willingness to initiate a covenant and maintain the obligations, (2) ability to maintain the obligations and/or manage the property, and (3) engagement through seeking information and support for covenant-related activities. Examining the relevance of each of these factors for covenanted landholders is the focus of subsequent chapters.

Specific objectives are to understand:

1. Covenantor willingness to continue with the covenant obligations by assessing both their initial motivations to covenant and their current views on covenanting (**Chapter 3**);
2. Covenantor ability to manage their property by determining the types of management activities they conduct and the challenges they face in doing so (**Chapter 4**);
3. Covenantor engagement with support networks by examining their sources of and preferences for information and advice related to the covenant and property (**Chapter 5**); and

4. The value to private landholders of engaging with support networks by reviewing the relevant literature on social network analysis and determine how social networks have helped to achieve conservation outcomes in the wider field of natural resource management (**Chapter 6**).

Interwoven among the results of landholder interviews and surveys are the perspectives of covenant provider staff as well. Given the range of covenant mechanisms and providers across Australia, and the providers' roles in overseeing the covenants, it was important to understand this added context of how the programs are administered, and the variability in the amount and types of support provided to landholders.

Results from my research reveals strengths and weaknesses of covenanting mechanisms in Australia, the complexity of individuals and circumstances, and opportunities to better support landholders to ensure the long-term integrity of covenanted properties. This dissertation makes several contributions towards a deeper understanding of conservation covenants and appreciation of the complexities of this social-ecological system.

Chapter outline

This dissertation is written as a “thesis including published works”, consisting of a published manuscript (Chapter 6, Groce et al. in press) and three unpublished manuscripts of empirical research intended for peer-reviewed journals (Chapters 3, 4, and 5), detailed below. These four chapters are framed with: a general introduction (Chapter 1) to place the work in the relevant theoretical context and outline the case study; general methods (Chapter 2) to limit repetition in subsequent empirical research chapters; and, a general discussion (Chapter 7) that synthesizes the overall findings and their contribution to the understanding of willingness, ability, and engagement in sustaining long-term management outcomes. Figure 1.2 illustrates how the dissertation chapters relate to the aforementioned conceptual framework.

Following the introductory chapter, **Chapter 2** provides an explanation of the mixed methods approach used in Chapters 3, 4, and 5. It describes the methodological approach, sampling procedures, and survey instruments used to collect data from covenanted landholders and covenant providers throughout Australia.

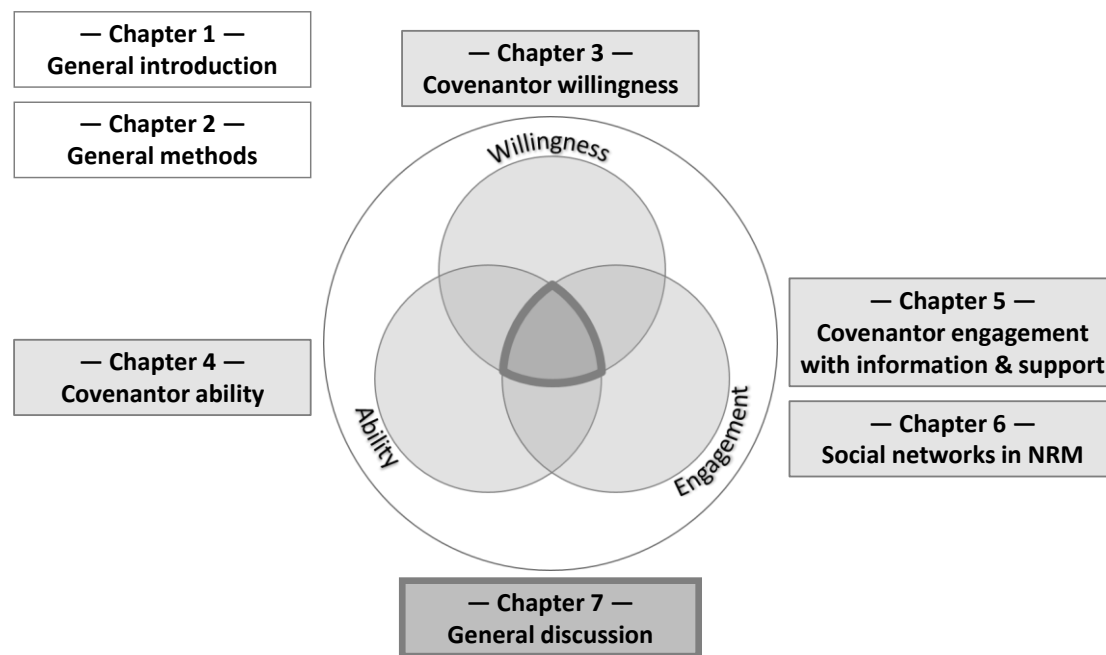


Figure 1.2. Structure of thesis chapters relative to the conceptual framework of factors involved in sustaining pro-environmental behavior. Figure adapted from Mills et al. 2017.

To understanding the willingness of landholders to persist with covenant obligations and management activities after their land has been dedicated to conservation, **Chapter 3** explores the initial motivations and current views of covenantors in Australia. Assessing initial motivations to covenant – or to acquire a covenanted property in the case of successive owners – provides useful context for understanding which types of covenantors may be at risk of losing willingness over time and how that might relate to the management of their property. Extending the body of research regarding management on private lands, **Chapter 4** assesses the management and monitoring activities covenantors undertake and identifies factors that enable or limit their ability to manage. This chapter provides important insight into the ways in which landholder ability could be better supported to achieve positive outcomes on their properties, and the emerging risks to achieving long-term outcomes without greater support. **Chapter 5** then examines the information seeking behavior of covenanted landholders to better understand their engagement with information and advice to support their ongoing land management efforts. Understanding the information landholders use and value can help target knowledge exchange strategies to better support landholders and create additional avenues for learning. Recognizing that numerous covenantor characteristics may impact their willingness, ability, and engagement, Chapters 3, 4 and 5 analyze landholder perspectives and behavior in relation to whether

they are original or successive signees to the agreements and resident or absentee owners of the properties to explore potential differences across these groups.

To expand on the potential role of engagement in successful covenants, **Chapter 6** provides a comprehensive literature review and typology of social network research within the broader context of natural resource management and conservation. Social networks – the connections among people or groups – are important for the transmission of ideas and information (Wasserman & Faust 1994). They can make resources, such as information or influence, available to members in the network and can enable shifts in understanding and behavior (Rogers 2003, Bodin & Crona 2009). The extent to which targeted interventions in social networks result in desirable conservation outcomes is yet to be disentangled by the research, but future work following a clear theory of change can help to advance our learning.

Finally, **Chapter 7** discusses the intersection of willingness, ability, and engagement (Fig. 1.2) and how the insights gained can help covenanted landholders maintain their conservation and management commitments long-term. It will provide an assessment of covenanting in Australia, discussing strengths, opportunities for improvement, and recommendations for future research.

CHAPTER 2: General methods

My study of conservation covenants in Australia used qualitative and quantitative data collection efforts to understand the covenanting programs and processes through the eyes of landholders and key staff working with the covenant providers. The data presented in Chapters 3, 4, and 5 were collected using the same methods, described here to limit repetition among the chapters.

I used a mixed methods research approach, which combines elements from qualitative and quantitative methods to provide both breadth and depth of understanding (Creswell & Clark 2011). Qualitative methods, such as interviews, allows for deeper inquiry into the perspectives and experiences of individuals while quantitative methods, such as closed-answer questionnaires, allows for a generalization of findings or estimation of frequencies across a larger population. Mixed methods thus draws on the strength of each approach, resulting in a more comprehensive understanding of a particular issue. Because covenanting programs include a diverse set of landholders (e.g., different programs, geographic locations, circumstances), the mixed methods approach was ideal; i.e., the use of questionnaires served to capture potential diversity in responses, while the use of interviews helped to build a deep understanding of the nuances – the challenges, perspectives, activities – in greater detail across the different contexts.

For the landholder dataset, I used an exploratory sequential design (Creswell & Clark 2011) in which I first qualitatively explored landholder perspectives by interviewing a sample and then used those data to inform the design of a second, quantitative phase (questionnaire) to determine whether the findings could be generalized to a larger sample (Creswell & Clark 2011). Due to the limited amount of data available about landholders with conservation covenants, using mixed methods was an ideal approach to first learn about landholder experiences and then shape the subsequent questionnaire based on those experiences (detail below). Additional interviews with key staff members working with the covenant providers – the formal bodies administering the covenants – gave insight into the perspectives of the providers along with past and current conditions surrounding the implementation of covenanting programs (detail below).

Sampling procedure

I sought views from private, individual owners or managers of properties with a conservation covenant registered on the title (hereafter covenantors). These covenantors were primarily private individuals, but in some cases were representatives of small not-for-profit groups or local councils. I was interested to capture a range of covenanting programs, administration arrangements, and land management needs throughout Australia, rather than focus on a particular covenanting program or location. Thus, covenantors were drawn from the six Australian states: New South Wales (NSW), Queensland (QLD), South Australia (SA), Tasmania (TAS), Victoria (VIC), and Western Australia (WA). I conducted interviews with covenantors from NSW, SA, TAS, and VIC, states which contain over 80% of the country's conservation covenants (see Chapter 1). Questionnaires were made available to covenantors in all states.

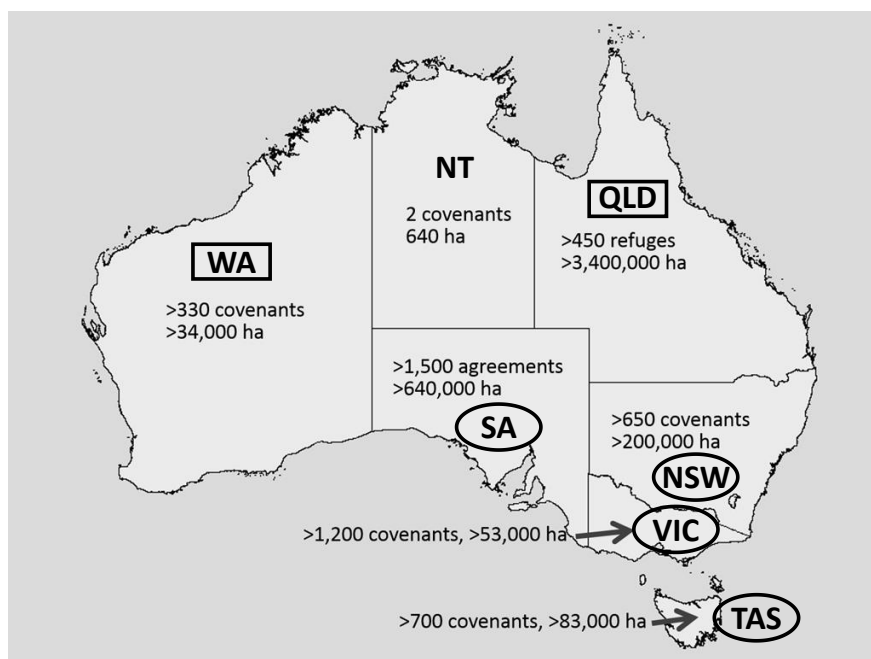


Figure 2.1. Approximate number and total area covered by in-perpetuity conservation covenants (including conservation agreements, nature refuges) in Australia, based on Fitzsimons 2015. Ovals indicate states in which landholder interviews and questionnaires were both used; rectangles indicate states in which only questionnaires were used.

In accordance with ethics approval, I worked with covenant providers in each state to recruit interview and survey participants rather than being able to contact landholders directly. Recruitment methods differed by covenant provider due to staff availability and their preference for contacting landholders (Table 2.1). This meant that a mix of passive (e.g., publicizing the request for participation through a newsletter) and active (e.g., personalized

contact from staff, usually via email) approaches were employed to reach potential participants (Table 2.1; Dillman et al. 2009). Although active recruitment was desirable, as it tends to result in a higher number of participants, passive approaches are still effective at recruiting participants (e.g., Estabrooks et al. 2017). The initial message to covenantors remained the same regardless of recruitment approach, which included a brief description of the project and an invitation to participate with instructions for how to contribute. In an attempt to reach as many covenantors as possible for the survey, I also promoted the online questionnaire through Landcare Associations, regional Natural Resource Management agency websites, and other environmental organizations. A snowball sampling approach (Patton 2002) was also used, whereby participants were asked to pass my contact information on to other covenantors who could then choose to participate.

To maintain anonymity of all participants throughout this dissertation, references to and quotes by participants are cited as L# (e.g., L30) for landholder interviewees and S# for staff interviewees and other identifying information has been removed from their comments. The project objectives and methods received approval from the Monash University Human Research Ethics Committee (project number CF15/236 – 2015000107).

Table 2.1. Covenant provider and recruitment methods used to promote participation in interviews (NSW, SA, TAS, VIC) and questionnaire (all states).

State	Covenant provider	Recruitment method(s)
NSW ¹	Office of Environment and Heritage	Direct contact (email) from staff to >100 landholders
	Nature Conservation Trust	Newsletter (>150 recipients)
QLD	Department of Environment and Heritage Protection	Newsletter (unknown number of recipients)
	Queensland Trust for Nature	Facebook (unknown number of recipients)
	Gulf Coast Councils	Direct contact (email) from staff to >30 landholders
SA	Department of Environment, Water and Natural Resources	Newsletter (480 recipients)
		Direct contact (email) from staff to 108 landholders
TAS	Department of Primary Industries, Parks, Water and Environment (partnered with Tasmanian Land Conservancy)	Newsletter (>1,000 recipients)
		Direct contact (phone or email) from staff to 65 landholders
VIC	Trust for Nature	Direct contact (phone or email) from staff to >50 landholders
WA	Department of Parks and Wildlife ²	Regular post (185 recipients)
Multiple	N/A	Promoted through Natural Resource Management regional websites, Bush Heritage, Landcare Associations, and individual landholders

¹ In 2017, conservation covenants established through OEH and NCT were transferred to the NSW Biodiversity Conservation Trust, as per the Biodiversity Conservation Act 2016.

² Currently called the Department of Biodiversity, Conservation and Attractions.

Data collection and analysis

Interviews

Covenantors

Interviews can provide highly detailed and nuanced data, offering great depth of understanding with a smaller number of participants (Patton 2002). I used semi-structured interviews to gain a deeper understanding of the experiences and perspectives of the covenantors. Semi-structured interviews involve a series of predetermined questions asked during the interview, but enable the interviewer to be flexible with the language used, ask additional questions for clarification or greater detail, and allow new questions and topics to be discussed (Patton 2002). Questions were asked in the same order except when interviewees provided responses to questions not yet asked, or where following the predefined order would interrupt the flow of the conversation.

I was the sole interviewer for this research and interviewed all participants between July and December 2015, using a mix of phone and in-person methods. Funding was available for travel to SA, TAS, and VIC for in-person interviews. In-person interviews typically occurred at landholder residences or public locations of their choosing (e.g., cafes). Approximately one-quarter of the interviews involved couples or coworkers, with each pair representing a single property; thus interview data are analyzed at the scale of the property (n=82) by pooling their responses to capture all perspectives offered.

Sixteen interview questions covered four main topics for the covenantor interviews: background information about the covenantor and covenanted property; experiences with the covenant program and process; management and monitoring activities conducted on the property; and accessing sources of information and support for those activities (full list of questions in Appendix A). Question wording varied slightly depending on whether the interviewee was an original signee or successive owner. Interview questions were first piloted with seven researchers and practitioners whose work focused on private land conservation in Australia, to check for clarity and whether the questions would elicit the desired information (Wainer & Braun 1988). Questions were revised based on their comments.

Although there are no explicit rules for interviewee sample size, widely held recommendations are that it be sufficiently large enough to reach a point where little or no new information is found in additional interviews (i.e., saturation), which can vary considerably by research aims, diversity of participants, and intended inference (Patton 2002; Guest et al. 2006). My goal was to gather a range of perspectives about covenanting across states. Redundancy in responses offered by interviewees tended to occur after 12-15 interviews within a state; thus approximately 20 interviewees per state (Table 2.2) was sufficient to ensure saturation.

Interviews averaged one hour in length (range of 0.5 to 2.5 hours) and were digitally recorded and transcribed verbatim. I transcribed approximately half the interviews; the remainder were transcribed by a transcription service, TranscribeMe (<https://transcribeme.com/>) and I quality-checked the returned transcripts. I coded and analyzed all transcripts in QSR International's NVivo 11 qualitative analysis software (see individual chapters for coding detail). Additional coding detail and thematic analysis, relevant to specific research questions, is provided in Chapters 3, 4, and 5. Validation of codes and themes occurred for each chapter. Validation involved an assessment of intercoder reliability and intercoder agreement (Campbell et al. 2013). Validators were provided codes, definitions, and relevant sections of transcripts and independently coded the text based on the information provided. Discrepancies between original and validators' coding identified where codes required clarification or modifications. Coding and thematic analysis were conducted after the completion of all interviews.

Covenant providers

Given the range of covenant mechanisms and providers across Australia, it was important to understand the diversity in how these programs are administered, and the variability in the amount and types of support provided to landholders. Thus, to provide additional context of covenanting programs in Australia, I conducted key informant interviews (Table 2.2) with staff who worked for most of the major covenant providers (see Chapter 1, Table 1.1) (Patton 2002). These staff were highly knowledgeable about their respective covenanting programs and/or worked closely with covenanted landholders (e.g., as stewardship officers). I used semi-structured interviews with the staff to understand the process of covenanting, the types of management or monitoring activities occurring on covenanted properties, and

their perspectives on the covenanting mechanisms and covenanted landholders (full list of questions in Appendix B).

I interviewed all key informants once between August 2015 and January 2016 using a mix of phone and in-person methods. In-person interviews were conducted with staff in SA, TAS, and VIC, which occurred at their offices or public locations (e.g., library). Interviews with staff in Queensland and Western Australia (outside the sampling frame of landholder interviewees) provided program information and context for the questionnaire data.

Table 2.2. Approximate number of conservation covenants by state and number of participants included in my research.

State	Approx. # Covenants ^a	Interviewees		Survey respondents
		# Staff	# Landholders	# Landholders
South Australia	1,500	2	20	23
Victoria	1,200	5	26	121
Tasmania	700	5 ^b	17	58
New South Wales	650	4	19	66
Queensland	450	0	n/a	10
Western Australia	330	2	n/a	51
Total	4830	18	82	329

^a Number of covenants does not equal number of landholders (i.e., some landholders own more than one covenanted property).

^b Includes key informants from the state environmental agency and a private organization.

Surveys

Based on the interview responses, and using Qualtrics software (Qualtrics, Provo, UT, USA), I developed a questionnaire targeted at covenantors throughout Australia, which consisted of fixed-response and open-ended questions (Patton 2002). Fixed-response questions serve to standardize responses and facilitate quantitative data analysis. Open-ended questions allow respondents to answer in their own words, providing a rich source of qualitative data, which is important when experiences are likely to be quite individual (Patton 2002). Questions were similar to those used in the interviews, with options for fixed-response questions informed by interview responses (see Appendix C for full list of questions). The questionnaire was piloted with four researchers involved in private land conservation in Australia and ten covenantors whom I had interviewed (Dillman 2009). I improved the questions and response options based on pilot participant feedback.

The questionnaire consisted of 35 questions covering five topics: information about the type of covenant and property details; motivations for and current views about covenanting (see Chapter 3); management and monitoring activities occurring in the covenanted area (see Chapter 4); sources of information and advice related to land management (see Chapter 5); and covenantor demographics (Appendix C). Fixed-responses included multiple choice (e.g., select one option or select up to three options) and 3- or 5-point Likert scales (Dillman 2009). In most cases, closed answer questions were accompanied by an option to indicate “other” and then specify a different category that best fit the respondent (Dillman 2009). Some questions were not presented to respondents depending on the survey flow logic (e.g., people who selected land manager instead of owner of the covenanted property were not asked about motivations for covenanting; Dillman 2009). Responses were not mandatory for most questions, thus people could skip questions and move ahead in the survey at their discretion. Where respondents had more than one property with a covenant on title they were directed to provide responses relating to the property on which they spent most of their time. All survey responses were anonymous.

I made the questionnaire available between January and September 2016 through a purpose-built website (www.connectandconserve.com) and as hard copy when requested. The duration of survey availability was due to staggered coordination with covenant providers and distribution of newsletters. One covenant provider (WA Department of Parks and Wildlife) opted to mail survey to covenantors, in which case procedures recommended by Dillman (2009) were followed. I supplied the covenant provider with a cover letter, 8-page survey, and stamped return envelope for each covenantor; the covenant provider then mailed the packets to the covenantors and also mailed a reminder postcard approximately two weeks after the initial mailing (Dillman 2009).

Data analyses for specific research questions are described in the Methods section of Chapters 3, 4, and 5.

CHAPTER 3: Landholder motivations to secure and maintain conservation covenants

Abstract

Conservation covenants are a widely used mechanism in Australia for dedicating private lands to biodiversity conservation, habitat connectivity, and ecosystem services. The permanency of covenants necessitates similarly long-term commitment by landholders to meet and maintain their conservation obligations under the covenant. Previous research suggests that three elements are needed to achieve sustained pro-environmental behavior: willingness to take on the behavior, ability to do so, and engagement with support networks. Through a mixed methods approach, this chapter examines the willingness of covenanted landholders to maintain long-term commitment, including landholders who initiated a covenant (original signees) or acquired a property with a covenant already in place (successive owners). I assessed their initial motivations for covenanting and their current views of covenants, with initial motivations providing context for how their attitudes may have shifted over time. Motivations and views of original and successive owners were similar overall, showing strong pro-environmental perspectives. However, within the group of dissatisfied landholders, there was a slightly higher representation of successive owners and landholders who covenanted due to regulatory requirements or financial incentives. In light of the impending increase in successive owners as aging covenantors transfer their properties, and the growing number of covenants required under environmental offset arrangements, this study identifies a risk that the willingness of landholders may decrease with title transfers. The challenges faced by landholders need to be better understood to identify opportunities to bolster the commitment to covenant obligations and the longevity of covenants as a mechanism for conservation outcomes.

Introduction

Adequate land protection and management is a critical strategy to halt the loss of terrestrial biodiversity (CBD 2010). As such, significant attention has been given to expanding the global protected area (PA) system to increase the representation of species and habitats (Butchart et al. 2015). Conservation initiatives have broadened in recent decades from the designation of state-owned PAs for biodiversity protection (UNEP-WCMC & IUCN 2016) to approaches involving short-term incentive-based stewardship on private lands and permanent protection of a variety of land tenures (Butchart et al. 2015; Kamal et al. 2015). PAs are intended to “achieve the long-term conservation of nature” through binding commitments (Dudley 2008, p. 8). Due to their permanence, conservation covenants (or conservation easements) are generally considered the private equivalent of public PAs and are used in numerous countries dominated by private land ownership (Chapter 1; Stolton et al. 2014). Conservation covenants (hereafter covenants) are binding on the property title such that the land use restrictions and any management obligations associated with the covenant apply to existing landholders and transfer to future owners (Saunders 1996; Figgis 2004; Cheever & McLaughlin 2015). The restrictions associated with a covenant have been shown to effectively limit development and habitat loss (Pocewicz et al. 2011; Hardy et al. 2017). Thus there is extensive interest in understanding the motivations to covenant and encouraging landholder participation in covenanting programs (Kabii & Howritz 2006).

Research into pro-environmental attitudes and behaviors has a long and expansive history (e.g., Harry et al. 1969; Kollmuss & Agyeman 2002; St. John et al. 2010), including extensive scholarly focus on landholder motivations (often farmers or foresters) to participate in private land conservation and stewardship (e.g., Kabii & Horwitz 2006; Lastra-Bravo et al. 2015). Encouraging landholders to consider and engage in a conservation initiative is a vital first step in the success of these programs, thus studies have focused on initial program participation (Lastra-Bravo et al. 2015) or uptake of environmentally-friendly land management practices (Pannell et al. 2006).

An individual’s willingness to act towards conservation goals is often examined through their motivations and associated attitudes (e.g., Theory of Planned Behavior [Ajzen 1991; Brain et al. 2014]), values, and norms (e.g., Value-Belief-Norm theory [Stern et al. 1999; Stroman & Kreuter 2015]). Motivations are broadly categorized as intrinsic (doing an activity for the

inherent satisfaction of the activity itself) or extrinsic (the performance of an activity in order to attain an external outcome; Ryan & Deci 2000, p. 71). In the context of conservation covenants, studies (mostly from the USA) suggest initial participation is often motivated by intrinsic factors, such as a desire to protect natural resources on the property (Ernst & Wallace 2008; Moon & Cocklin 2011; Horton et al. 2017) or personal experiences of nature (Farmer et al. 2011a; b). Extrinsic motivations for covenanting, such as financial incentives (Rilla 2002; Farmer et al. 2015) or the influences of family or friends (Farmer et al. 2011b; Horton et al. 2017), are noted less often by participants but are nevertheless important for some individuals. The use of financial incentives has attracted a broader group of individuals to many covenanting programs (Stern 2006).

Understanding landholder motivations for establishing covenants aids in designing suitable policies and programs, targeting appropriate landholders (Moon & Cocklin 2011), and determining the cost-effectiveness of payment schemes (Adams et al. 2014). Given the permanency of conservation covenants, however, it is important to understand the ongoing commitment to covenants by landholders and the views of those who own covenanted property but were not involved in establishing the covenant (e.g., successive owners). The success of conservation covenants requires a long-term commitment by current and future landholders to ensure the covenant obligations continue to be met, including through active management of the property. As with public PAs, active management of threats on covenanted properties is critical to achieving conservation outcomes, and the management conducted is primarily dependent on the landholders themselves (Fitzsimons & Carr 2014; Stroman & Kreuter 2015).

To avoid landholders becoming disengaged from a program or discontinue a management practice it is important to find ways to sustain pro-environmental behavior long-term (Dayer et al. 2017). Yet few studies have assessed the long-term commitment of landholders towards environmental goals (Race & Curtis 2009; Reimer et al. 2014; Swann & Richards 2016). Based on a review of studies into pro-environmental behaviors of farmers, Mills et al. (2017, p. 283) developed a conceptual framework of elements that influence “sustained and durable environmental management”, broadly categorized as willingness to adopt an action, ability to do so, and engagement with support and advice. Mills et al. (2017) propose it is at the nexus of these three elements where sustained action is mostly likely to occur. Other

studies of environmental management by landholders (Dayer et al. 2017) or of behavioral change more broadly (Frey & Rogers 2014, Kwasnicka et al. 2016) have arrived at the same fundamental concepts: i.e., an individual's attitudes, motivations, perceived abilities, and habits (all related to willingness), their resources (related to ability), and external influence or support (related to engagement) can all impact sustained action. In the context of conservation covenants, the framework can be applied to the *willingness* of landholders to initiate a covenant and maintain its obligations, the *ability* of landholders to maintain the obligations and/or manage the property, and their *engagement* through seeking information and support for those activities (see Chapter 1). Each of these elements needs to be understood, with willingness the first hurdle that must be overcome in a voluntary conservation program.

The willingness of landholders has two important implications for the success of covenanting programs – their participation in a covenanting program and commitment to carry out management activities throughout their ownerships. The longevity of covenants makes it important to understand whether initial motivations remain constant over time or may be influenced by changing circumstances (Ryan & Deci 2000) or ownership (Stern 2006). While the permanency of covenants is part of their strength, it also presents a risk if people's views towards covenanting change over time. The emphasis of previous research on initial motivations to covenant (e.g., Kabii & Horwitz 2006; Bastian et al. 2017) leaves a critical gap in our understanding of whether motivations are sustained.

The two studies that have included an assessment of landholder activities on properties after they had been covenanted (both examining conservation easements in the USA), suggest that landholders were more likely to continue with conservation management practices if they valued environmental land uses over other types of land use (Farmer et al. 2017; Stroman & Kreuter 2015), if their financial motives were of low importance (Farmer et al. 2017), or if they perceived their actions helped to improve natural conditions (Farmer et al. 2017). Having positive relationships with the covenant providers – the organizations or agencies with whom the landholders signed the easement – also appeared to positively influence management activities, although to a lesser degree than other motivations (Stroman & Kreuter 2015). The influence of changing ownership of covenanted properties on willingness to conduct management has likewise been poorly studied, although Stroman &

Kreuter (2015) found no significant differences in land management activities between original and successive owners.

Given the preliminary evidence that pro-environmental perspectives are more likely to translate into active management (e.g., Farmer et al. 2017), it is all the more critical to understand the longevity of landholders' perspectives on covenanting. This is particularly important to understand for landholders whose motivations for covenanting were not intrinsic, such as landholders who were required to covenant under existing regulations (e.g., Fitzsimons & Carr 2014; see conditional covenants in Chapter 1) or purchased or inherited a property with a covenant already in place (i.e., successive owners; Fitzsimons & Carr 2014). For example, successive owners may not hold the same environmental values or interests as the original covenant signees, nor were they involved in the negotiation of the agreement, thus they may be less inclined to follow the covenant obligations (Cheever 1996; Rissman & Butsic 2011) or undertake management activities (Fitzsimons & Carr 2014).

For covenanting programs to meet their in-perpetuity conservation goals, landholders must be willing to persist with covenant obligations and management activities. To fill gaps in understanding the constancy of landholders' willingness after their land has been dedicated to conservation, this study explores the initial motivations and current views of landholders in Australia who own or manage conservation covenants (hereafter covenantors). Assessing initial motivations to covenant – or to acquire a covenanted property in the case of successive owners – provides useful context for understanding which types of landholders may be at risk of reduced willingness over time and how that might relate to their management of the property. Furthermore, because successive owners are a growing portion of covenantors, and little is known about whether their motivations and experiences may differ, I compare their responses against those of original signees.

Methods

To assess motivations to covenant and current views about covenanting, I used a mixed methods approach combining qualitative and quantitative datasets as detailed in Chapter 2. Qualitative data used in this chapter stem from three open-ended questions asked during interviews with covenanted landholders:

1. *What motivated you to establish a conservation covenant (or the purchase a property with a covenant already on title)?*
2. *What are your opinions about covenants as an option for private land conservation?*
3. *Do you conduct any management or monitoring activities in the covenanted area?*

Additional qualitative data is drawn from interviews with 18 key staff members across most major covenanting programs (details in Chapter 2). The interviews captured covenant provider perspectives about the covenanting programs, the covenantors, and their role in providing support to covenantors (described further in Chapter 2). Furthermore, several questions in the online survey were open-ended, allowing respondents to expand on any details if desired. Comments that provide a deeper understanding of the respondents' answers are referenced in the results.

Quantitative data used in this chapter are derived from an online survey available to covenantors throughout Australia in which respondents were asked a range of questions relating to their demographic and property characteristics. Data are also presented from three closed-answer survey questions relating to motivations and management (details in Chapter 2):

1. *In your decision to establish the covenant or acquire the covenanted property, how important was each item?* For each statement following the question, respondents selected from a 5-point Likert scale: very important, important, neutral, unimportant, very unimportant. The question was only posed to property owners (not those managing land on behalf of the owners).
2. *What are your current views towards the conservation covenant and covenanted property?* For each statement following the question, respondents selected from a 5-point Likert scale: strongly agree, agree, neither agree nor disagree, disagree, strongly disagree. This question was posed to all respondents.
3. *Do you conduct any management activities within the covenanted area of your property?* Respondents selected yes or no.
4. *What motivates you to conduct management activities in the covenanted area?* Respondents selected up to three reasons from a list of eight options, including an open-ended response for "other".

Qualitative analysis

The interview transcripts were open-coded via an inductive category development method, in which individual codes emerged from the data and were used to capture distinct ideas and concepts (Braun et al. 2015; details in Chapter 2). I specifically coded items pertaining to each landholder's motivations for covenanting, along with positive, negative, or neutral opinions about the covenants. I then grouped individual codes into themes to capture related concepts (Braun et al. 2015). Transcripts were coded using QSR International's NVivo 11 qualitative analysis software. Codes and themes were validated by researchers involved in the project (see Chapter 2). To help contextualize the covenantor results, key informants' comments about types of programs, types of covenantors, and covenant provider capacity are also presented. To maintain anonymity of all participants, quotes cited in results are referenced as L# (e.g., L30) for landholder interviewees and S# for staff interviewees.

I compared responses between original signees and successive owners through an assessment of the frequency of codes and themes emerging from the different groups of interviewees (Bazeley & Jackson 2013). As the comparison was at the level of the interviewee, each covenantor was reflected once per code regardless of how often they mentioned the same idea during the interview. Similarly, after aggregating responses into themes, the percent of interviewees per theme was calculated such that each covenantor was reflected once per theme even if their responses fall into multiple codes within that theme. Land managers (i.e., those who managed but did not own the properties) and covenantors who purchased properties through revolving fund programs were included in the comparison between original and successive owners because it could be determined from the interviews whether they were involved in the original signing of the covenant or had limited say in the covenant details.

Quantitative analyses

I used descriptive statistics to provide an overview of the sample population (including demographics and covenant type) and responses to the four survey questions. To determine whether there were differences between original signees and successive owners in their motivations for covenanting or in their current views about covenanting, I conducted Mann-Whitney U nonparametric tests because the response variables were ordinal data (Quinn & Keough 2002). Responses of original signees and successive owners about their motivations

for managing the property were descriptively compared. In contrast to the interview data, land managers or owners who entered through revolving fund programs were excluded from the tests because it was not possible to determine whether they participated in the negotiation of the covenant and thus could not be categorized as either “original” or “successive” owners.

The survey data indicated a subset of covenantors who held relatively negative views of the covenant and/or the administration of the covenanting program. Specifically, respondents who selected strongly agree, agree, or neutral for “I am satisfied with the existing conservation covenant” and “I am satisfied with my Covenant Scheme Provider” were considered satisfied, while those who selected disagree or strongly disagree were considered unsatisfied. Respondents who selected strongly disagree, agree, or neutral for “I would like to remove the conservation covenant from the property title if possible” were considered satisfied while those who selected agree or strongly agree were considered dissatisfied. To explore whether the initial motivations or characteristics of dissatisfied covenantors differed from satisfied covenantors, I created three mutually exclusive groupings: satisfied, dissatisfied with the provider, or dissatisfied in general (Table 3.1). The three groups attempted to capture different types of dissatisfaction; i.e., covenant administration versus the covenant instrument itself. I used Kruskal-Wallis nonparametric tests to compare each groups’ responses about motivations for covenanting. To visualize differences between groups, I used means and standard error values from the Likert scale in creating the graphs; however, statistical tests are rank based, rather than parametric, due to ordinal data. Descriptive comparisons were also made for the proportion of satisfied and dissatisfied covenantors who were undertaking management activities. I conducted all quantitative analyses in IBM SPSS Statistics 23.0 (IBM Corp., Armonk, NY, USA).

Table 3.1. Survey respondents who were categorized for analysis as “satisfied”, “dissatisfied with the provider” or “dissatisfied in general” based on their responses about satisfaction with the covenant provider, satisfaction with covenant, and desire to remove the covenant.

Survey respondents who are:	Categorized as	# of respondents
Satisfied with provider, covenant, and do not want to remove covenant	Satisfied	281
Dissatisfied with provider	Dissatisfied with provider	20
Dissatisfied with covenant	Dissatisfied in general	3
Remove covenant	Dissatisfied in general	8
Dissatisfied with provider and covenant	Dissatisfied in general	4
Dissatisfied with covenant and want to remove covenant	Dissatisfied in general	2
Dissatisfied with provider, covenant, and want to remove covenant	Dissatisfied in general	11

Results

Covenantor and property characteristics

I received 419 survey responses, 329 of which were considered suitable for analysis (i.e., at least one-third of the survey was completed, including one or more sections relevant to this chapter). There is very little information about the population of landholders from which these responses are drawn, making it difficult to assess the representativeness of this sample. However, respondents held covenants with covenant providers across all major covenanting programs (see Chapter 1, Table 1.1). Ninety percent of respondents were covenantors in New South Wales (NSW), Tasmania (TAS), Victoria (VIC), or Western Australia (WA) (Table 3.2). Based on the distribution of covenant types across Australia (Chapter 1), respondents slightly under-represent covenantors in Queensland (QLD) and South Australia (SA). Otherwise, landholder and property characteristics (below) are similar to those of a separate recent survey of covenantors within Australia (Selinske et al. unpublished data).

The interviewees represented 82 properties with covenants on title in NSW, SA, TAS, and VIC (Table 3.2). There was less diversity in the type of covenant program across the four states compared to survey data (Table 3.2), mainly due to the use of covenant providers to contact possible participants (see Chapter 2).

Table 3.2. Covenanting programs represented in this study and number of covenantors per program.

State	Covenanting Program	Interviews		Surveys	
		Count	%	Count	%
NSW	Voluntary Conservation Agreements	14	17.1	37	11.2
	Nature Conservation Trust covenants	3	3.7	15	4.6
	Registered Property Agreements	0		11	3.3
	Property Vegetation Plans ¹	2	2.4	0	0.0
	Other ²	0		3	0.9
QLD	Nature Refuges	n/a		8	2.4
	Voluntary Conservation Agreement (local council)	n/a		2	0.6
SA	Heritage Agreements	20	24.4	23	7.0
TAS	Private Land Conservation Program covenants	17	20.7	57	17.3
	Other ²	0		1	0.3
VIC	Trust for Nature covenants	26	31.7	113	34.3
	Landowner Agreements (DELWP)	0		5	1.5
	Other ²	0		3	0.9
WA	Nature Conservation Covenant (DPAW)	n/a		46	14.0
	National Trust covenants	n/a		3	0.9
	Other ²	n/a		2	0.6
Total		82		329	

¹ Offered through the Catchment Management Authority (currently Local Land Services).

² Includes miscellaneous programs or multiple programs listed by respondent.

Landholder characteristics were similar between the qualitative and quantitative samples, thus only quantitative results are described below. Full details of the program, property, and covenantor characteristics for all interviewee and survey respondents are provided in Appendix D. Most respondents (74%) were the original signees to the conservation covenant; 19% were successive owners, while the remainder were either covenantors who purchased their property through a revolving fund program or were managers of the property but not owners. Covenants had been in place from less than one year to over 30 years, with most less than 10 years old (median of 2007). The covenanted area of properties ranged from <0.5 ha to 54,000 ha (median of 30 ha). Approximately one-quarter of respondents generated income from the property (e.g., through primary production, hobby farms, ecotourism). Just over half the respondents (53%) considered the covenanted property their primary residence while the remainder lived elsewhere (hereafter resident and absentee owners, respectively). Respondents were primarily older (≥ 55 years), well-educated, and with a mix of work status and annual incomes. Approximately half the respondents said they had experience with land management prior to taking on a conservation covenant. Most survey respondents (89%), and all but one interviewee, indicated they currently conduct management activities in the covenanted area of the property (Appendix D).

For original signees compared to successive owners, details of program, property, and covenantor characteristics are in Appendix E. Again, findings were similar between the qualitative and quantitative datasets so only quantitative results are described below for brevity. Program and property characteristics and demographic information were generally similar between original signees and successive owners. However, compared to original signees, a slightly higher percentage of successive owners are younger, absentee owners, working full-time, relatively well educated and have higher annual incomes (Appendix E). Slightly fewer successive owners had previous management experience prior to owning a covenanted property (47% compared to 52% original signees) and fewer conduct management activities (80%) relative to original signees (90%). Although successive owners have owned the covenanted property for fewer years than original signees (average year of ownership of 2008 versus 1994, respectively), many of the original signees finalized the covenant within the past five years, thus the number of years each group has been dealing with a covenanted property is similar (Appendix E).

Motivations to covenant and manage

Both the qualitative and quantitative datasets showed similar findings regarding the covenantors' initial motivations to covenant. Landholders described multiple motivations for covenanting, with conservation the primary motivation (Table 3.3; Fig. 3.1). Interviewees expressed interest in protecting biodiversity and ensuring permanent protection from land use change, and/or a sentiment that protecting nature was an important part of their personal identity (Table 3.3; specific codes and indicative quotes are in Appendix F). The majority of survey respondents rated the three elements of protecting the landscape (protecting natural values, permanent protection, and protection from land use change) as important or very important motivations for deciding to establish or acquire a covenanted property (Fig. 3.1).

Table 3.3. Themes developed from interview codes regarding interviewee motivations to establish a conservation covenant (original signees, n=65) or to buy or inherit a covenanted property (successive owners, n=17). Interviewees could be included in more than one theme. Codes and indicative quotes per theme are in Appendix F.

Theme	Description	Covenantors per Theme	
		Original	Successive
Conservation	Motivated by a desire to protect biodiversity, prevent land use change, and/or having a general conservation ethos and desire to be active stewards.	60 (92%)	13 (76%)
Social	Motivated through the influence of family or friends, or wanting to protect the land for the good of the community and/or future generations.	20 (31%)	4 (24%)
Economic	Motivated by financial incentives received at or after signing the covenant (e.g., grants, rate rebates), using the covenanted property as an offset, or seeing the "green" business value of the property (e.g., current or future ecotourism).	22 (34%)	1 (6%)
Property	For successive owners, motivated by an interest in the characteristics of the property (e.g., bush block) which overrode any concerns about the covenant.	0 (0%)	7 (41%)

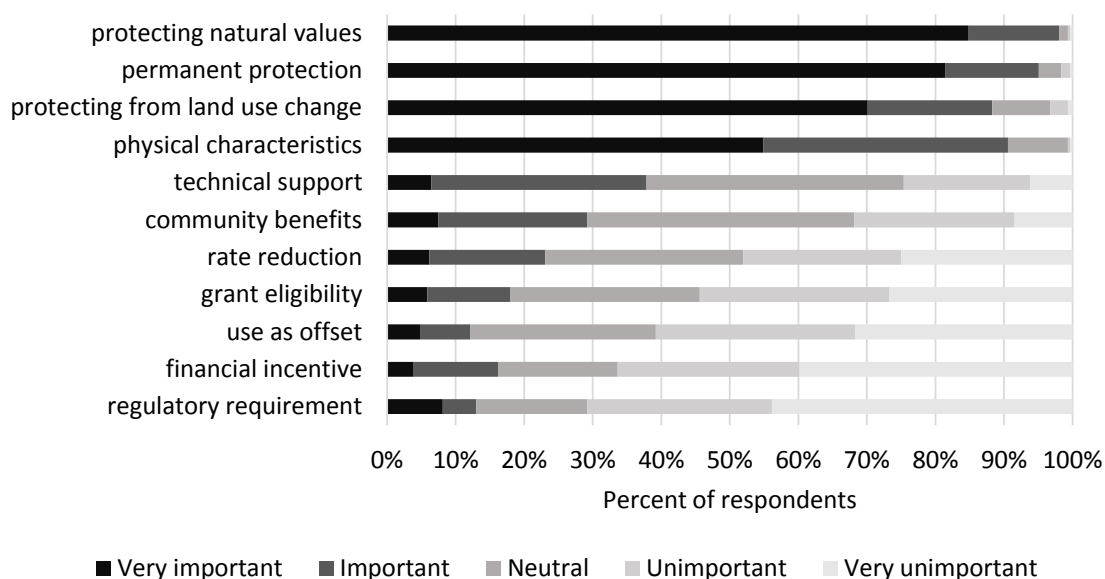


Figure 3.1. Percent of respondents (n=306-310) selecting from a 5-point Likert scale in response to their motivations for establishing a conservation covenant or acquiring a covenanted property. Respondents who were land managers but not owners of the property were not asked this question. Listed in order from lowest mean score, where 1 = very important and 5 = unimportant.

Social and economic incentives were noted less frequently by landholders but nevertheless important for approximately one-third of interviewees (Table 3.3) and for approximately 12-30% of survey respondents depending on the item (Fig 3.1). Interviewees described being influenced to covenant by friends or family, or seeing broader community and educational benefits through covenanting (Table 3.2). Economic factors included receiving financial incentives at the time of signing (e.g., for fence construction), using the covenanted land as an environmental offset, or becoming eligible for land management grants and/or tax relief in the form of reduced council rates or state land tax (Fig. 3.1; Table 3.3). Most interviewees noted that the economic reasons, while helpful, were supplemental to their interest in conservation (Table 3.3), although for three interviewees, rate reduction or use as an environmental offset were the primary motivators. Economic considerations also included increased agricultural productivity in the non-covenanted portion of the property or opening opportunities for ecotourism (Table 3.3). Describing the economic potential of the covenanted property, one landholder noted *“That cottage, within what is effectively a private conservation park, has a huge potential as an ecolodge rental property...”* (L77). Regulatory requirements, such as covenanting a portion of a property to meet subdivision requirements, were important or very important for 12% of the survey respondents (Fig. 3.1), most of whom had covenants either in VIC (n=17; 14% of VIC respondents) or WA (n=13; 25% of WA respondents). Regulatory requirements were not mentioned among the interviewees.

Based on survey responses, original signees and successive owners showed similar patterns in their motivations for covenanting (Fig. 3.2). Interview data suggests a greater interest in economic incentives by original signees than successive owners (Table 3.3), which may reflect the importance of one-off financial incentives offered at the time of signing (see ‘Administration of covenants’ below). There were significant differences among original and successive owners with regard to conservation motivations and technical support, with successive owners rating these as slightly less important than original owners (Fig 3.2; Table 3.4). Around 41% of the successive owners interviewed expressed that the fact that there was a conservation covenant on title was secondary to the fact that they enjoyed other aspects of the property, such as its isolation, or the desire for a bush block (Table 3.3).

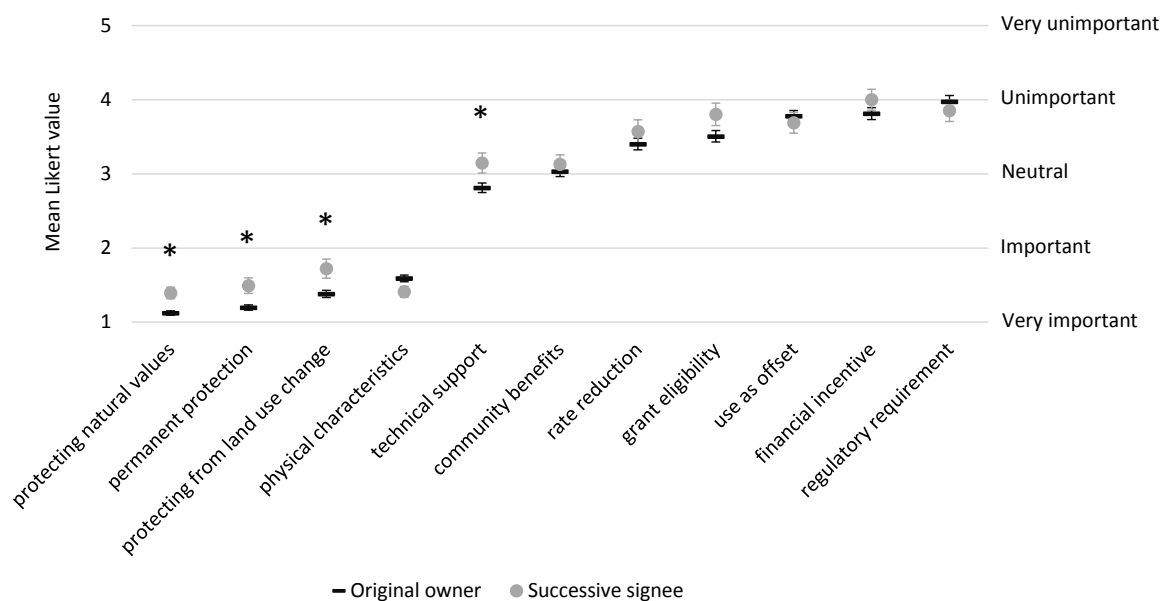


Figure 3.2. The mean (± 1 SE) importance score for factors in covenanting decisions as reported by original signees (dashes) and successive owners (circles). Scores are based on a 5-point Likert scale, where 1 = “very important” and 5 = “very unimportant”. Asterisk indicates significant difference at $p < 0.05$.

Table 3.4. Mean scores, standard error (SE), sample size (N), and results of Mann-Whitney U tests for differences in motivations of original signees and successive owners. Scores are based on a 5-point Likert scale, where 1 = “very important” and 5 = “very unimportant”.

Survey question: In your decision to establish the covenant or acquire the covenant property, how important was each item below?

	Original			Successive			Mann-Whitney U	Z score	p-value
	Mean	SE	N	Mean	SE	N			
Protecting the natural values of the property	1.12	0.028	236	1.39	0.079	61	5546.00	-4.48	0.000*
Permanently protecting the property	1.20	0.036	234	1.49	0.104	61	5800.50	-3.32	0.001*
Protecting the property from changes in land use	1.38	0.048	234	1.72	0.128	61	5828.00	-2.75	0.006*
Physical characteristics of the property	1.59	0.046	234	1.41	0.075	61	6207.00	-1.77	0.077
Technical support for management of the property	2.81	0.064	235	3.15	0.136	61	5946.00	-2.15	0.032*
Providing benefits to the community (e.g., recreation, education)	3.03	0.070	234	3.13	0.125	61	6778.00	-0.63	0.528
Reduction in council rates	3.40	0.079	234	3.57	0.156	61	6558.50	-1.00	0.316
Becoming eligible for land management grants	3.51	0.077	233	3.80	0.151	61	6089.50	-1.78	0.076
Using it as a vegetation, biodiversity, or carbon offset to generate money or credits	3.78	0.076	232	3.69	0.139	61	6676.00	-0.71	0.480
Financial incentive at the time of signing (e.g., payment for fencing)	3.81	0.080	235	4.00	0.142	61	6622.50	-0.96	0.338
Fulfilling regulatory requirements for changes in land use (e.g., subdivision)	3.97	0.083	234	3.85	0.146	61	6413.00	-1.30	0.195

Similar to initial motivations to covenant, both original signees and successive owners were primarily motivated to conduct management activities on the covenanted property by their desire to protect or enhance the natural values (Fig. 3.3). Successive owners were slightly more motivated than original signees through enjoyment of the work and obligations within the covenant agreement. Only 3 survey respondents overall selected covenant obligations as the sole motivation for management.

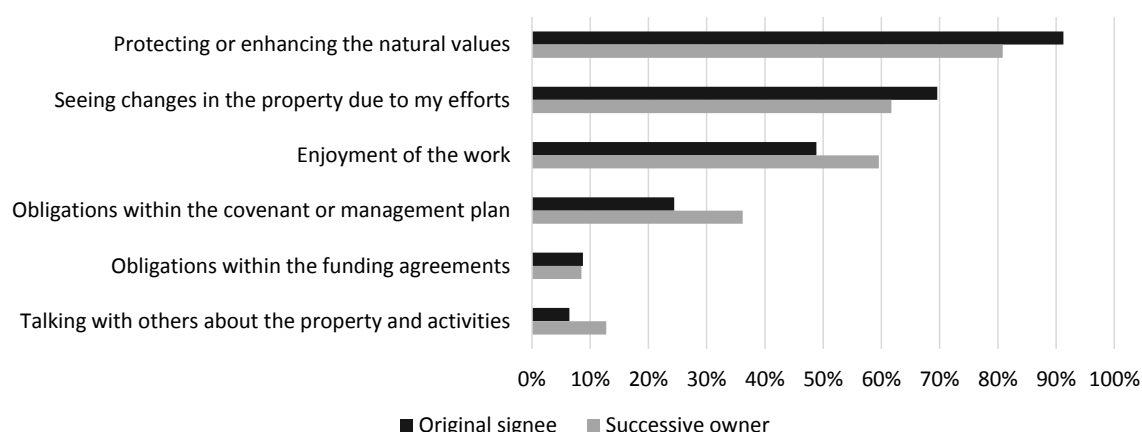


Figure 3.3. Percent of survey respondents (original signees, n = 217; successive owners, n = 47) who indicated each motivation was among the top three motivations for managing the covenanted property. Respondents could select three or fewer choices.

Current views and opinions

Landholders' views and opinions about their covenants, and conservation covenanting in general, were asked and assessed in different ways between the qualitative and quantitative approaches, with both offering insights into landholder satisfaction.

The current opinions of interviewees about conservation covenants were grouped into positive, negative, or ambivalent responses (Table 3.5; specific codes and indicative quotes are in Appendix G), with 29% providing extensive comments about covenants that included a mix of positive, negative, and/or ambivalent opinions. Interviewees with positive opinions liked that the covenants provided permanent protection of the land and opened opportunities for financial assistance (e.g., land management grants) or technical support, mentioning many of the same ideas that attracted them to covenant. Over half the interviewees (60%) held solely positive opinions.

Table 3.5. Themes developed from interview codes regarding the opinions of conservation covenant by original signees (n=65) or successive owners (n=17). Interviewees could be included in more than one theme. Codes and indicative quotes per theme are in Appendix G.

Theme	Description	Covenantors per Theme	
		Original	Successive
Positive	Covenants provide legally binding, in-perpetuity protection to the land, which contributes to biodiversity conservation, and increases eligibility for grants and other support. Knowing about covenants gets people thinking differently about land management options, and signing on makes them feel a part of something bigger than themselves.	53 (82%)	15 (88%)
Negative	Doubts about current and future effectiveness of the scheme in limiting land degradation, and disappointment about lack of support from the covenant providers. Although eligibility for financial or technical assistance increases with having a covenant on title, that assistance is rarely available or has decreased over time.	19 (29%)	3 (18%)
Ambivalent	Comments about covenants that were not strongly positive or negative; a mix of indecisive and neutral comments.	12 (18%)	4 (24%)

Negative opinions (27% of all covenantors; Table 3.5) encompassed issues about the perceived effectiveness of and durability of covenants and displeasure about the lack of support (financial, technical, or administrative) from covenant providers or other government agencies. Lack of support limited their ability to learn about and manage the property and update management plans if needed. Two interviewees (2%) had solely negative opinions of conservation covenants, both from South Australia. While they described themselves as conservation-minded and agreed with conservation covenants in principle, they were frustrated by the lack of support available to covenantors and the apparent lack of government commitment to the scheme.

Ambivalent comments were those not clearly positive or negative, e.g., *“I don’t really have much of an opinion either way. I’m not a great advocate of it, but I’m not against it.”* (L56).

Overall, 20% of interviewees indicated ambivalence about their current views on covenanting, often mixed with positive or negative opinions (Table 3.5); 9% of interviewees offered only ambivalent comments.

Survey respondents were not grouped into positive or negative opinions, rather they

indicated levels of agreement with, and satisfaction about, covenanting. Nearly all respondents continued to see conservation as an important motivation, agreeing or strongly agreeing with maintaining the property's natural values (Fig. 3.4). The majority were satisfied (agreed or strongly agreed) with the covenant document and/or their covenant provider (Fig. 3.4). Although 16% of respondents agreed or strongly agreed they would like to change some details in the covenant, only 6% wanted to remove it entirely (Fig. 3.4). Successive owners showed similar views overall to original signees (Fig. 3.5). Statistically, however, successive owners had a significantly poorer understanding of their obligations, were less satisfied with the covenant or covenant provider, and had more interest in selling the property or removing the covenant than original signees (Fig. 3.5; Table 3.6).

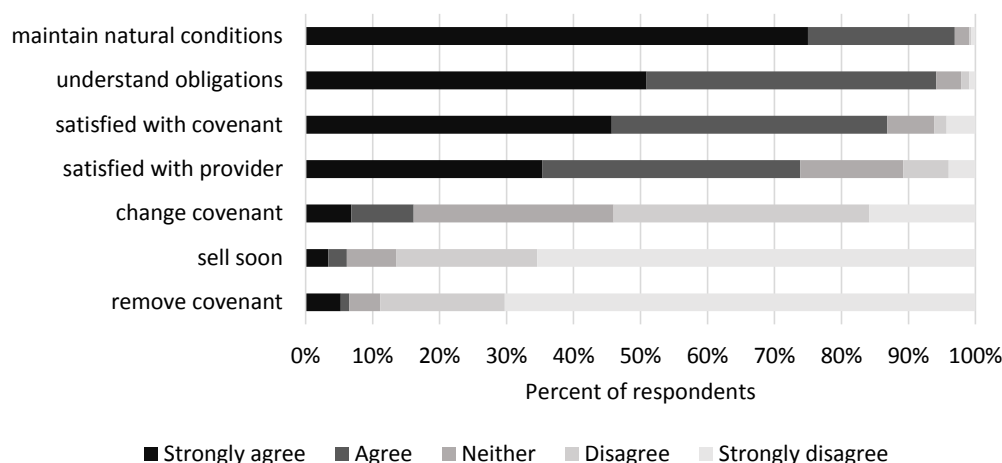


Figure 3.4. Percent of respondents (n=316-326) selecting from a 5-point Likert scale regarding current views of their conservation covenant. Listed in order from lowest mean score, where 1 = strongly agree and 5 = strongly disagree.

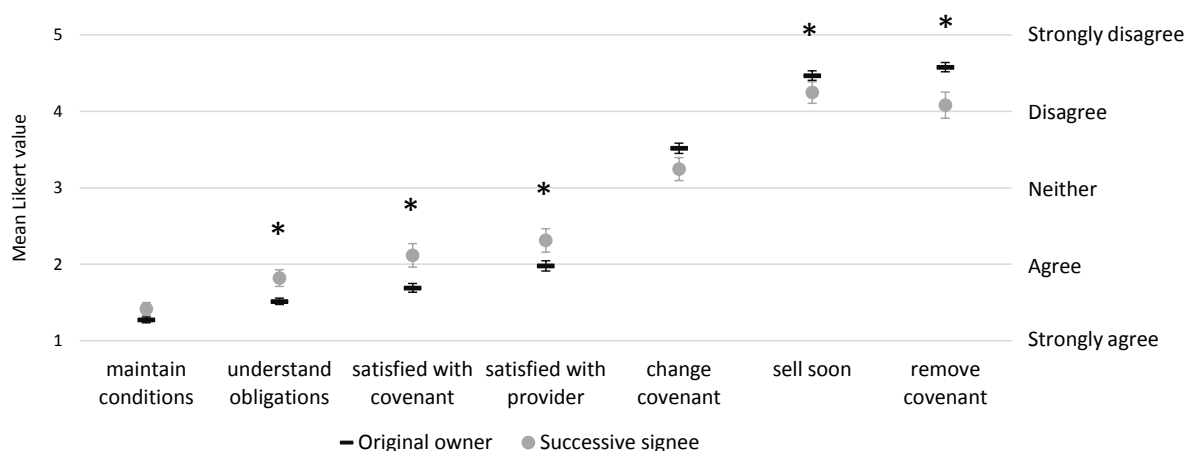


Figure 3.5. The mean (± 1 SE) agreement score for current views of conservation covenants as reported by original signees (dashes) and successive owners (circles). Scores are based on a 5-point Likert scale, where 1 = "strongly agree" and 5 = "strongly disagree". Asterisk indicates significant difference at $p < 0.05$.

Table 3.6. Mean scores, standard error (SE), sample size (N), and results of Mann-Whitney U tests for differences in current views of original signees and successive owners. Scores are based on a 5-point Likert scale, where 1 = “strongly agree” and 5 = “strongly disagree”.

Survey question: What are your current views towards the conservation covenant and covenanted property?									
	Original			Successive			Mann-Whitney U	Z score	p-value
	Mean	SE	N	Mean	SE	N			
I intend to maintain the natural conditions in the covenanted area	1.27	0.038	238	1.42	0.083	60	6330.00	-1.80	0.072
I understand the covenant and my obligations as a covenantee	1.51	0.041	239	1.82	0.108	61	5899.00	-2.59	0.010*
I am satisfied with the existing conservation covenant	1.69	0.058	239	2.11	0.153	61	5777.00	-2.74	0.006*
I am satisfied with my Covenant Scheme Provider	1.98	0.067	238	2.31	0.152	61	6118.50	-2.00	0.045*
I would like to change some details in the conservation covenant if possible	3.52	0.068	236	3.25	0.151	61	6423.50	-1.36	0.175
I intend to sell the covenanted property as soon as possible	4.47	0.063	237	4.25	0.140	61	6166.00	-2.11	0.035*
I would like to remove the conservation covenant from the property title if possible	4.58	0.060	237	4.08	0.171	61	5618.50	-3.36	0.001*

Subset of dissatisfied respondents

While most respondents were generally positive in their current views about covenanting, a small portion were dissatisfied with their covenant provider and/or with the covenant (Fig. 3.4; Table 3.1). Examining the initial motivations to covenant among the groups classed as satisfied, dissatisfied with the provider, or dissatisfied in general suggests several significant differences (Fig. 3.6). Respondents dissatisfied in general were more likely than the other groups to have established a covenant because it was a regulatory requirement ($H_2 = 16.36$, $p < 0.001$) or because of financial incentives offered at the time of signing ($H_2 = 9.14$, $p = 0.010$). Furthermore, although the dissatisfied in general group indicated various aspects of land protection were important motivations, they were statistically less motivated by these factors than those who were satisfied (Fig. 3.6; protect natural values: $H_2 = 21.79$, $p < 0.001$; permanent protection: $H_2 = 16.41$, $p < 0.001$; protect from land use change: $H_2 = 14.70$, $p < 0.001$). The group dissatisfied only with the covenant provider had similar motivations overall to the satisfied group (Fig. 3.6).

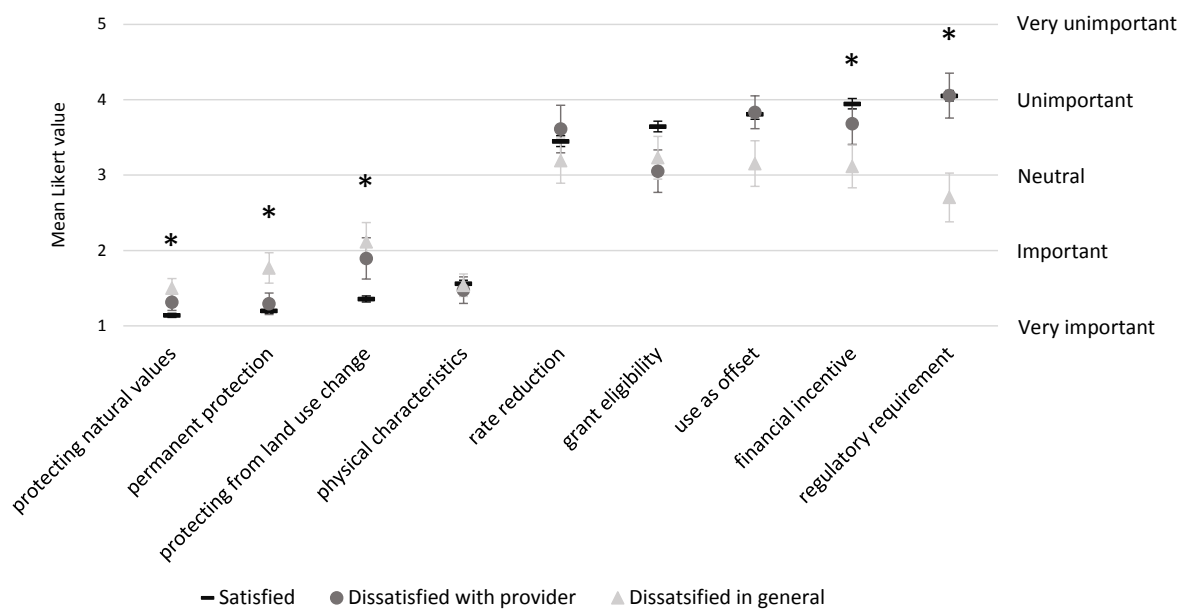


Figure 3.6. The mean (± 1 SE) importance score for factors in covenanting decisions as reported by respondents who were satisfied with both the covenant and covenant provider ($n=281$), dissatisfied with the covenant provider ($n=20$), or dissatisfied in general ($n=28$). Scores are based on a 5-point Likert scale, where 1 = “very important” and 5 = “very unimportant”. Asterisk indicates significant difference at $p < 0.05$.

A similar proportion of original signees and successive owners were dissatisfied with the provider, while a slightly larger proportion of successive owners were dissatisfied in general (Fig. 3.7A). Looking at covenant types with relatively high number of responses (Table 3.2) Compared to covenantors in other states, covenantors with a Nature Conservation Covenant in WA were more dissatisfied in general while those with Heritage Agreements in SA were more dissatisfied with the provider. The majority of dissatisfied landholders were nevertheless actively managing their properties, although this comprised a slightly lower percentage than the satisfied respondents (Fig. 3.8). Of the dissatisfied respondents, a higher percentage of successive owners were not managing the covenanted property compared to original signees (Fig. 3.8).

Responses to several open-ended survey questions (e.g., provide suggestions to improve covenanting programs or provide additional comments in general) suggested a variety of reasons for dissatisfaction. Similar to comments made by interviewees, survey respondents indicated issues such as lack of financial assistance or technical advice coming from covenant providers or environmental agencies, lack of contact and communication with covenant providers, and concern about the inability of providers to effectively enforce covenant obligations, as seen through the degradation of certain covenanted properties. The recurring

theme was that dissatisfied covenantors felt unsupported and under-appreciated. Although still willing to maintain the natural conditions on the property, respondents described being stifled by what they saw as unreasonable or inappropriate requirements that ran counter to their vision for reaching their management goals. Of the respondents who were dissatisfied with the covenant (including those who wanted to remove the covenant), in addition to the above issues, they also expressed a desire to see more flexibility in the covenant document or a desire for fair compensation for the restrictions on land use. Two respondents, both from WA, indicated they were “forced” into covenants because of regulatory requirements (e.g., LS130, LS145); thus covenanting as a requirement for subdivision may be the reason why several WA landholders were dissatisfied and wanted to remove the covenant.

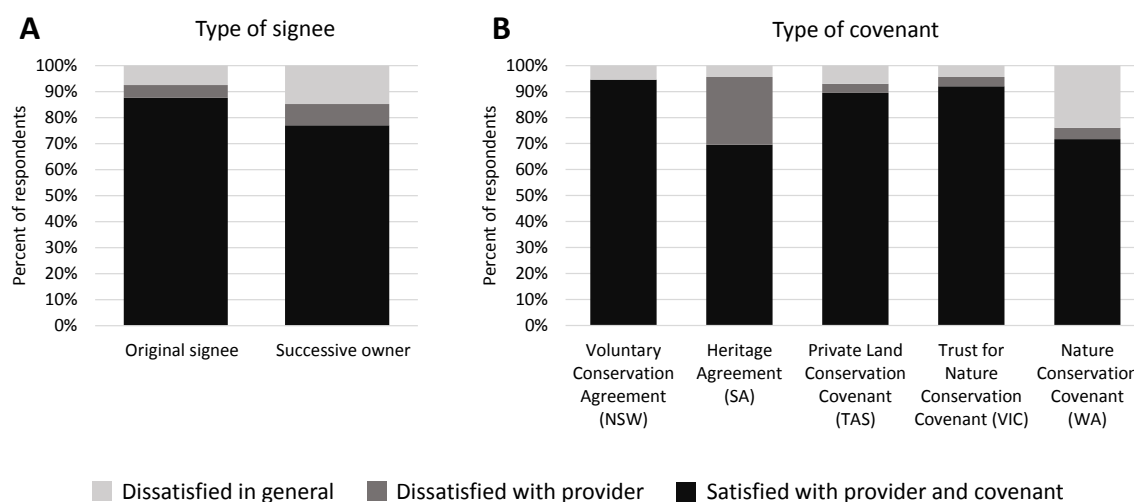


Figure 3.7. Comparison of (A) signee type and (B) covenant type for respondents who were satisfied with both the covenant and covenant provider, dissatisfied with the covenant provider, or dissatisfied in general. Legend applies to both bar graphs. Sample sizes are in Appendix D for signee type and in Table 3.2 for covenant type.

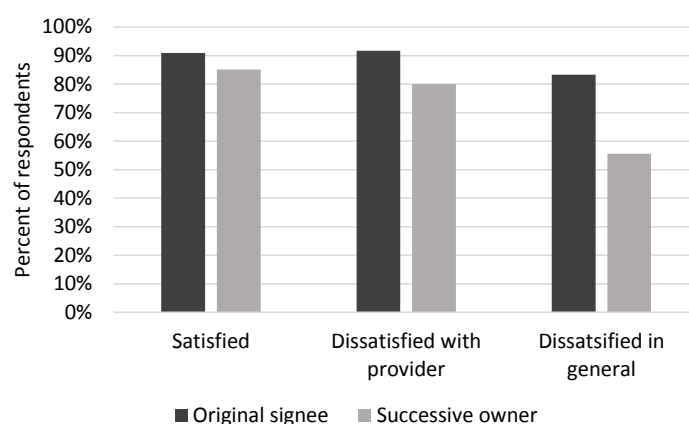


Figure 3.8. Percent of original signees or successive owners who are actively managing the covenanted property, relative to whether they were satisfied with both the covenant and covenant provider (original n=210, successive n=47), dissatisfied with the covenant provider (original n=12, successive n=5), or dissatisfied in general (original n=18, successive n=9).

Administration of covenants

Key informant interviews reinforced the survey and interview results from covenantors.

They described covenantors as a diverse group, with demographics that are often changing as new covenants are registered and change hands, and with varying levels of involvement or interest in the covenant.

“...you go to their [the covenantors’] forums and there's lots of opinions in the room... They come from really different and diverse backgrounds, which is what's interesting... You might think “conservation landholders” labels someone, but... some of them live in mansions, some of them live in yurts.” (S11)

“...it is only a portion of our stakeholders that would be a gold star covenanter. And then you have them all right through to disinterested, to apathetic, to maybe might even breach. You've got that whole spectrum of stakeholders...” (S21)

The diversity is due in part to the ways in which landholders entered into covenants. The majority of covenants have been voluntary, either through landholders seeking out covenant providers on their own initiative to covenant, or covenant providers seeking properties that harbor particular habitats or species. Depending on funding availability, financial incentives have been provided to covenantors, ranging from payments to assist with management (e.g., fencing costs) or for compensation of loss in land value (resulting from restrictions on land use). A smaller but growing portion of covenants are conditional covenants or offsets, required as a condition of subdivision or clearing native vegetation. Staff noted that, in general, landholders who covenanted because of larger incentives or regulatory requirements can be less conservation-minded and more difficult to deal with.

“The voluntary landowners are the ones – they're the pure gems. They're the ones that do it for the love of the bush and do it for the right reasons, and actually want to uphold all of the conditions in the covenant. And 90% of the time they do... They're the ones that generally look after their bush.” (S29)

“I think the last program... had so much money compared to the other ones, that people that signed up through that program are potentially some of the highest risk ones because it was purely a financial decision... [The incentive] was so much money that it was worth doing, and it's not an area they cared about particularly... It's a bit of a mixed bag. But the altruistic ones do tend to be the easiest because they did it because they loved it.” (S13)

The staff see the success of covenants as largely dependent on the motivations and actions of the covenantors, which in turn depends in part on the covenant providers' ability to support the covenantors.

"A successful [covenant] would be if the landholder is on-side and understands what their responsibilities are, and then if the government's on-side and supports that landholder in that process of managing that area for conservation as opposed to agriculture." (S22)

Yet staff across all states expressed frustration about funding cuts in recent years that has reduced their capacity to support landholders, leading to fewer site visits and limited ability to assist landholders to prepare and revise management plans. They believed this engagement with landholders was important but described program funding as prioritizing the establishment of new covenants over stewardship visits and monitoring.

"So I know when I first started there was money coming out our ears and it was great. Whereas now you're not sure where your job will be every 12 months." (S06)

"Our unit recently got downsized by about two-thirds, so everybody's doing quite a lot of roles." (S27)

"The staff are flat out dealing with the new [covenants], let alone dealing with revisiting the old ones." (S22)

"We try and keep in contact [with covenantors] every three years, or email and call and see how they're managing their land. But outside of that, it's not a consistent, critical thing right now for our program. Because those stewardship visits aren't... financed or funded. There's no cost recovery for that either, so with the limited funds we rarely go out to do stewardship visits." (S31)

Limited ability to engage with successive owners, especially at the time that they take ownership of the property, was of particular concern to the staff. Reduced staff results in delays both in finding out about new owners and having time to meet with them, making it hard to establish rapport with the new owners and ensure their understanding about obligations. In addition, while some staff shared concerns about successive owners (e.g., not having the same conservation ethic as original signees), they were quick to point out that the individual's attitude and interest is more important than whether they are original signees or successive owners.

“And the most important thing is getting out there and meeting with the new people, giving them a copy of the management plan, making sure they have a copy of the deed. Showing what's on their property, making sure they understand what their obligations are. At the moment we aren't notified... when a property changes hands... And so that can be really problematic because... we may not find out that a property's been sold with a covenant for months down the track.” (S01)

“... my team talks now about the main threat being when [the properties] sell, and I keep saying, ‘I don't think that's our experience there.’ I can see the logic of it, that when you purchase a [covenanted] property, you don't have that inherent love of that area. But it seems to me that there's also a risk from people who've owned it for a while. Economic times change, and they see new opportunities, and they think, ‘I'd like to be able to do that now. I wish I hadn't put that area aside in a covenant.’” (S13)

Discussion

The willingness of landholders to participate in conservation covenants and maintain the covenant obligations long-term is an essential component of successful covenanting programs. In this study, willingness of landholders was assessed through their motivations to covenant their property and manage the land, and possible shifts in willingness were assessed by capturing their current views towards covenanting. Most landholders were motivated by pro-environmental values to participate in covenanting programs (Fig. 3.1, Table 3.2), as has been seen in similar studies about conservation easements in the USA (Ernst & Wallace 2008; Horton et al. 2017) and covenants in Australia (Stephens et al. 2002; Moon & Cocklin 2011). The desire to protect natural values on the properties (a subcategory of pro-environmental values) was important both for establishing a covenant and to actively manage the property (Figs. 3.1, 3.3). The draw for many of the covenantors is knowing that the land is protected into the future. These pro-environmental values, such as a concern for the environment and desire for land protection, are a common, if not primary, motivation for participation in non-perpetual conservation programs as well, for example in South Africa (Honig et al. 2015), Brazil (Zanella et al. 2014), England (Fish 2003), and Canada (Drescher et al. 2017).

A small portion of landholders participated in covenanting because of financial incentives (e.g., payments at the time of signing, rate reduction), environmental offsets, and/or regulatory requirements. This finding is again consistent with other studies that report financial incentives are a relatively minor consideration for covenantors (reviewed in Stern 2006; Farmer et al. 2011b; Bastian et al. 2017). Covenants established as an offset to

development and through other regulatory requirements (see Chapter 1) have not been studied to the same extent as fully voluntary covenants. Given this group appears to respond differently in terms of willingness and satisfaction (e.g., Fig. 3.6), additional research should assess to what extent they remain committed to the covenant obligations over time, whether they manage the property as effectively as intrinsically-motivated covenantors, and whether they require ongoing incentives to meet their obligations.

Given the lack of research into successive owners, key insights from this work is that successive owners generally shared similar pro-environmental motivations to original owners (Fig. 3.2) and were often motivated by the physical characteristics of the property, including its remoteness or the extent of native vegetation, which overrode doubts they might have had about the covenant (Table 3.3). Concerns have been raised in the literature that successive owners do not share the same values as original signees (Cheever 1996; Pidot 2005) and may have less enthusiasm towards and willingness to pursue biodiversity outcomes (Fitzsimons & Carr 2014), which can lead to disregard of the agreement (Hardy et al. 2017) and legal challenges with the covenant provider (Rissman & Butsic 2011). Other studies have found lower satisfaction with a conservation easement and the easement provider among successive owners (Stroman & Kreuter 2014), but this did not necessarily translate into less management action (Stroman & Kreuter 2015). My findings show most successive owners have positive views about their covenant and covenant provider, understand their obligations, and are willing to maintain the natural conditions on their properties (Fig. 3.3, Table 3.5). However, data also revealed minor differences between original signees and successive owners that indicate successive owners are slightly less satisfied and slightly less likely to actively manage their properties. Although minor – and thus suggests previous concerns about successive owners may be exaggerated – we do need to better understand the perspectives and actions of successive owners through targeted surveys and tracking responses over time as successive owners become a larger portion of covenantors.

The small portion of covenantors who are dissatisfied appear to fall into two groups – those who are dissatisfied in general, expressing negative opinions about the covenant and the covenant provider, and those who are satisfied with the covenant but feel unsupported by the provider. There is a slightly higher representation of successive owners within these

groups (Fig. 3.7A) along with landholders who covenanted due to regulatory requirements, financial incentives given at the time of signing, or to use the property as an offset (Fig. 3.6). Despite being dissatisfied, it appears many of these landholders do still manage the property (Fig. 3.8), although it is unclear whether this will continue long-term if their concerns are not addressed. Frustrations expressed by dissatisfied covenantors generally stemmed from a lack of access to or communication from the covenant provider. This concurs with many of the concerns raised by provider staff, that budget cuts had reduced their ability to support landholders (an increasingly common issue for covenant providers; England 2015). As the number of covenants grows and the amount of funding plateaus or declines, the issue of limited engagement between these parties to the agreement will likely grow. It is already most pronounced in SA (Fig 3.7B), the state with the largest number of covenants (Chapter 1, Table 1.1) but with only two staff dedicated to the covenanting program. Other studies likewise point to lower satisfaction among landholders when they have less contact with program providers for either in-perpetuity (Stroman & Kreuter 2014) or fixed-term agreements (Blackmore & Doole 2013), suggesting greater resourcing for covenant providers to engage with private landholders will be key to achieving good on-ground conservation outcomes.

The longevity of funding is critical to the long-term success of conservation programs (e.g., Taylor 2012). However, funding to covenant and stewardship programs in Australia has declined significantly since 2012 (Australian Government 2012). Continuity of funding may not be sufficient to maintain levels of support to covenanting programs as new covenants continue to be signed and the number of successive owners, who may be unfamiliar with the property and require additional assistance (England 2015; Stroman & Kreuter 2017), continues to grow. Funding levels may need to be set on a per property basis, or proportional to the area under covenant. The level of funding behind a program can be indicative of the government's commitment to that program. This perspective was evident among many interviewees, who saw the lack of engagement with the provider as a sign that long-term outcomes of covenanting programs may be compromised.

The dissatisfaction of covenantors with the covenant document was often related to wanting more flexibility and/or autonomy when managing the property. The security of covenants, and assurance of ongoing land protection, is due in part to the fact that multiple

parties are involved in the agreement, all of whom must then agree to alter or remove it (Fitzsimons 2006; Hardy et al. 2017). The consequence, however, is that in-perpetuity covenants are not always appropriate for changing conditions of landholders, properties, or broader society (McLaughlin 2007). Attempts towards flexibility have been made, in part, through compromises over the types of land uses allowed on covenanted properties (Owley & Rissman 2016). Linking management plans to the covenant has also been used as an approach to increase flexibility and build in a mechanism for periodic review (e.g., Fitzsimons & Carr 2014). However, negotiations and changes in management plans still require assistance from, and agreement with, the covenant providers, which is difficult to attain when the providers are resource-limited. Analyzing and recommending changes in the legal aspects of covenants is beyond the scope of this study; nevertheless options should be considered that enable a more effective (i.e., less expensive, less time-consuming) process for altering covenants over time (McLaughlin 2007).

Despite revealing some challenges, and areas for improvement, the findings of this study overall suggest a positive situation with covenants – with mostly satisfied covenantors and management activities occurring on the properties. However, it will be important to monitor several risks identified, which may grow with time if not addressed, including the dissatisfaction of successive owners and of landholders who covenanted for reasons other than pro-environmental values. Slightly fewer dissatisfied covenantors are managing the property relative to satisfied covenantors (Fig. 3.8) suggesting a risk for covenanting programs. Although I did not examine specific reasons for lack of management, research suggests lack of satisfaction can lead to lack of maintaining desired behaviors (Kwasnicka et al. 2016). Use of incentives to encourage new covenants (e.g., Iftekhar et al. 2014) can result in greater risk for the programs as the owners may be less satisfied and less willing to follow the covenant and management needs long-term. This supports the perspective in the literature that voluntary approaches are important for long-term outcomes (Stern 2006; Segerson 2013). Dissatisfied owners may take up more staff time and effort, spreading limited resources more thinly to the detriment of the rest of the program.

Although the dissatisfied landholders currently comprise a relatively small portion of covenantors, they may increase over time as both successive owners and the use of environmental offsets increase (e.g., Miller et al. 2015), with as yet unknown implications for

the viability of covenanting programs. Furthermore, given that participation in this study was voluntary and I was unable to follow up on non-responses, these findings may underestimate dissatisfaction if non-respondents consist of a larger portion of dissatisfied or disengaged covenantors. It is important to understand – and try to address – these negative perspectives as a potential risk to the longevity of conservation covenants (Selinske et al. 2015). Concerted outreach to current and future successive owners, whether through covenant providers, government agencies, or conservation organizations, could serve to improve the awareness and acceptance of conservation covenants and management options (Stern 2006; Stroman et al. 2017; see also Chapter 5). Targeted surveys of landholders and their properties with conditional covenants would improve our knowledge of their motivations and the conservation outcomes of non-voluntary covenants. In addition, since most covenants in this study are less than 10 years old, longitudinal studies would help illustrate how covenantor views change in relation to changing personal, societal, and political circumstances.

Conclusions

The use of conservation covenants continues to be an important strategy for biodiversity conservation. To understand the potential longevity and effectiveness of permanent options requires understanding the current and future landholders involved – their attitudes and motivations, ability and behaviors – as they ultimately influence the conservation outcomes on their land. This chapter has provided important insights into the motivations of covenantors, their views of covenants, and how this links to their willingness to actively manage their properties. A large portion of covenanted landholders are willing to continue to uphold the covenant obligations and manage the properties to meet conservation objectives. Yet this study also identifies a risk that the willingness of landholders may decrease over time in light of the impending growth in successive ownership as aging covenantors transfer their properties, and the increasing endorsements of covenant use under environmental offset arrangements. As the administering bodies of these covenants, covenant providers need to play a greater role in engaging with the covenantors and help to bolster their willingness. That, however, requires greater commitment in turn from the government and philanthropic sources that support covenanting programs. Continuing to encourage and incentivize the placement of conservation covenants on additional properties

is important to limit development and maintain open space. Commitment to maintaining existing covenants through resourcing the programs is also crucial, enabling the providers to create and sustain connections with the growing pool of covenantors.

CHAPTER 4: Landholder ability to sustain management activities on private protected areas

Abstract

Conservation covenants have become an important mechanism in Australia for protecting biodiversity values on private lands. As with any protected area, the land use restrictions placed on properties under covenants help to maintain natural areas and limit non-environmentally-friendly land uses. With appropriate management and monitoring they can also enhance desired habitats and ecosystem functions. Although conservation covenants specify the restrictions placed on a property, little is known about the on-ground management activities undertaken by covenanted landholders on their properties after the covenant is registered. This study is one of the first to provide insight into the management activities undertaken on covenanted properties and the perspectives of covenantors and covenant providers regarding the challenges faced in managing the properties throughout Australia. Pest control is the primary activity on covenanted properties, and often the only one required under covenants over and above basic land use restrictions. For many landholders, meeting these minimal requirements, let alone expanding into other activities, is constrained by lack of finances, lack of time, and external influences that impact the property's condition. Resource constraints are also experienced by the covenant providers, which prevent them from being able to support the landholders through financial or technical assistance. A diversity of solutions will be required to address these challenges. Facilitating opportunities for covenanted landholders to support one another and strengthen cross-boundary management offers a promising option in the short-term. However, a greater commitment at state and national levels to supporting biodiversity outcomes on private land is required to truly achieve the goals of covenanting programs.

Introduction

Protected areas have great promise as a tool for achieving conservation outcomes. However, the focus on protected area expansion, rather than ecological outcomes has led to criticism that many protected areas are paper parks, essentially lines on a map with no active management (Carey et al. 2000; Rife et al. 2013). As such, there is increasing recognition that protection must be married with effective management that maintains or improves ecosystem functions to realize full conservation benefits (Gaston et al. 2008; Bertzky et al. 2012; Hockings et al. 2015). While these lessons have emerged from scrutiny of public protected areas (Leverington et al. 2010), they apply equally to privately protected areas.

Private lands harbor a high proportion of threatened species and habitats (e.g., Scott et al. 2001), provide important ecosystem services (Villamagna et al. 2015), and can assist in the creation of corridors between or buffers around existing protected areas (Fitzsimons & Wescott 2008). Effectively protecting these values requires that privately protected lands receive regular management to counteract past land uses or current threats (Farrier 1995) along with monitoring to determine the ecological response to management activities (Kiesecker et al. 2007) and the overall efficacy of the conservation programs (Kamal et al. 2015). Many of the same obstacles exist in effectively managing private and public lands, such as comprising relatively small or isolated areas of remnant vegetation (Stolton et al. 2014) and requiring varying intensities of restoration and management to remedy degradation caused by past land uses (Farrier 1995). Yet privately protected lands also face changes in ownership over time, with new owners (hereafter successive owners) having different understandings of the properties' management needs (Mendham et al. 2012) and varying knowledge of or social norms regarding land management (Halliday et al. 2012; Minato et al. 2012). Achieving the best outcomes for biodiversity across these properties requires sufficient support at local and regional levels to facilitate management and monitoring (Stolton et al. 2014).

Private properties with conservation covenants on title (also known as conservation easements; see Chapter 1) suffer from all of the challenges mentioned above. Given the primary intent of conservation covenants is to protect or enhance natural values, such as biodiversity (Cowell & Williams 2006), ongoing, active management (e.g., pest control, revegetation) is essential to maintain or restore these natural areas (O'Connell & Noss 1992;

Fitzsimons & Carr 2014). While the covenants specify restrictions to land uses and activities on the property, additional proactive management obligations may be outlined in an accompanying management plan, but are only legally binding if written into the legal document (Fitzsimons & Carr 2014). Management plans are often developed while the covenant is being established, or soon after, and provide landholders with objectives and guidance about appropriate actions to take on the covenanted property. They can range from general guidelines to detailed activity plans, and are intended to be reviewed and updated over time with changing environmental conditions or ownership (e.g., Govt of Western Australia 2010; Trust for Nature 2017; Native Vegetation Council 2017). One role of the covenant providers is to “ensure that adequate, ongoing management does in fact take place” (Cowell & Williams 2006, p. 10).

The specific management needs of properties vary enormously by location and environmental condition but in Australia generally include control of pest species (plants and animals), bushfire management, boundary security, and restoration or revegetation (Halliday et al. 2012; Race et al. 2012; Beilin et al. 2013). Achieving biodiversity goals on private land depends in large part on the landholders themselves being willing to undertake necessary and effective management (Pannell et al. 2006; Chapter 3), especially where covenant providers are unable to monitor or enforce covenant agreements (Fitzsimons & Carr 2014). The adoption and continued implementation of sustainable management practices by agriculturalists has been suggested to depend on three key elements: the landholder’s willingness, their ability, and their engagement with support networks (Mills et al. 2017; see Chapter 1). A landholders’ ability is critical to undertaking active management and depends on characteristics of the land (e.g., property size, terrain), the landholder (e.g., physical ability), and their resources (e.g., finances and knowledge) (Dayer et al. 2017; Mills et al. 2017). All three elements are important to achieve sustainable and durable environmental management (Mills et al. 2017), therefore it is critical to understand the ability of landholders who have entered into agreements that commit them to managing their properties for conservation. Here I focus on how the ability of landholders with conservation covenants on their property (hereafter covenantors) influences the degree to which they undertake and persist with management and monitoring activities on the covenanted property.

Previous research into the challenges and opportunities of environmental management has focused primarily on farmers' management practices (Race et al. 2012; Jellinek et al. 2013; Mills et al. 2017). However, the covenanting population comprises both farmers and non-farmers (e.g., Moon & Cocklin 2011), thus a broader range of perspectives than just those who are production-focused need to be considered to adequately assess the ability of covenantors to manage or monitor their properties. Filling this knowledge gap is critical for understanding the current ecological outcomes of covenanting programs (Rissman et al. 2013; Fitzsimons & Carr 2014) and whether they are likely to persist into the future.

There are many reasons to suspect that the factors influencing the ability of covenantors in general may not be the same as those for farmers specifically. For example, covenantors encompass a wide range of personal, social, and economic circumstances (Appendix D) and have varying levels of knowledge of natural resource management (NRM) (e.g., Harrington et al. 2006). Moreover, covenantors include landholders who are original signees to the covenant or successive owners who purchased or inherited a property with a covenant already in place. Successive owners can have different attitudes towards the covenant (Stroman & Kreuter 2015) and less familiarity with the property and management plan than the original signees (Fitzsimons & Carr 2014). There is also a high portion of absentee owners, whose rural property is not their primary residence (Appendix D). Based on a review of forest, range, and farm owners in the USA, Petrzalka et al. (2013) found that land management activities were less likely to be conducted by absentee landholders than owners who reside on the property, due in part to less available time or lack of connections with management advisors. The decreased time spent on the covenanted property by absentee owners relative to residents can likewise impact their ability to recognize and respond to management needs (Farmer et al. 2015; Stroman & Kreuter 2015). Although successive and absentee owners are a growing portion of the private ownership landscape (Mendham & Curtis 2010; Fitzsimons & Carr 2014), it is unknown how they might differ with regards to management ability from original signees or resident owners, respectively.

Extending the body of research regarding management ability on private lands, this study provides a nationwide assessment of the extent of management and monitoring occurring on covenanted properties in Australia. The aim was to identify the factors limiting covenantors' ability to undertake management and monitoring on their properties,

understand whether those challenges vary among different types of covenantors, and identify opportunities to facilitate effective management of conservation covenants.

Methods

To explore the management activities undertaken by covenantors and the management challenges they face, I used a mixed methods approach combining qualitative and quantitative datasets as detailed in Chapter 2. Qualitative data used in this chapter stem from four open-ended questions asked during interviews with covenanted landholders:

1. *Can you tell me a few details about your property and the portion of it that's covenanted?*
2. *Is there a management plan for the covenanted property?*
3. *What kind of management and monitoring activities occur on the property?*
4. *Are your current activities on the covenanted property different than what you would do if it were not covenanted?*

Additional qualitative data is drawn from interviews with 18 key staff members across several major covenanting programs (details in Chapter 2). The interviews captured covenant provider perspectives about the expectations on covenantors with regards to management and monitoring, the development of management plans, and support available to covenantors to undertake the activities (described further in Chapter 2).

Quantitative data used in this chapter are derived from an online survey available to covenantors throughout Australia, in which they were asked a range of questions about their covenanted property (details in Chapter 2). This chapter presents data related to covenantors' demographic and property characteristics, along with responses from two closed-answer survey questions focused on management activities and challenges:

1. *What types of management and monitoring activities do you implement on the covenanted property, and with what frequency do they occur on average?* For each activity following the question, respondents selected from a 6-point Likert scale: daily, weekly, monthly, yearly, every five years, and never.
2. *What challenges do you experience when trying to manage the covenanted area?* Respondents selected up to three reasons from a list of nine options, including an open-ended response for "other".

Qualitative analysis

The interview transcripts were open-coded via an inductive category development method, in which individual codes emerged from the data and were used to capture distinct ideas and concepts (Braun et al. 2015; details in Chapter 2). While the interview responses provided extensive detail about covenantor circumstances and activities, I specifically coded items pertaining to difficulties encountered during the management or monitoring of their properties. I then grouped individual codes into themes to capture related concepts (Braun et al. 2015). To determine percentages per code and theme, each covenantor was reflected once per code regardless of how often they mentioned the same idea during the interview (i.e., percentages are based on number of sources rather than number of references); similarly, after aggregating responses into themes, the percent of interviewees per theme was calculated such that each covenantor was reflected once per theme even if their responses fall into multiple codes within that theme (Bazeley & Jackson 2013). Transcripts were coded using QSR International's NVivo 11 qualitative analysis software. Codes and themes were validated by researchers involved in the project (see Chapter 2). To help contextualize the covenantor results, key informants' comments about management plan development, management expectations, and resource limitations are also presented. To maintain anonymity of all participants, quotes cited in results are referenced as L# (e.g., L30) for landholder interviewees and S# for staff interviewees.

Quantitative analyses

The demographic characteristics of covenantors who did or did not conduct management activities on the property were compared descriptively, as were their responses to management challenges. In addition, to explore the activities of, and challenges facing, different types of covenantors, respondents were categorized as: (1) original signees or successive owners, and (2) resident or absentee owners. All quantitative analyses were conducted in IBM SPSS Statistics 23.0 (IBM Corp., Armonk, NY, USA).

Results

Covenantor and property characteristics

The interviewees represented 82 covenanted properties across New South Wales (NSW; n=19), South Australia (SA; n=20), Tasmania (TAS; n=17), and Victoria (VIC; n=26). A total of

329 surveys were suitable for inclusion in the analysis (i.e., respondents answered the majority of questions about demographics, property characteristics, and management). The majority of survey respondents (90%) were covenantors in NSW, TAS, VIC, and Western Australian (WA), states that include 60% of covenants in Australia (see Chapter 3, Table 3.1), while the remainder were from SA and Queensland (QLD). Covenantor and property characteristics were similar among interviewees and survey respondents (although not all demographic data was collected from interviewees). Full details of the program, property, and covenantor characteristics for all interviewee and survey respondents are provided in Appendix D. Most covenantors were original signees to the covenant, owned a single covenanted property of relatively small size (<100 ha), and did not earn income from the property. Nearly half of the covenantors were absentee owners. Survey respondents were primarily older (≥ 55 years), well-educated, and with a mix of work status and annual incomes. Approximately half the respondents said they had experience with land management prior to taking on a conservation covenant.

The majority of survey respondents (89%), and all but one interviewee, said they conduct some management activities on the covenanted property (Appendix D). Compared to covenantors who did conduct management activities, a higher proportion of those who did not conduct management activities were successive and/or absentee owners, located in TAS, worked full-time, or had higher annual incomes (Table 4.1). A higher proportion of covenantors who did not have, or were not aware of, a management plan for their property were also not conducting management activities (Table 4.1). Although most interviewees reported conducting management on their property, 23% noted their properties were in good condition (47% of whom lived in TAS) and thus required minimal management beyond occasional hand-pulling of weeds or general oversight. Since no data were collected on the condition of properties, it is unknown whether survey respondents likewise considered active management unnecessary if they had properties in good condition.

Table 4.1. Counts and percentages of survey respondents' program characteristics, property characteristics, and demographics, based on whether they conduct management activities on the covenanted property (Yes, n=290; No, n=37).

Covenanted property (Yes, n=258; No, n=57)						Conduct management					
						Yes		No			
						#	%	#	%	Total	
Program characteristics						Covenantor characteristics					
Signee						Resident					
Original	217	90.4	23	9.6	240	Yes	157	92.4	13	7.6	170
Successive	49	80.3	12	19.7	61	No	130	84.4	24	15.6	154
RevFun	11	84.6	2	15.4	13	Work status					
LanMan	13	100.0	0	0.0	13	Full-time	72	79.1	19	20.9	91
State						Part-time	82	91.1	8	8.9	90
NSW	64	97.0	2	3.0	66	Retired	103	93.6	7	6.4	110
QLD	10	100.0	0	0.0	10	Other	20	87.0	3	13.0	23
SA	20	87.0	3	13.0	23	Age					
TAS	41	70.7	17	29.3	58	25-34	6	100.0	0	0.0	6
VIC	110	92.4	9	7.6	119	35-44	12	80.0	3	20.0	15
WA	45	88.2	6	11.8	51	45-54	47	83.9	9	16.1	56
Year covenant registered on title						55-64	103	88.0	14	12.0	117
pre-1996 (>20 yrs)	94	92.2	8	7.8	102	65-74	94	91.3	9	8.7	103
1996-2005 (11-20 yrs)	98	88.3	13	11.7	111	75+	16	88.9	2	11.1	18
2006-2015 (≤10 yrs)	79	85.9	13	14.1	92	Education					
Size of covenanted area (ha)						Secondary school	38	86.4	6	13.6	44
<20	81	86.2	13	13.8	94	Trade course/cert.	32	91.4	3	8.6	35
20-100	100	85.5	17	14.5	117	Advanced diploma	29	80.6	7	19.4	36
>100-500	30	90.9	3	9.1	33	Bachelor degree	78	87.6	11	12.4	89
>500	10	100.0	0	0.0	10	Postgraduate degree	99	90.8	10	9.2	109
Management plan						Annual Income					
Yes, is current	218	92.8	17	7.2	235	<\$25,000	31	93.9	2	6.1	33
Yes, is not current	24	88.9	3	11.1	27	\$25,001-\$50,000	69	90.8	7	9.2	76
No	36	78.3	10	21.7	46	\$50,001-\$75,000	53	88.3	7	11.7	60
I do not know	9	56.3	7	43.8	16	\$75,001-\$100,000	39	83.0	8	17.0	47
Property characteristics						>\$100,000	64	85.3	11	14.7	75
Year of property ownership						Number of covenanted properties owned					
pre-1996 (>20 yrs)	19	86.4	3	13.6	22	1	240	87.9	33	12.1	273
1996-2005 (11-20 yrs)	86	86.9	13	13.1	99	>1	37	90.2	4	9.8	41
2006-2015 (≤10 yrs)	159	90.9	16	9.1	175	Previous experience with land management					
Generate income in from property*						Yes	149	92.5	12	7.5	161
Yes	71	84.5	13	15.5	84	No	129	83.8	25	16.2	154
No	216	90.4	23	9.6	239						

*Includes primary production, hobby farm, or ecotourism on either covenanted or non-covenanted portion of property.

Administration of covenants

Information about and staff perspectives on covenanting programs, management plans, and expectations placed on covenantors were provided during the key informant interviews. A common element to all covenant programs is the covenant document, which outlines the broad restrictions placed on the property, and an associated management plan, which describes desired management activities on the property. While covenant documents vary among providers, they are relatively standardized within an organization. Management plans, however, vary by property according to conditions and management needs, and are

intended to be routinely updated (e.g., every five to ten years or when there are new owners). In the past, covenants did not always include the development of a management plan, but management plans are now required by all providers before the covenant is registered on title. As such, *“there’s a lot of old covenants out there with no management plans”* (S06), although the covenant providers aim to create plans for those covenants as resources allow. Management plans typically provide baseline information about: the natural values and condition of the property; detail about the covenant requirements (i.e., *“maintaining the covenant to its bare minimum standard”* [S05]), such as restrictions on grazing or firewood collection; and additional guidelines or management prescriptions that counteract threatening processes, such as feral animal control, weed control, or erosion control. Minimum management requirements follow those placed on all landholders under existing legislation (e.g., the Victorian *Catchment and Land Protection Act 1994*); management activities beyond that was typically negotiated based on landholder interest.

“[Improving environmental conditions on a property] is always optional, but we can’t hold them [the covenantors] to it. It’s more about maintaining, and enhancing if possible. We can’t require someone to put in that effort to enhance it, other than specific control actions like weed control and fencing works. If something’s been identified as a management threat, then we can require them to treat the weeds, that sort of thing.” (S13)

Although the level of specificity or inclusivity depends on the covenantors’ level of interest and ability, some plans are *“quite prescriptive because the agreements were often signed with some money. So they had to do a certain amount of weeding, for example, and then there was a kind of recognition of payment for them.”* (S17). Similarly, monitoring is encouraged by the covenant provider and descriptions may be included in the management plan, but it is not required unless tied to particular projects or funding.

“We encourage landholders to do monitoring, but generally people haven’t got much time... There’s no obligation on landholders to do monitoring unless they’ve been funded to do so under a management grant.” (S30)

Monitoring might include the use of photo points (i.e., photographs taken in a specific location, direction, and time of year) to assess vegetation change over time, create species lists, or anecdotal observations of shifts in condition. Covenant providers have various approaches to monitor conditions on properties themselves, although this is not

systematically applied, being often tied to regional objectives or conducted opportunistically.

Covenants signed under a particular funding program or mechanism tend to place the greatest management expectations on landholders, although covenant providers are not always able to enforce conditions. Covenant providers reported keeping management plans fairly simple and straightforward because covenantors encompass a wide range of interest, knowledge, and capacity with regards to managing the property. *“What gets difficult is when you have someone that’s either physically or financially not able to do something... so we have to be realistic about what people can do.”* (S13). Covenant providers aim to contact covenantors periodically, as a means to create or sustain relationships with the covenantors and to view the property, although this varied with provider capacity. At best, providers were connecting with landholders about once per year by phone or in-person; typically contact was made every few years.

“[We have] One and a half FTEs [full-time employees] responsible for the whole state. So, 800 covenants, 100,000 hectares, 500 landholders. When you do the numbers, it works out to one visit per landholder between five to ten years... which isn't much.” (S11)

Limited connections with covenantors was mainly due to insufficient resources within the covenanting programs. Staff across all states noted a decrease in government funding to environmental departments in recent years, which impacted covenanting staff. Funding cuts reduced stewardship visits and enforcement, slowed the signing of new covenants, and limited financial support to covenantors for management activities.

“We're not able to [provide funding for management activities]... [We] will help them apply for funds elsewhere, but the availability of funds to help with that sort of thing has come and gone with various other Commonwealth programmes.” (S08)

Management plans and activities

Survey responses show most covenantors have up-to-date management plans (73% of all respondents; Table 4.1), although interview data suggests the existence of plans did not always influence or guide the covenantors’ activities. Interviewees described the relevance

of the plans as ranging from being central to directing their management activities (e.g., L10) to being relatively unimportant (e.g., L14).

“The plan includes timelines and strategies and investigations and further directions and monitorings and so on... It’s for my own benefit, because I don’t know what to do unless I kinda know what’s going on and keep track of it. It’s a big place. You can get lost in just thinking about it.” (L10)

“Theoretically we do [have a management plan], but as for having a fancy document and something that we read every night before we go to bed, we’re not quite into that. But it’s just basic common sense. We know what weeds can be a menace around here...” (L14)

Covenantors were aware that the lack of a specific management plan did not absolve them of their management responsibilities. One covenantor who did not have a management plan explained, *“We just basically have to keep all stray animals off there and keep the rabbits under control... And otherwise, with as little interference as possible, let nature take its own course.” (L28).*

Controlling pest plants and animals were the dominant activities on the majority of properties (Fig. 4.1; Table 4.2). Plant species noted most often by interviewees included horehound (*Marrubium vulgare*) and blackberry (*Rubus fruticosus* aggregate) in VIC, lantana (*Lantana camara*) in NSW, gorse (*Ulex europaeus*) in TAS, and Cape broom (*Genista monspessulana*) and English broom (*Cytisus scoparius*) in SA. Weed coverage ranged from a few scattered individual plants to patches of several hectares or more. Common pest animals managed included feral predators, such as cats (*Felis catus*), red foxes (*Vulpes vulpes*), and cane toads (*Rhinella marina*), to protect native wildlife. Rabbits, pigs, goats, deer and kangaroos were controlled to protect native vegetation and revegetation efforts. Specific activities and efforts needed to deal with the species varied across properties and levels of infestations, typically related to past and neighboring land uses.

“Because what we’ve got is essentially as good as you can get, there’s not really anything that needs to be done, except to minimize threats that may occur in the future.” (L51)

“I’d estimate we probably put somewhere in the vicinity of about 10,000 liters of brush-off herbicide to try and control the blackberries in the back gully. And it’s probably as bad now as when we got here, to be quite honest. So there’s a lot of work still to go.” (L57)

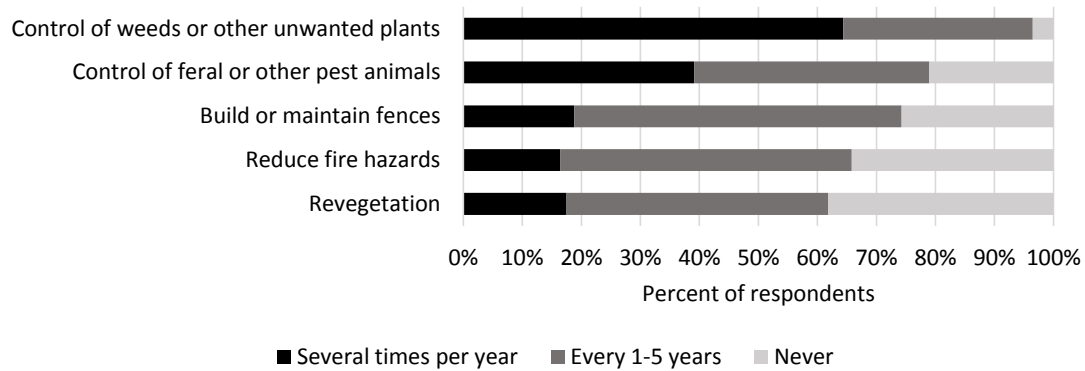


Figure 4.1. Type and frequency of management activities conducted by the subset of survey respondents (n=290) who said they manage the covenanted property.

Interview data showed that some activities, such as fencing and revegetation, were often limited by resources, and therefore tended to be undertaken when funding was available, such as offered by covenant providers when the covenant was signed or through local or regional management grants (e.g., Landcare). Fuel reduction and fire management were considered important (Table 4.2), but only four interviewee properties were involved in controlled burns. Activities noted less frequently were creating habitat to encourage wildlife (e.g., nest boxes), and erosion control along creeks (Table 4.2), usually associated with specific funding.

Although general oversight of the property was common (90% of survey respondents and 93% of interviewees conducted at least one type of monitoring activity; Fig. 4.2), monitoring to assess the effect of management practice was rare. Providers neither required nor expected monitoring beyond general oversight under standard agreements. Interviewees often interpreted monitoring to be mainly opportunistic and anecdotal, “*keeping an eye out*” (L06) for certain plants or animals rather than formal assessment of change in biodiversity or environmental condition over time. Interviewees who monitored did so either for personal interest or to meet requirements of management grants or offset funding.

Table 4.2. Types of management and monitoring activities undertaken on covenanted properties based on qualitative data, including examples of activities and barriers that limit management effectiveness.

	Activity	Description	Barriers
Common and/or required activities	Control weeds or unwanted plants	Hand-pull or spot-spray small patches; chemical or mechanical removal of large patches	<ul style="list-style-type: none"> - Inability to identify undesirable species - Concern about or inexperience with using chemicals - Lack of broader, coordinated effort with other landholders and properties, limiting effectiveness
	Control feral or pest animals	Reduce habitat where applicable (e.g., remove rabbit warrens); use lethal control (e.g., poison bait, trap, shoot); construct exclusion fences	<ul style="list-style-type: none"> - Inability to identify undesirable species - Concern by owners or neighbors about using animal bait products - Lack of broader, coordinated effort with other landholders and properties, limiting effectiveness
	Build or maintain fence lines and access tracks	Walk or drive along tracks or boundary to assess and clear; build new fences or tracks. Also possible to clear out unwanted fences or revegetating unwanted tracks	<ul style="list-style-type: none"> - High cost of fencing - Difficulty coordinating with neighbors for construction or payment of boundary fences
Optional but not obligatory	Revegetation of native plant species	Encourage recruitment by limiting herbivory (e.g., tree guards); supplemental planting in remnant patches; revegetate cleared/disturbed areas* (direct seeding or tubestock); use of controlled burns	<ul style="list-style-type: none"> - Limited knowledge of historic or desired species - Difficulty finding local varieties - Time frame in which project funds must be used is incompatible with best environmental conditions for planting
	Reduce fire hazards	Remove excess dead wood; use livestock grazing to reduce buildup; maintain fire breaks and access tracks; use of controlled burns	<ul style="list-style-type: none"> - Lack of knowledge about where, when, and how to conduct controlled burns - Difficulty coordinating with appropriate entities for controlled burns - Disagreement between covenantors and covenant providers about use of grazing
	Erosion control	Revegetation (see above); create berms or other small-scale structures to control run-off	<ul style="list-style-type: none"> - Inability to coordinate with neighbors where erosion issues stem from surrounding properties
	Encourage native animals	Use nest boxes; revegetation and/or feral animal control as noted above; active reintroduction of desired species	<ul style="list-style-type: none"> - Isolation of properties or habitat (limiting movement of native species) - Lack of broader, coordinated effort with other landholders/properties
	Observations and monitoring	Opportunistic observations; maintain records of management activities and/or species sightings; use photo points; use wildlife cameras; use repeated and/or systematic measurements	<ul style="list-style-type: none"> - Knowledge of and ability to identify species - Lack of or unclear objectives

*Usually occurring in areas outside of or adjacent to the covenanted portion of property.

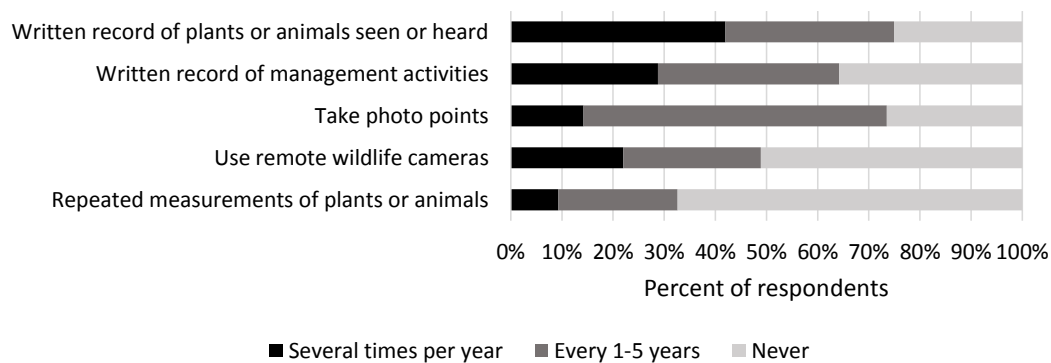


Figure 4.2. Type and frequency of monitoring activities conducted by the subset of survey respondents (n=290) who said they manage the covenanted property.

Barriers to effective management

External issues along with financial and time constraints were common to both the interviewees and survey respondents, while interviewees gave greater importance to knowledge constraints (Fig. 4.3, Table 4.3), discussed in more detail below. Of the external impediments noted by interviewees, issues arising from neighboring properties was by far the most common complaint (Table 4.3).

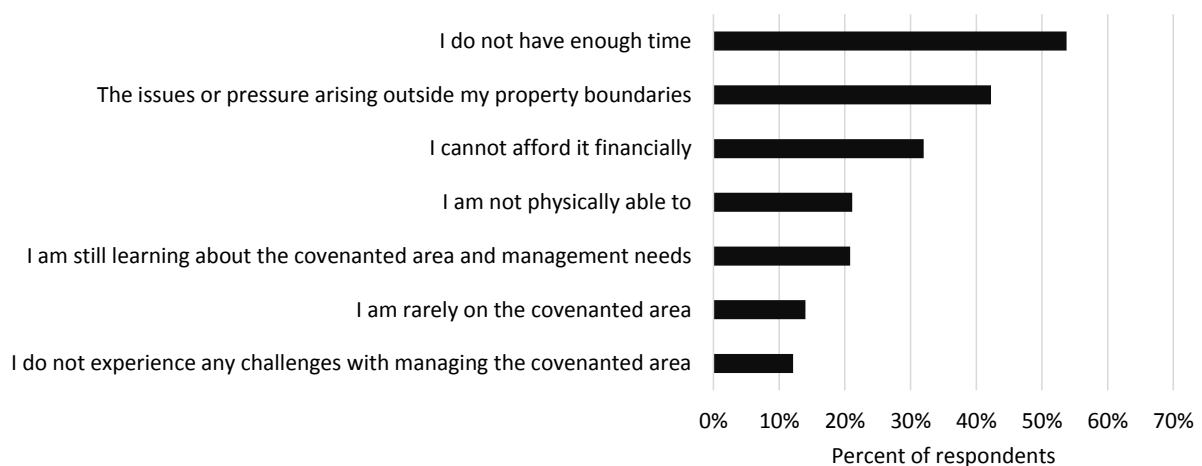


Figure 4.3. Percent of survey respondents (n=322) who indicated each challenge was among the top three challenges they face when managing the property. Respondents could select three or fewer choices.

Table 4.3. Land management challenges as described by interviewees (n=82). Individual codes have been grouped by theme. Interviewees could be included in more than one code and more than one theme but are only counted one time per each.

Challenges	% of interviews	Indicative samples
<i>Covenantor impediments (72%)</i>		
Knowledge constraints	35%	<ul style="list-style-type: none"> - "We had a botanical survey done [and] when the botanist came out, she got a real shock. All along the river was this berberis, and we'd seen it spreading over the years but we didn't know it was a weed. We thought it was just a pretty native plant and the birds seemed to love it." (L36) - "I've got areas of remnant rainforest that I'm trying to restore... they have now got in them occasional advanced eucalypts [whose] presence represents an ongoing threat to the rainforest... But it's a magnificent big eucalypt. The dilemma is, should you kill it?" (L62) - "Certainly when we started out, it would have been really useful to be able to talk to some people who'd sort of been there before us and could give us advice. We didn't really get that. We sort of feel we've discovered a lot ourselves, and we're still discovering." (L67)
Financial constraints	33%	<ul style="list-style-type: none"> - "There are [funding] programs that I could apply for, but the sort of amounts they've got available nowadays are so low, and the amount of work you've got to do is so huge that it's hardly worth it." (L16) - "I looked at applying for funding, but of course they don't fund for fencing. So that's out. And if I had to do it myself it would be about \$50,000." (L27) - "We're quite happy to have [the property] but we can't actually manage it... We have problems finding enough money... I'm looking at clearing a bit around the fence-lines just to improve light and act as a fire buffer and that's \$5,000 worth of work just to do that." (L39)
Time constraints	18%	<ul style="list-style-type: none"> - "I mean, to be quite honest, we just have been so busy with a whole range of things, I haven't got back to revising or reviewing the management plan, but it'll happen in due course." (L57) - "I got a tiny weeny bit of funding once to start some surveys from particular points. But... I just ran out of time in the end. Family commitments and that." (L76)
Physical constraints	16%	<ul style="list-style-type: none"> - "[Using] the chemical sprays, you know, it's too dangerous, and we just go and hire a contractor. And we've spent a lot of money on contractors." (L30) - "I manage the place on my own. One of the issues since the [car] accident, is my back's not what it used to be." (L37)
Difficult terrain	9%	<ul style="list-style-type: none"> - "And what happens in the very steepest slopes... by the end of the season, when the thistles are getting be in flower, we're just exhausted. Going up and down very steep, rocky slopes with a backpack..." (L38) - "We have to employ people to help us because some of it's very steep. We can't do it ourselves." (L78)
Distance from property	6%	<ul style="list-style-type: none"> - "To [deal with the weeds] properly would be a lot of work. We're not up there enough to really do it properly." (L02) - "It's difficult looking after a property like this [that's] five or six hours away. We had problems with the neighbor's cattle getting in. We have people down there that were supporting us in looking after the place, but it's just so difficult." (L54)
<i>External impediments (72%)</i>		
Influence of neighboring properties	51%	<ul style="list-style-type: none"> - "One year we had the fence between us and our neighbor fall over and all these cattle came in... that was just after one of our tree planting festivals, and the cattle ate most of the plants that we'd planted, so we had to start again the next year." (L16) - "Foxes are a big problem, and in the past we haven't been able to bait for those because our neighbors had dogs and we're too close to their land." (L18) - "There's a new owner on the west side and he's bulldozing everything he can on this property... They don't weed their property, so there's threat of groundsel bush coming onto mine." (L25)
Impact of trespassers	18%	<ul style="list-style-type: none"> - "I had an old quarry road on the northern part of our place and some dirt bikers were coming in. We were remediating the track, but the bikers were coming down and destroying it." (L15)

Need broad-scale management	15%	<ul style="list-style-type: none"> - “Soon after we got [the property], there was some enterprising locals that decided they'd grow some marijuana out there.” (L76) - “So whatever I did on my property to do with weeds or feral cats, it's just not gonna make a difference if other people nearby aren't doing the same. So there are certain site-based problems you can manage... But there are other environmental pressures that are so broad and regional that I think expecting landowners to manage them is not going to work.” (L31) - “The other thing is, the forest has got quite a lot of deer... I mean, our view is that we'll monitor those... but I don't feel a responsibility to address the issue of deer personally. I think it's an issue for the forest owners.” (L49)
Controlled burn limitations	9%	<ul style="list-style-type: none"> - “We're interested in trialing some little ecological burns, but the risk of things getting out of control tempers our enthusiasm a little bit. And... because of the legislative agreement that we've had to protect the vegetation, we have to prove that by undertaking a fire, that we're only improving the vegetation.” (L12) - “The fire people said [the property] is just not worth burning, it's too small... Unless we can involve all the neighbors.” (L42)
Development pressure	6%	<ul style="list-style-type: none"> - “Every time the local council released a new local plan or whatever, you'd hold your breath and wonder what your land is going to be zoned and whether you would be able to afford to stay and would you be able to maintain the natural values of the place as suburbia crept closer and closer. We're in a really suburban area now. We weren't when we first bought the land, but it is now.” (L45)
Wildfire	6%	<ul style="list-style-type: none"> - “[My neighbor's land] is all bare and devoid of native veg and that was an advantage in the fire... his didn't burn as hot... whereas in mine it stuck around because it had so much to burn. And that's the double-edged sword of a heritage listing.” (L81)
Weather	5%	<ul style="list-style-type: none"> - “The last two summers have been dry and hot... so everything was dying. If you look around, you just see dying eucalypts everywhere... So there was hardly any success with all the tree planting here... maybe a quarter survived [of the 1,500 planted].” (L05)
Wildlife disease	4%	<ul style="list-style-type: none"> - “So a lot of our bigger white gums, which were what interested us most... are dying cuz of this ginger syndrome.” (L38) - “The wombats have got mange... and last year, we had about ten pademelons die from toxoplasmosis.” (L39)

Structural impediments (39%)

Lack of continuity	15%	<ul style="list-style-type: none"> - “But unfortunately, a patch that big, you can't get [all the weeds] the first time around. When I applied for more money, there had been a change of government and they said, sorry you can't have the money.” (L30) - “There's a lot of staff turnover [and] they inherit half-done projects. This new employee, when I mentioned to her about [our management issue], she was totally unaware of it.” (L56)
Lack of knowledge-sharing	15%	<ul style="list-style-type: none"> - “There's a whole lot of really rare species that are using this place that [the covenant provider] didn't know about and they still don't know about cuz we haven't actually entered the data or told them.” (L22) - “I think what would be really beneficial would be a mechanism by which different covenant owners – and I live in an area with a lot of covenants – could share experiences and advice.” (L31)
Issues with management plans	15%	<ul style="list-style-type: none"> - “We've developed our own management plan. If it was left to anyone other than the landowner to do, it wouldn't be done.” (L15) - “I'm specifically not allowed to graze on the covenant. But my argument would be that in these grassy areas where there's not a tree in sight, letting them [the cattle] in there for a week occasionally... would be good for them and would cut the grass down.” (L38)
Lack of researcher connections	5%	<ul style="list-style-type: none"> - “Our original vision when we came here was to try and encourage uni students and others to partner with us. But we found it very difficult to make any headway on that.” (L67)

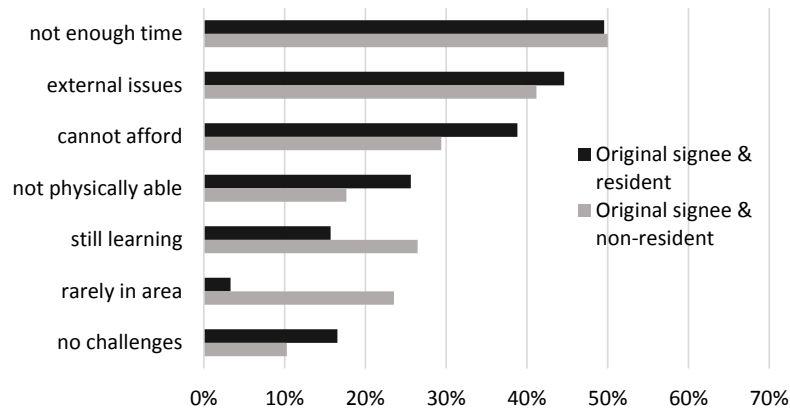
Covenantor impediments

Covenantor impediments among interviewees were common (72%; Table 4.3) and included a variety of factors related to the covenantor (e.g., knowledge and financial constraints) or their property (e.g., the condition of the covenanted area). Financial constraints often interacted with time constraints, requiring covenantor to prioritize their actions. Time constraints not only limited the amount of management accomplished, but also the ability to source grant funding to help with management. Physical limitations also interacted with financial constraints, which restricted the ability of covenantors to bring in contractors when they were not able to conduct management themselves (Table 4.3). Quantitative data indicated that lack of time was more of an impediment for successive owners compared to original signees (Fig. 4.4). Absentee owners noted many of the same challenges as resident owners (Fig. 4.4). While often less limited by financial or physical constraints than residents, absentee owners were more likely to be still learning about the property and its management needs (Fig. 4.4). Covenantors who did not conduct management activities were primarily challenged by limited time, limited financial capacity, and being rarely on the property (Fig. 4.5). Only 14% selected external issues compared to 46% of those who did conduct management activities (Fig. 4.5).

External impediments

External impediments were reported by 72% of interviewees (Table 4.3) and by 42% of the survey respondents (Fig. 4.3). These edge effects resulted in additional effort by, and added cost to, the covenantor (e.g., dealing with weed encroachment) or restricted their choices for action (e.g., unable to use poison baits because of neighbors' pets). Trespassers who poached or vandalized the property (Table 4.3) were noted more often as an issue for absentee owners interviewed (30%) than for residents (9%). Several covenantors noted that broad-scale issues like wide-ranging pest species required similarly broad-scale management, and thus they avoided management actions that they considered futile without coordination across multiple properties or at regional levels.

A. Original signee: resident vs non-resident



B. Successive owner: resident vs non-resident

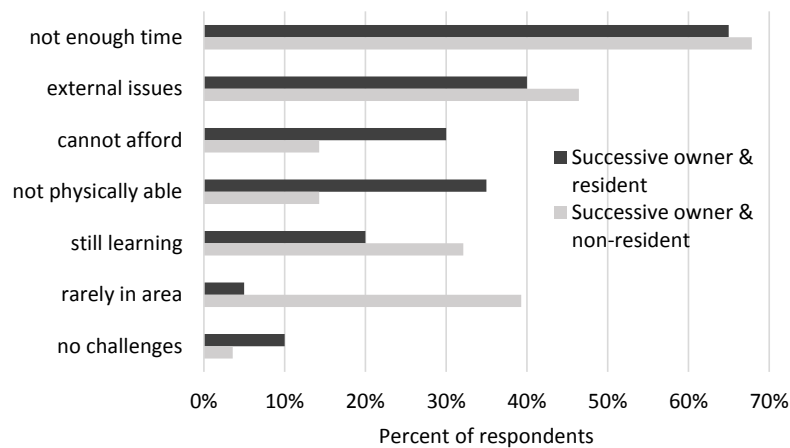


Figure 4.4. Percent of survey respondents who reported being affected by different challenges, separated by whether they were: A. Original signee and resident (n=142) or non-resident (n=92) on the covenanted property; and B. Successive owner and resident (n=23) or non-resident (n=38) on the covenanted property.

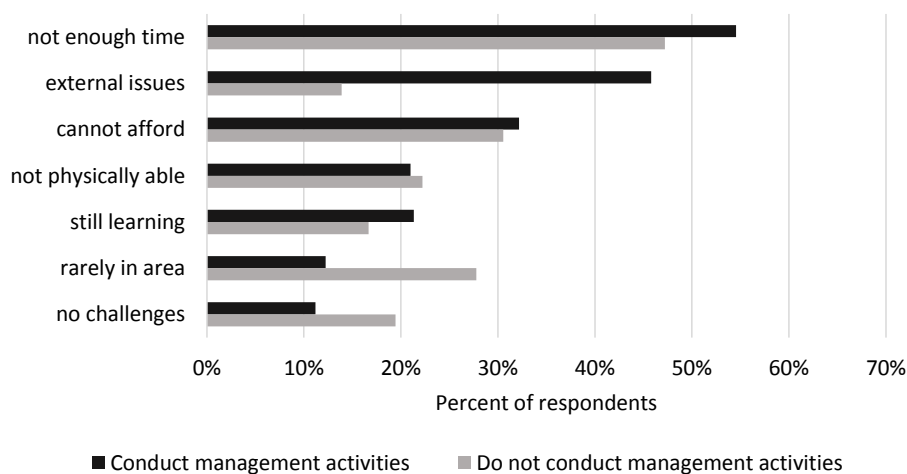


Figure 4.5. Challenges reported by survey respondents for those who do (n=286) and do not (n=36) conduct management activities on their covenanted properties.

Structural impediments

A small proportion of interviewees identified formal or informal rules or procedures relevant to covenanting which constrain their management ability (Table 4.3). The lack of continuity in funding programs for land management, the changes to or reduction of staff within the covenant providers, and the limited ability to connect with other covenantors were the most common frustrations.

Discussion

Conservation covenants in Australia are promoted as a means to protect or enhance biodiversity and other natural values on private lands (Australian Government 2018b). However, it is recognized that positive environmental outcomes depend in large part on the ongoing actions of owners and land managers of the covenanted properties (Fitzsimons & Carr 2014). It is thus essential to understand the factors that promote or inhibit a landholder's ability to effectively manage their property (e.g., Lockwood et al. 2015). This study is one of the first to provide insight into the management activities undertaken on covenanted properties and the perspectives of covenantors and covenant providers regarding the challenges faced in managing their properties.

As with many land managers throughout Australia (Cresswell & Murphy 2017), covenantors are primarily occupied by pest plant and animal control on their properties, which are obligations on all landholders under existing legislation and addressed through state- and national-level strategies (e.g., IPAC 2016a, b). Most covenantors appear to be meeting the minimum requirements of the covenant agreements and expectations of the covenant providers (e.g., pest control or fence maintenance), with a smaller portion of covenantors going beyond the minimum requirements (Fig. 4.1; Table 4.2).

Covenant providers place relatively low expectations on covenantors to undertake management action, possibly in recognition of the constraints on both parties. Whether achieving these minimal management expectations is sufficient to maintain or improve habitat for biodiversity is beyond the scope of this current work; however, it is clear from the landholder and staff interviews that the process of developing a management plan is a much-needed opportunity for covenantors and covenant providers alike to become familiar

with the ecological conditions on the property, the threats to biodiversity, and options to reduce those threats. Covenant providers – in their role as administering the covenanting programs and representing one of the parties in these multi-party covenant agreements – are responsible for ensuring that “adequate, ongoing management does in fact take place” (Cowell & Williams 2006, p. 10). At a minimum, this responsibility should extend to developing and updating management plans for each property. However, constraints on providers mean that establishing and updating management plans for properties is not always accomplished.

Covenantors who manage beyond minimum requirements do so out of personal interest and as time and money allow. The barriers covenantors face that influence their ability to manage, such as time constraints, the cost of management, or lack of knowledge about appropriate management options, are common to land managers in many Australian contexts (Race et al. 2012; Jellinek et al. 2013; Meadows et al. 2014). A lack of financial and technical assistance to help with land management are persistent challenges for covenantors (Stephens et al. 2002). Although these same challenges are experienced by managers of public land (Cook & Sgro 2018; Addison et al. 2017), private land conservation is further complicated by the aging population of covenantors (76% of covenantors are 55 or older; Table 4.1). Covenantors will face increasing physical constraints as they age and financial constraints as they retire, limiting their ability to do the work themselves or hire contractors in their stead. Furthermore, the growing pool of successive owners, who purchase or inherit land covenanted by these older covenantors, indicated a lack of knowledge about the property and management issues (Fig 4.4), and will thus require more support from covenant providers, placing greater strain on already limited resources.

Opportunities exist to access funding and advice from groups external to covenant providers to enable more management, but comprise additional challenges: these support services have not kept pace with the increasing number of covenants nor management issues; funding comes with conditions on when the money must be spent and is often focused on regional priorities that do not always match landholder needs (e.g., Cooke & Hemmings 2016); application processes can be disproportionately complex relative to the funding amounts offered; and/or the information provided may not be relevant to covenantors’ needs (e.g., targeted at agriculture rather than conservation properties; see Chapter 5).

Continuity of funding is important for ongoing management problems. The current situation in Australia of transient programs and short term funding commitments (e.g., Metcalfe & Bui 2017) are suited to short-term or one-off activities such as fencing but inadequate to address the scale of threats such as invasive species. Sustainable solutions are needed, through more consistent investments by governments or philanthropic sources, to support both the covenantors and the capacity of covenant providers (Taylor et al. 2014; Cochrane 2015). For covenantors specifically, consistent rate relief and tax concessions for covenanted properties would provide continuous financial resources to assist ongoing management activities (Smith et al. 2016).

The apparent decreasing support for private land conservation efforts reported by covenant staff suggest it will be important to develop approaches that rely less on direct financial support for landholders or covenant providers and improve the efficacy and reach of the funding that is available. Opportunities exist to better support landholders by: 1) facilitating connections among covenanted landholders (see Chapter 5) and between covenantors and covenant providers (e.g., Stern 2006; Chapter 5) that promote knowledge exchange and motivational reinforcement; 2) organizing and sharing management supplies among covenantors; 3) facilitating connections between covenantors and experts to create more avenues for learning and knowledge exchange (e.g., Carr & Hazel 2006); and 4) greater promotion of volunteer activities, such as working bees on private lands.

Like any protected area, covenanted properties are situated within larger landscapes and thus faced with edge effects from neighboring properties and broad-scale factors (e.g., climate) that influence conditions within the property. These are typically outside the control of covenantors and can limit the effectiveness of their management actions, requiring additional time and money to resolve. With the majority of covenanted areas less than 100 ha (83%; Table 4.1), they will remain susceptible to edge effects (e.g., disturbance, change in species composition; Wilcove et al. 1986) without landscape scale management efforts (Vilà & Ibáñez 2011). Third-party impacts (e.g., actions by neighbors, trespassers) are of equal concern. Hardy et al. (2017) found one-quarter of covenant breaches in Australia were due to damage by a third party (e.g., road construction through part of the property). These types of breaches may become more prevalent with increasing development around

covenanted areas. Thus, cross-tenure initiatives (Gass et al. 2009) and building communities of practice (Agrifoglio 2015) among covenantors and with their neighbors are important for the longevity of conservation outcomes and ongoing effectiveness of covenanting programs. These initiatives already occur to some extent through Landcare and non-profit organizations (Cowell & Williams 2006), and regional NRM organizations that address management issues at a catchment scale (Lockwood & Davidson 2010). These organizations also offer management-related events and workshops for landholders (Chapter 5), but could be tailored to target conservation properties. Whether between covenantors and their providers or other organizations, a partnership approach to land management may help alleviate some of the management challenges.

Conclusions

Ongoing management is needed on many covenanted properties to maintain biodiversity values and landholders are undertaking a variety of actions. Creative solutions are required to help alleviate the many challenges covenantors face that limit their ability to manage their properties effectively. Challenges are also experienced by the covenant providers, which prevent them from being able to discharge their obligations as the other party to covenant agreements. This study reveals that challenges to covenantors and covenant providers are likely to grow as the proportion of successive owners increases over time. While a diversity of solutions will be required, facilitating opportunities for covenantors to support one another offers a promising option in the short-term. However, a greater commitment to supporting conservation on private land, including sustained, adequate funding, is required to truly achieve the goals of covenanting programs.

CHAPTER 5: Engagement with information and support by landholders of private protected areas

Abstract

One goal of private land conservation initiatives is to facilitate pro-environmental behavior change among landholders that ideally persists long-term. Research into the decision-making of resource managers (e.g., farmers, foresters) suggests their engagement with environmental advice and support networks helps to sustain environmentally friendly management decisions made during their involvement in conservation programs. With in-perpetuity conservation covenants, a long-term commitment of landholders towards maintaining and managing the covenanted property is needed, but little is known about the options and opportunities covenanted landholders have to access information, advice, and other forms of support. This study addresses this gap by using a mixed methods approach to explore the sources of information and advice used and valued by covenanted landholders and the barriers to engaging with those sources. Results show a range of knowledge levels and experiences with land management among covenantors, along with variations in their levels of interest in engaging with new information. While written materials are frequently used, direct contact with individuals and organizations that can share knowledge is highly sought after because they can provide information specific to landholders' needs or tailored to their property. Challenges to accessing information are fairly universal among covenantors, with successive and absentee owners having weaker information networks and requiring greater assistance to bridge their knowledge gaps. Findings suggest that building covenantors' social networks, through creating connections with professionals and peers, can improve access to desired information or support. However, with an ever-increasing pool of successive and absentee owners, reliable funding streams for covenant providers are needed in order to sustain their role in connecting with covenantors and helping to connect covenantors to each other. Covenantors and covenant providers agree that improving support networks will require current social and institutional barriers to be removed.

Introduction

The expansion of biodiversity conservation efforts to include multiple tenures beyond government-owned areas has resulted in a burgeoning number of private landholders participating in environmental programs and managing their lands to promote conservation values (Stolton et al. 2014). Although conservation or sustainable resource management may be a goal for many of these landholders, specific reasons for their participation are nevertheless quite diverse (Fish et al. 2003; Raymond & Brown 2011; Lute et al. 2018; Chapter 3). Likewise, landholders have varying backgrounds, attitudes, and experiences with, and knowledge of, natural resource management (Lobley et al. 2014; Meadows et al. 2014).

Private land conservation initiatives include voluntary activities through to legally-binding agreements that are either fixed-term or in perpetuity (Kamal et al. 2015). Ideally the initial decisions by the landholders to participate in the programs, and their corresponding shift in land management, would lead to conservation behavior that lasts well beyond the program obligations, particularly for programs that include payments (e.g., one-off or fixed-term) to landholders (Dayer et al. 2017). Conservation outcomes are unlikely to be realized if landholders simply revert to old practices once funding or contractual obligations end (e.g., Kuhfuss et al. 2015). In their conceptual framework of farmer environmental decision-making, Mills et al. (2017) propose that sustained environmental behavior occurs at the intersection of three elements: a landholder's willingness to undertake the activities, their ability to do so, and their engagement with advice and support networks. While willingness (Chapter 3) and ability (Chapter 4) are certainly important in the context of conservation covenanting in Australia, they may not translate into action unless the landholders are supported through knowledge and advice to take action (Mills et al. 2017). Therefore, it is critical to understand the engagement of landholders with support networks to determine the degree to which conservation covenants are likely to achieve long-term outcomes.

Numerous studies focused on land management decisions related to farming and forestry have identified how landholders acquire information and advice through a mix of formal and informal structures (e.g., Rogers 2003; Lockie 2006; Lubell & Fulton 2007; Knoot & Rickenbach 2011). Initial knowledge gained by landholders about a practice or program often comes from formal sources, such as extension officers or government agencies; whereas decisions to participate in a program or implement a certain practice are influenced

through informal networks, such as communicating with and observing the activities of peers (Garbach et al. 2012; Isaac 2012; Matous & Todo 2015). This peer learning, or peer exchange, is the acquisition of knowledge and skills through active support among equals, such as family, neighbors, other landholders, and without relevant professionals (Topping et al. 2005). Peer learning in the context of natural resource management (NRM) has been found to foster relationships, increase awareness, and influence behavior (Kueper et al. 2013). Landholders show high retention of information over time from peer-to-peer settings, and such environments can also encourage participation by landholders who are typically unengaged or inexperienced with management activities (Ma et al. 2012).

There are, however, a diversity of landholders involved in conservation programs who may have correspondingly diverse means of engaging with advice. Conservation incentive programs have been targeted at landholders in traditional roles, such as agriculture (Lubell et al. 2013; Lastra-Bravo et al. 2015) or forest management (Andrejczyk et al. 2016), and increasingly at lifestyle owners. Lifestyle owners tends to move to rural areas for amenity values (e.g., recreation; Mendham et al. 2012) or small-scale farming (e.g., hobby farms) and do not rely on the land for income (Pannell & Wilkinson 2009). Some lifestyle owners have little knowledge of species or appropriate management practices (Gill et al. 2010). Within conservation programs there is also a high portion of absentee owners whose rural property is not their primary residence (e.g., Butler & Ma 2011) and these absentee owners tend to be less knowledgeable about or engaged in management activities than resident owners (Petrzelka et al. 2013). Given the variety of landholder types and their differing levels of knowledge about natural resources and management activities, conservation program providers need to understand landholder information-seeking behavior to thus develop and target knowledge exchange strategies to promote positive conservation outcomes (Emtage & Herbohn 2012; Case & Given 2016).

Similar to rural landholders in general, landholders with conservation covenants (hereafter covenantors) encompass numerous personal, social, and economic circumstances, and have varying levels of NRM knowledge (e.g., Harrington et al. 2006). Covenantors include landholders who are original signees to the covenant or successive owners who purchased or inherited a property with a covenant already in place. Successive owners can have different motivations for the covenants (Stroman & Kreuter 2015; Chapter 3) and less

familiarity with the property and management plan than original signees (Chapter 4). Absentee owners are also common (Appendix D) and the decreased time spent on the covenanted property (relative to residents) can impact their ability to recognize and respond to management needs (Farmer et al. 2015; Stroman & Kreuter 2015).

During the establishment phase of a conservation covenant, communication and exchange of information occurs between the landholder and the covenant provider (or a third party) to assess the property, establish the conditions of the covenant, and develop a management plan (Chapter 4). This includes baseline information about the property (e.g., species lists) along with recommendations about management options (e.g., weed control). The long-term commitment to maintain and manage conservation values associated with covenants (Chapter 1) means that after establishment, the information needs of covenantors shift to ongoing learning and problem-solving related to their property and land management. This is especially true for those who are less familiar with the property either through new ownership or absenteeism. The extent to which active management is needed on a property – whether it involves relatively minimal oversight or extensive restoration and rehabilitation (Chapter 4) – can also influence information needs. Furthermore, as species composition and other environmental conditions change over time (because or irrespective of management activities), there will be a need for landholders to adapt their management strategies and acquire new information to assist with the adaptations (Raymond & Robinson 2013).

Sources of information and advice used by rural landholders in making land management decisions has been well-studied, although often in the context of their initial decision to participate in a conservation program or adopt a new management practice (e.g., Rogers 2003; Leventon et al. 2017). Given the information needs of covenantors shift over time, it is critical to understand how they meet their information needs and access support long term. The demographics of covenantors will shift over time as well, thus it is also necessary to determine whether the available options meet the needs of different types of covenantors with differing knowledge requirements, such as successive and absentee owners. To fill this gap, I conducted an exploratory study of the information seeking behavior of Australian covenantors to understand whether their engagement with information and advice supports their ongoing land management efforts. Specifically, I investigated: (1) From whom or where do landholders source information and advice about land management activities? (2) Which

sources of information are most valued by landholders? (3) Is the current frequency of access to different sources of information sufficient to meet covenantors' needs? (4) Do sources of information, and the value of those sources, differ among types of covenantors? Understanding information use and needs can help target knowledge exchange strategies in support of covenantors achieving the best conservation outcomes.

Methods

To explore covenantors' engagement with information and support networks and barriers to desired access, I used a mixed methods approach combining qualitative and quantitative datasets as detailed in Chapter 2. Qualitative data used in this chapter derive from two open-ended questions asked during interviews with covenanted landholders:

1. *Who or what do you turn to when looking for information or advice about the covenant or land management?*
2. *Do you feel like your current sources or networks are sufficient to help you get the answers or information you need?*

The question regarding information and advice allowed for free recall of sources (e.g., people, groups, or items) by each covenantor. This name-generator method tends to capture detail about fewer but stronger connections (Marin 2004; Lin & Erickson 2008) compared to, for example, having the covenantors choose from a list of options. Because of this, standard prompts were used to elicit responses about additional sources (e.g., regional organizations, landholder groups) beyond those initially volunteered. There were no restrictions on the number of sources that could be mentioned nor on the time period during which sources were used.

Additional qualitative data is drawn from interviews with 18 key staff members across most major covenanting programs (details in Chapter 2). The interviews captured covenant provider perspectives about the covenanting programs, the types of outreach and education options available to covenantors, and the covenant provider's role in providing support to covenantors (described further in Chapter 2).

Quantitative data used in this chapter were derived from an online survey available to covenantors throughout Australia, in which they were asked a range of questions about their covenanted property and experiences (details in Chapter 2). Data presented here relate to covenantors' demographic and property characteristics, along with responses from three closed-answer survey questions focused on sources of information and advice:

1. *In general, how often do you provide information or advice to other landholders about management activities on their property?* Respondents selected from a 6-point Likert scale: never, every few years, yearly, monthly, weekly, or daily.
2. *In general, how often do you seek information or advice about management activities on the covenanted property?* Respondents selected from a 6-point Likert scale: never, every few years, yearly, monthly, weekly, or daily.
3. *What sources do you turn to when you are seeking information and advice about land management activities on the covenanted property?* This question was not visible to respondents if they chose "never" for seeking information or advice.

The third question used a recognition method (Marsden 1990) in which respondents were provided with a list of possible sources, along with an option to write in additional sources. The list of sources was separated into: (1) individual people (e.g., staff within an agency), and (2) written materials and activities (see Appendix C, questions 25 and 26). Recognition methods generally provide a more complete set of connections per respondent than free recall methods as the respondents can consider sources used less frequently or with whom they have weaker connections (Marsden 1990).

The list of people included staff working with: the Covenant Scheme Provider; state departments or agencies (other than the Covenant Scheme Provider); regional bodies (e.g., Natural Resource Management regions); local government (e.g., shire, council); or non-government organizations (e.g., Greening Australia). The list of people also included academic researchers, contractors, local experts, neighbors, and other covenanted landholders. Written sources included: newsletters; online resources (e.g., agency websites, blog posts); and other written material, such as books or manuals (hereafter miscellaneous written material). Activities included: attending local Landcare meetings or meetings of conservation-focused groups (e.g., Conservation Management Networks, conservation landholder groups); interactive workshops or field days; and certification programs.

To assess the strength of connections to and value of these sources, for each potential information source respondents were asked:

1. *How often do you use this resource?* Response options: never, rarely, sometimes, often, or always.
2. *How much do you value this resource?* Response options: not much, some, or a great deal.
3. *Would you like more access to this resource?* Response options: yes or no.

Qualitative analysis

Interviews averaged one hour in length (range of 0.5 to 2.5 hours) and were digitally recorded and transcribed verbatim. Covenantor interview transcripts were open-coded via an inductive category development method, in which individual codes emerged from the data and were used to capture distinct ideas and concepts (Braun et al. 2015). While the interview responses provided extensive detail about sources of information and variation over time, I specifically coded items pertaining to barriers experienced when covenantors tried to access information or advice. I then grouped individual codes into themes to capture related concepts (Braun et al. 2015). To determine percentages per code and theme, each covenantor was reflected once per code regardless of how often they mentioned the same idea during the interview (i.e., percentages are based on number of sources rather than number of references); similarly, after aggregating responses into themes, the percent of interviewees per theme was calculated such that each covenantor was reflected once per theme even if their responses fall into multiple codes within that theme (Bazeley & Jackson 2013). Transcripts were coded using QSR International's NVivo 11 qualitative analysis software. Codes and themes were validated by researchers involved in the project (see Chapter 2 for details). To help contextualize the covenantor results, key informants' comments about outreach and education options available to covenantors – whether through the covenantor provider or other organizations – and factors that might restrict those options are also presented. To maintain anonymity of all participants, quotes cited in results are referenced as L# (e.g., L30) for landholder interviewees and S# for staff interviewees.

Quantitative analyses

To test for differences in the types of information sources used, valued, and desired by different types of covenantors, I compared the survey responses of: (1) original signees and successive owners; and (2) residents and absentee owners. Survey respondents were not required to provide answers for all sources, which resulted in missing data (i.e., 15% of responses for 'use', 16% for 'value', and 20% for 'more access'), suggesting some respondent fatigue (i.e., non-response rate increased as respondents moved through the questions; Patton 2002). Although 'never' was offered as a possible response to the frequency of use, data exploration revealed that when a respondent left 'use' blank, they usually also left 'value' or 'more access' blank, suggesting they did not use the source and therefore did not answer for value or access. Given this recurring pattern, where respondents selected a frequency of use greater than 'never' for one or more sources and left other sources blank, the blanks were replaced with the response 'never' based on an assumption that the respondents skipped over the sources they did not use. Where respondents selected 'never' for the use of any sources, any blank responses were treated as missing data. All blank responses for 'value' or 'more access' were treated as missing data. For statistical analyses, missing data points (incomplete cases) were excluded using pairwise deletion method (Enders 2010).

Mann-Whitney U non-parametric tests were used to compare responses between the types of covenantors noted above because the data were ordinal. Statistical analyses were conducted in IBM SPSS Statistics 23.0 (IBM Corp., Armonk, NY, USA).

Results

Covenantor and property characteristics

The interviewees represented 82 covenanted properties across New South Wales (NSW; n=19), South Australia (SA; n=20), Tasmania (TAS; n=17), and Victoria (VIC; n=26). A total of 317 surveys were suitable for inclusion in the analysis (i.e., respondents answered the majority of questions about demographics, property characteristics, and seeking information). The majority of survey respondents (90%) were covenantors in NSW, TAS, VIC, and Western Australia (WA), with the remainder from SA and Queensland (QLD). Full details of the program, property, and covenantor characteristics for all survey respondents are

provided in Appendix H. Covenantor and property characteristics were similar among interviewees (Appendix D) and survey respondents (Appendix H). Most covenantors were original signees to the covenant and owned a single covenanted property of relatively small size (<100 ha) on which the covenant was registered within the previous 10 years, and did not earn income from the property. Nearly half of the covenantors were absentee owners. Survey respondents were primarily older (≥ 55 years), well-educated, and with a mix of work status and annual incomes (Appendix H). Approximately half the respondents said they had experience with land management prior to taking on a conservation covenant.

Sources of information and advice

The majority of survey respondents (84%) sought information and advice about land management activities on their covenanted properties at least once every few years, and most (68%) provided information to others (Fig. 5.1). Covenantors who sought information ($n=267$) used an average of 11.0 different sources ($SE=0.29$).

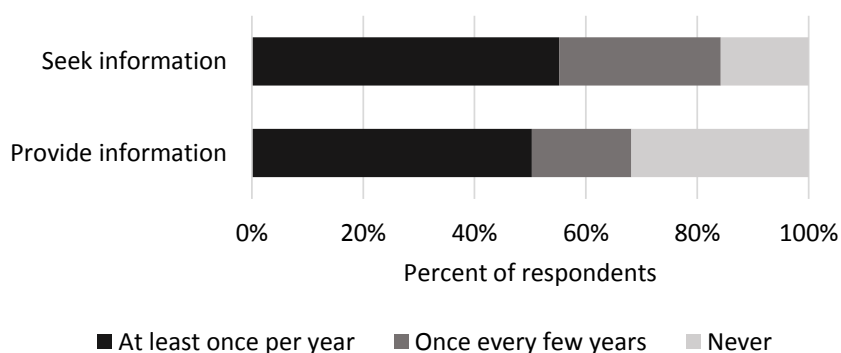


Figure 5.1. Percent of covenantors ($n=317$) who seek or provide information or advice about land management. “At least once per year” aggregates responses for yearly, monthly, weekly, and daily.

Fewer successive owners (76%) sought information than original signees (86%), however there was no significant difference in how often information was sought nor the number of sources used between the groups (Table 5.1). Residents and absentee owners also had similar information seeking behavior, with slightly fewer absentees (81%) seeking information compared to residents (87%) but no significant differences in the frequency or number of sources used (Table 5.1).

Table 5.1. Mean scores, standard error (SE), sample size (N), and results of Mann-Whitney U tests for differences in seeking information and use of information sources relative to certain covenantor characteristics. Scores for seeking information are based on a 6-point Likert scale, where 1 = “never” and 6 = “daily”. Number of sources include sources used rarely to always.

	Seek information ¹						Number of sources ²					
	Mean	SE	N	Mann-Whitney U	Z score	p-value	Mean	SE	N	Mann-Whitney U	Z score	p-value
Signee												
Original	2.63	0.065	236				10.97	0.315	203			
Successive	2.55	0.156	58	6545.50	-0.54	0.591	10.34	0.895	44	4303.50	-0.38	0.704
Resident												
Yes	2.72	0.081	165				11.42	0.385	144			
No	2.50	0.083	149	10853.50	-1.87	0.062	10.40	0.446	121	7719.50	-1.60	0.109

¹ Includes all respondents (n=317).

² Includes the subset of respondents who seek information or advice (n=267).

In their responses to the question about management advice, interviewees revealed that they want information regarding species identification (e.g., weeds, native animals), options for controlling pest species, and/or general management directions for their property (e.g., determining desired conditions, what to plant where). Although their information interests are universal, the sources of information they used were quite variable, including their personal experience (e.g., from long-term ownership of the property), friends, family, or neighbors, and formal sources such as regional bodies (e.g., regional NRM organizations) that offer written material, workshops, or other direct contact with practitioners.

The use of sources generally depended on the personal interest of the covenantor (e.g., “*We’re actually very introverted people, very private people.*” [L42]) or the condition of the covenanted property. Some covenantors were satisfied with seeking a minimal amount of information, because of feeling secure in the management activities they undertake, or the property requiring minimal management. “*I’m quite competent now in terms of knowing what’s what with the flora and fauna.*” (L62). Whereas other covenantors took a more active approach to acquiring information, often using a wider variety of sources.

“I very quickly learned to become a bit more self-sufficient and go directly to people with the expertise who might be able to help... And we’ve met people through our field days and also who I’ve made contact with by cold-calling – just introducing myself and explaining what we’re trying to achieve and what the problem is.” (L43)

Face-to-face interactions were particularly valued by interviewees, including those with covenant provider staff or other experts, during conservation-focused landholder meetings,

and through involvement in group activities (e.g., workshops, field days, working bees). These activities offered relaxed and interactive opportunities to learn from other people and share experiences.

“It was really valuable to us having the [covenant provider’s] stewardship program and having [staff members] come out and help us to ID things on our land and just talk to us about a few different things we could do to control weeds... We learnt heaps from [them], and we still do.” (L06)

“If I’ve got an issue with a particular weed, wanting to know what’s been the most successful way people have found to manage it or eradicate it, I’d like to hear from somebody else who’s done it or has tried something, whether it didn’t work or it did work... I’d like to talk to somebody else who’s had to grapple with it and do it.” (L62)

In addition, some covenantors spoke of the moral support they received through these shared experiences, not only in seeing tangible results from management efforts but also being able to “*get together with like-minded people*” (L67) and “*feel part of that bigger picture*” (L50). Meeting specifically with other covenantors further bolstered their sense of support and learning. Landholders described creating local and regional groups (e.g., local Landcare groups, informal neighborhood groups, Conservation Landholders Tasmania) to facilitate connections among covenantors and coordination of management activities beyond their property borders. However, these covenantor-focused groups were relatively rare, primarily grassroots driven, and based on the motivation and dedication of individual landholders.

“I did my gathering [of covenantors] because I saw the desperate need to interconnect. I wanted to know what other people did with their land, and how they contacted people, and how they attacked problems, and what problems there were... I thought it [the meeting] was extremely positive... Everybody went away encouraged.” (L17)

Survey data revealed written sources were most commonly used (i.e., books or manuals captured under “miscellaneous written materials”, newsletters, and online websites), followed by local experts and staff with covenant providers (Fig 5.2a). Workshops and field days were the most frequently used in-person activities (Fig. 5.2a). The most frequently used sources were also valued most highly, although covenant providers were highly valued relative to the frequency of their use (Fig. 5.2b). At least half of the respondents wanted greater access to workshop/field days, other covenanted landholders, local experts, and

researchers (Fig. 5.2c). The relatively low use of, but desired access for, covenanted landholders and researchers as sources of information suggests a lack of availability of those sources; whereas the relatively high use and high value of workshop/field days and local experts suggests maintaining access to these sources is important.

Examining the top six sources for use, excluding newsletters and online sources (Fig. 5.2a), revealed similar patterns of information use by original signees and successive owners (Fig. 5.3a). Miscellaneous written material were valued most highly by both groups, followed by covenant providers (Fig 5.3b). While successive owners valued most sources more highly than original signees these differences were not significant (Fig. 5.3b; see Appendix I for test results and sample sizes). Successive owners also showed a consistent pattern of wanting more access to all information sources than original signees, although this difference was only significant for Landcare meetings ($U=2276.0$, $z=-2.17$, $p=0.030$; Fig. 5.3c). Both groups wanted greater access to workshops/field days and other covenanted landholders (Fig. 5.3c).

Overall, residents used most sources more often than absentee owners (Fig. 5.4a), especially local experts ($U=6125.0$, $z=-3.18$, $p=0.001$), workshops/field days ($U=6199.0$, $z=-3.34$, $p=0.001$), and Landcare meetings ($U=5511.0$, $z=-4.28$, $p<0.001$). The value placed on those sources followed a similar pattern, with written material, covenant providers, and local experts being most highly valued by all, but residents valuing Landcare meetings significantly more than absentee owners ($U=4859.0$, $z=-2.49$, $p=0.013$; Fig. 5.4b). Again, both groups wanted more access to workshops/field days and other covenanted landholders (Fig. 5.4c).

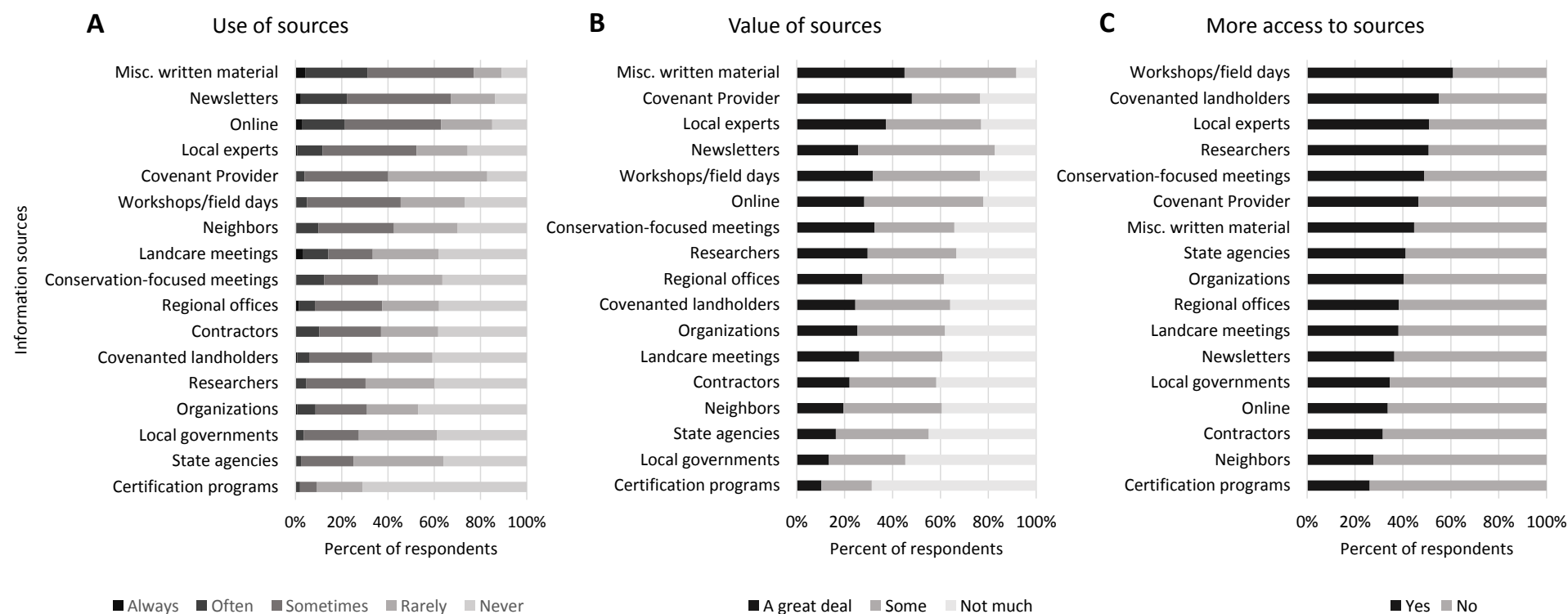


Figure 5.2. Frequency of use (A), extent of value (B), and desire for more access (C) noted by survey respondents regarding sources of information or advice for land management activities. (A) Scores for use: 1 = never, to 5 = always; n=247-259. (B) Scores for value: 1 = not much, to 3 = a lot; n=213-240. (C) Scores for more access: 0 = no, 1 = yes; n=206-228. Order of sources is based on mean score per graph.

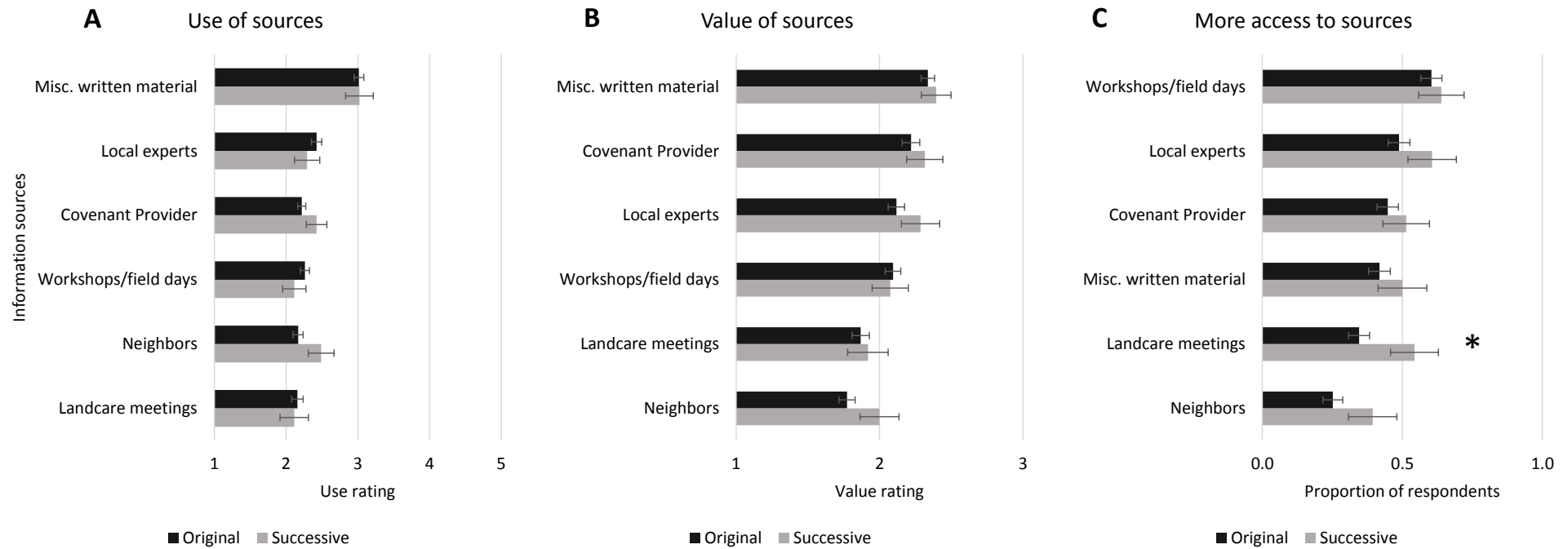


Figure 5.3. The mean (± 1 SE) rating scores for a subset of land management information sources (A) used, (B) valued, and (C) desired by original signees and successive owners. (A) Scores for use: 1 = never, to 5 = always; original $n=186-195$, successive $n=40-44$. (B) Scores for value: 1 = not much, to 3 = a lot; original $n=160-184$ successive $n=32-40$. (C) Scores for more access: 0 = no, 1 = yes; original $n=155-172$, successive $n=31-37$. Order of sources is same as for ‘all respondents’ in Fig. 5.2. Asterisk indicates significant difference at $p < 0.05$.

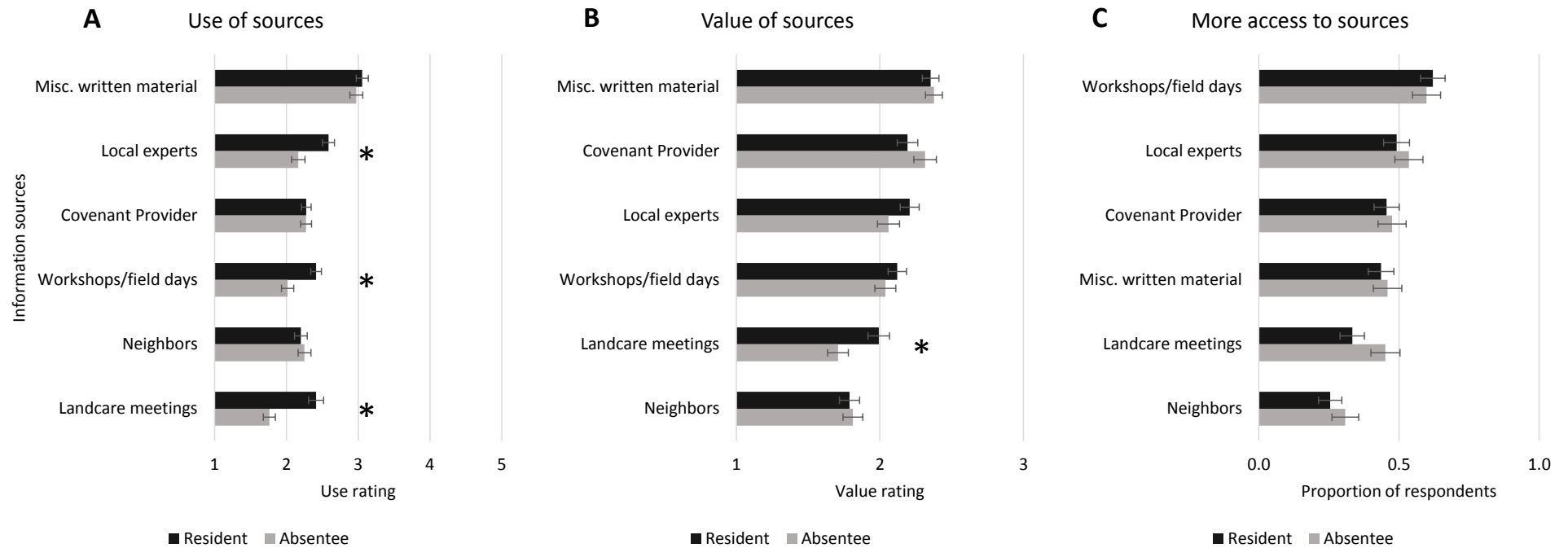


Figure 5.4. The mean (± 1 SE) rating scores for a subset of land management information sources (A) used, (B) valued, and (C) desired by residents and absentee owners. (A) Scores for use: 1 = never, to 5 = always; resident $n=133-140$, absentee $n=110-117$. (B) Scores for value: 1 = not much, to 3 = a lot; resident $n=115-132$, absentee $n=92-109$. (C) Scores for more access: 0 = no, 1 = yes; resident $n=110-125$, absentee $n=88-101$. Order of sources is same as for ‘all respondents’ in Fig. 5.2. Asterisk indicates significant difference at $p < 0.05$.

Barriers to gaining information and advice

Interviewees revealed a number of barriers that restrict their access to information, advice, and other support, occurring at the level of institutions, locally, or personally (Table 5.2; specific codes and indicative quotes are in Appendix J). At the institutional level, limited availability of staff, experts, or researchers slowed access to local information covenantors desired, i.e., tailored to their individual property and management needs. Interviewees felt restricted by privacy policies that prevented the sharing covenantors' details, and by lack of staff time to facilitate connections with other covenantors in their area (Table 5.2). Local barriers related to a lack of covenantors groups in many areas, or group dynamics that were challenging for active participation (Table 5.2). This was a frustration for landholders who were motivated to engage and create opportunities to share experiences on this peer-to-peer level. Personal barriers most often related to time constraints, which were a particular issue for absentee owners living far from the property, or when activities of interest (e.g., field days) were not run locally. Notably, many covenantors did not raise specific barriers to gaining information or support during the interviews, but as this was not a specific question this does not necessarily equate to the absence of barriers.

Table 5.2. Themes developed from interview codes regarding barriers to acquiring land management information and advice and engaging with other individuals. Interviewees (n=82) could be included in more than one theme. Codes and indicative quotes per theme are in Appendix F.

Type of barrier	Description	% interviews
Institutional barriers	Structures, policies, or priorities within agencies and organizations that result in limited availability of knowledgeable staff, experts, and researchers, and limited access to other covenanted landholders.	34%
Local barriers	Absence of covenantor-focused groups; difficulty in gaining and maintaining interest and dedication of covenantors to group activities and exchanging information; topics that are irrelevant to the covenantor's issues or not specific to conservation.	29%
Personal barriers	Circumstances at the level of individual covenantors, such as constraints of time, distance, technology, finances, or health.	34%
No specific barriers mentioned		33%

Key informant interviews

Staff from the covenant providers reinforced the views of covenantors expressed in the interviews and survey. They saw a range of knowledge levels among covenantors regarding native species and land management, along with varying interest among covenantors in

engaging with new information. Ensuring covenantors continued to build their knowledge was seen as requiring a variety of approaches, with covenant providers relying on other groups that offered land management support for private landholders, such as regional NRM organizations, Landcare, or local councils.

“We rely quite heavily on local catchment groups and natural resource management groups. I have in the past sent landowners to [certain NRM] groups for weed control... so the NRM groups are really like our backup... They're really practical, they've got good knowledge that the landowners can use, and they're local which is really important.” (S29)

However, the availability of these options varied spatially and temporally, being limited by funding levels and the experience of staff and facilitators, and were not always focused specifically on conservation.

“But unfortunately with all the cuts our department has experienced recently, there are less and less staff in those district offices and a lot of them have very high workloads. So they can't – unfortunately a landowner with a covenant is not necessarily a priority for them.” (S31)

The staff preferred to engage directly with covenantors via stewardship visits to the property or other opportunities for meeting, but were restricted by resource limitations within the covenanting programs (see also Chapter 4). Limited time to visit with covenantors had the potential to impact the quality of these interactions.

“...it takes you five years to just get around the majority of the properties. And so you have one interaction with them and you need to be able to, in that interaction, get all this information about management, make sure they're doing the right thing, but also engage them and empower them to continue to do it and motivate them. You might have ten minutes to do that.” (S11)

Staff saw connecting with successive owners as particularly important, but also time-intensive and not always possible immediately after the sale of a property (see Chapter 4).

“...the buyer that hadn't put the covenant on, many times they don't have that understanding of conservation or management that the previous landholder had. So really we're starting off back at scratch with an education training program with the new landholders.” (S21)

Staff in several programs encouraged covenantors to meet with and learn from each other and find additional sources of support, suggesting some landholders may be more open to information if it comes through peers. Whether through peers, covenant providers, or other environmental organizations, the staff saw value in connecting with covenantors and continued to seek creative ways to do so.

"I found that if you can give them a little bit of knowledge, that then engages them to go do more and investigate more, they'll learn more and then they'll feel more empowered to do it [the management]." (S11)

Discussion

This study of covenantors in Australia reveals they are a diverse group of individuals, with different levels of ecological knowledge and experience with land management. They range from those with intimate knowledge of the species and habitats on their property, gained from years of ownership and interest, to new owners who are becoming familiar with the area. Their different circumstances require a diversity of approaches to meet their information needs.

The information and support preferences of covenanted landholders are similar to those of farmers and forest owners who seek information about conservation programs or sustainable management advice; that is, they value a mixture of local and regional sources (Baird et al. 2016) from professional advisors, neighbors, and other landholders (Kittredge et al. 2013; McKenzie 2013). These similarities may be due to the fact that outreach approaches and programs available to landholders are often focused on natural resource management practices more generally (e.g., fire management) rather than specifically targeted at conservation management.

A key difference from past studies of other natural resource management contexts, however, is the presence of covenant providers who represent the other party to the conservation agreement. Covenantors clearly value the information and support of covenant providers, who are involved in developing management plans and can link covenantors with resources such as small grant programs. Nearly half the survey respondents expressed a desire for more access to providers (Fig. 5.2C), a view which was supported by provider staff

members who expressed frustration that resource limitations prevented them from engaging more with landholders.

Written material is valued and well-used by all types of covenantors (Fig 5.2), presumably because it is widely available and covers a diverse range of topics. While this may be welcome news for resource-poor covenant providers, since written materials are less expensive to deliver than face-to-face interactions, covenantors displayed a desire for more interactive learning with professionals and through peer learning. A key element of this face-to-face learning was their desire to have information translated for their context. Interactive learning offers opportunity for translation and helps reduce uncertainty in ways that written materials cannot (Case & Given 2016). It is often difficult to apply general advice or study findings to decisions in a different context, a concern also expressed by protected area managers (e.g., Cook & Sgrò 2018). Translating research findings can be even more challenging for landholders who are not professional land managers and who may be doing the work in their spare time or out of personal interest (Chapter 4).

Successive and absentee owners indicated they could benefit from more information and a wider range of sources (Figs. 5.3C and 5.4C). Both these types of covenantors are looking to learn about the property – successive owners because they are relatively new to the property and lack personal experience of the property to draw on, and absentee owners because they are not on the property to learn about or monitor it and have less opportunity to connect with local resources in the way residents can. These novel findings fill an important gap in understanding the changing needs of covenantors. Despite being a growing portion of covenantors, successive owners have rarely been addressed in covenanting research (but see Stroman & Kreuter 2014, 2015), with no consideration of their information needs. The growing portion of absentee owners in rural landscapes have made them of scholarly interest relatively recently (Petrzelka et al. 2013; Bond et al. 2018), although few studies that have focused on their information seeking behavior (Schubert & Mayer 2012). The present study provides critical information about absentee owners in a covenanting context, and highlights their differing needs compared to other covenantors.

Successive and absentee owners appear willing in general to manage (Chapter 3) and seek information but they experience different challenges to other landholders and require a

degree of engagement with covenant providers that appears to be lacking. Limited resources within covenanting programs introduce barriers to staff connecting with successive owners shortly after they acquire the property, and as properties continue to change hands this will only add to the workload of existing staff. Absentee owners have less opportunity to integrate into their local communities (Schubert & Mayer 2012) and may rely more on covenant providers to help connect them with local resources. With an ever-increasing pool of successive owners, and nearly half the covenanted landholders identifying as absentee owners (Appendix D), it will become harder for covenant providers to sustain their role in offering management advice and covenant oversight without additional resources (Cowell & Williams 2006).

The interview data revealed that for a portion of covenantors (regardless of the type of covenantor), their information seeking behavior is motivated by more than improving their knowledge base. Feelings of reassurance and empowerment are also gained through interactions with other individuals. Covenantors can see how their management actions and issues compare to other covenantors, along with gaining a sense of ‘doing the right thing’ and their contribution to the ‘bigger picture’. This serves to demonstrate why it is engagement, more so than just information, which is the third element in the Mill et al. (2017) framework as engagement “can help create interest, responsibility and a sense of personal and social norms... that leads to sustained and high quality environmental outcomes” (Mills et al. 2017, p. 286).

Social networks provide an excellent framework with which to consider the transmission of information and experiences among individuals. Connections among people or groups promote the transmission of ideas, influence, and resources through their interactions (Wasserman & Faust 1994). This flow of ideas or information enable shifts in understanding and behavior among members of the network (Borgatti & Halgin 2011), through improving their capacity and helping them realize and maintain social norms (Bodin & Crona 2009). Social norms are “the common and accepted behaviors for a specific situation” (Schultz et al. 2008, p. 386), including a covenantor’s management behavior relative to that of other covenantors. Furthermore, networks with peers create avenues for social learning (à la Reed et al. 2010), which can further influence change in behavior and habits (Matous & Todo 2015) and complement technical learning accessed through professional staff or programs

(Garbach & Long 2017). Social network theory thus suggest that landholders' networks may help to sustain long-term commitments to covenants and management action (Chapter 6). Given covenantors' desires for greater engagement through face-to-face interactions with a range of groups (e.g., experts, other covenanted landholders), the present study suggests there are many opportunities to help build the social networks of landholders.

The capacity of covenant providers to oversee and support hundreds of covenantors is hampered by a lack of resources. However, providers could make their limited resources extend further if they adopted the role of fostering networks among covenantors, through which covenantors can support one another. Fostering these connections would not only connect the landholders, but offer opportunities for landholders to coordinate management action. One of the goals of conservation covenanting is the protection of biodiversity, yet achieving this goal is limited when protected areas are small (Appendix D), isolated, and not integrated into landscape-scale management activities (Gass et al. 2009). A study of agri-environment schemes in Europe found the schemes unintentionally increased landholder separation and fragmentation, and thus hampered biodiversity outcomes, by focusing on payments to individual farmers and not promoting collaboration or coordination of activities among farmers (Leventon et al. 2017). Although the schemes are different in many ways from conservation covenants, similar issues occur within covenanting programs, such as where maintaining privacy of covenantors is a barrier to their ability to find and support each other. Many landholders expressed a desire for more access to other covenantors (Fig 5.2C), with the depth of that feeling demonstrated by some covenantors forming their own networks. Leventon et al. (2017) demonstrate that managing biodiversity across landscapes, in which covenanted properties are embedded, is more effective with "coordinating actors" who facilitate collaboration between covenantors and their management activities. Such an approach would ideally incorporate non-covenanted properties as well. Landcare groups and regional NRM organizations offer this opportunity to some extent but their frequent focus on agricultural systems may not coincide with that of covenantors or conservation.

Environmental agencies and organizations in Australia have made great strides towards outreach and education opportunities for landholders (Hajkowicz 2009), much of which is available to and used by covenantors. Nevertheless there is a clear desire from landholders for more in-person activities, and establishing covenantor-focused groups may serve to

strengthen covenantor commitment to management action and more effectively achieve long-term conservation outcomes.

Conclusions

This study reveals covenantors are actively seeking information and advice about land management activities and have access to a wide range of sources that can help meet the diverse needs of different types of landholders. However, covenantors perceive a lack of connection to sources that could provide insights specific to their property and management needs, and lack of opportunities for peer learning. In particular, successive and absentee owners experience different challenges to seeking information than other landholders and require a degree of engagement with covenant providers that appears to be lacking. Given the range and diversity of existing sources, new sources are unlikely to be needed; rather, the support for and expansion of interactive sources that promote the development of social networks may be most worthwhile. Creating and strengthening social networks will not work for everyone; it is clear that the diversity of individuals and their properties requires a diversity of approaches for learning and engagement, including a continued mix of government-led and landholder-led initiatives (e.g., Carr 2002). Increasing support to covenant providers, in which funding mechanisms enable stewardship visits with covenantors, are important to achieving long-term covenanting goals. Additionally, increased support to building networks among covenantors could help strengthen their own commitment to those goals.

CHAPTER 6: Using social network research to improve outcomes in natural resource management

Abstract

The conservation and management of natural resources operates within social-ecological systems, in which resource users are embedded in social and environmental contexts that influence their management decisions. Characterizing social networks of resource users has received growing interest as an approach for understanding social influences on decision-making, and social network analysis (SNA) has emerged as a useful technique to explore these relationships. In this review, we synthesize how SNA has been used in studies of natural resource management. To present our findings, we developed a theory of change which outlines the influence between social networks and social processes (e.g., interactions between individuals), which in turn influence social outcomes (e.g., decisions or actions) that impact environmental outcomes (e.g., improved condition). Our review of 85 studies demonstrate frequent use of descriptive methods to characterize social processes, yet few studies considered social outcomes or examined network structure relative to environmental outcomes. Only 4 studies assessed network interventions intended to impact relevant processes or outcomes. The heterogeneity in case studies, methods, and analyses preclude general lessons. Thus, we offer a typology of appropriate measures for each stage of our theory of change, to structure and progress our learning about the role of social networks in achieving environmental outcomes. In addition, we suggest shifts in research foci towards intervention studies, to aid in understanding causality and inform the design of conservation initiatives. We also identify the need for developing clearer justification and guidance around the proliferation of network measures. The use of SNA in natural resource management is expanding rapidly, thus now is the ideal time for the conservation community to build a more rigorous evidence base to demonstrate the extent to which social networks can play a role in achieving desired social and environmental outcomes.

Introduction

Effective and sustainable management of natural resources by communities or private individuals is an essential factor in reducing the loss of biodiversity, complementing or enhancing protected areas and enabling landscape-scale conservation approaches that target important natural ecosystems (Gutiérrez et al. 2011; Stolton et al. 2014). Natural resource management (NRM) can be viewed as functioning within social-ecological systems (Berkes & Folke 1998), with resource users or managers embedded in broader social, political, and environmental contexts that influence their management decisions (Chaffin et al. 2016). To encourage individuals to conserve biodiversity, mechanisms and programs have been developed that range from regulatory restrictions imposed on resource use to voluntary strategies adopted by willing resource users (Rydin & Falleth 2006; Kamal et al. 2015). Given both the extent of private lands in many countries and the pressing need to sustainably manage common-pool resources, there is much scholarly interest in what influences individual or collective motivations and decisions to engage in conservation initiatives (Knowler & Bradshaw 2007; Chaffin et al. 2016).

Whether complying with existing norms of resource use or participating in new conservation initiatives, individuals need the necessary awareness, attitude, and capacity to implement those actions (Honig et al. 2017). This involves learning about new management options (Pannell et al. 2006), forming attitudes about the best options for their situation (Lawrence & Dandy 2014), shifting their management practices (Stroman & Kreuter 2015), and committing to conservation approaches long-term (Dayer et al. 2017). Acquiring information, improving capacity, and changing attitudes can come about through social interactions, such as communication with family or neighbors (Borgatti & Halgin 2011). Thus, the decision of whether to take on and commit to a conservation initiative is influenced in part by the social networks of the individual (Kittredge et al. 2013).

The ways in which an individual's behavior can be influenced by their relationships with others has generated interest in understanding social networks, with many disciplines seeking to identify how these networks might be leveraged to promote desirable behaviors (Wasserman & Faust 1994; Valente 2012). To analyze relationships, social network analysis (SNA) examines *who* is connected to whom in a system, *how* they are connected, and to *what extent* those connections enable the movement of ideas and information, or influence

the beliefs and behaviors, of the individuals comprising it (Valente & Davis 1999, Borgatti & Halgin 2011). SNA uses concepts from graph theory for constructing networks, in which nodes often symbolize actors (e.g., individuals, organizations) and ties between the nodes symbolize ways in which actors are connected (e.g., friendship, movement of materials; Borgatti et al. 2009). Networks can be visualized from the perspective of individuals (actors) and their connections, known as egocentric networks, or visualized as whole networks, where the position of individuals are viewed relative to each other (Wasserman & Faust 1994). Network structure can then be described by calculating various metrics that characterize individuals, subgroups, or the network as a whole (commonly used metrics are described in Appendix K).

SNA expanded initially in the fields of psychology, anthropology, and sociology (Prell 2012) and while arguably a theory in itself (Borgatti & Halgin 2011), SNA has also offered a lens through which other concepts and theories can be further analyzed, such as social capital (Burt 2000) and diffusion of innovations (Valente & Davis 1999). It has been applied across many disciplines, including public health (Latkin & Knowlton 2015), economics (Wilkinson 2006), and education (Cela et al. 2015), and increasingly within the context of NRM (e.g., fisheries, forestry) and governance (e.g., co-management of resources) as a way to understand learning and collaboration towards sustainable resource use (Bodin & Prell 2011). Crona et al. (2011) describe several theories that apply within natural resource governance and management, such as social learning, social influence, social movements, and social capital. Social interactions are fundamental to these theories, thus “SNA can be used [for example] as a tool to identify actors for participatory processes, [or] it can serve as an analytical tool to understand an ongoing collaborative resource governance process or why an adaptive co-management initiative has stalled.” (Crona et al. 2011, p. 48). This enhanced understanding would ideally lead to improved management or governance processes.

Analyzing network structure in other fields has generated insights into how networks influence social processes and outcomes (Borgatti & Halgrin 2011). This and other work within NRM and social-ecological systems can be described through a theory of change, in which influences between network characteristics and social processes can, in turn influence social outcomes that impact environmental outcomes (Fig. 6.1). A social process is an

approach or activity that involves interactions between people or organizations (e.g., communication; Bardis 1979), which can both be influenced by and serve to form the structure of a social network. That is, social processes can influence network structure (e.g., through the formation of new connections; Snijders et al. 2010) and network structure (e.g., the presence of sub-groups) can likewise influence social processes (e.g., information transfer). Social outcomes result from social processes and could be a decision or change in behavior (e.g., participating in a conservation program) or an achievement or level of performance (e.g., access to funding; Borgatti & Halgin 2011). These social outcomes are sometimes more akin to what the conservation science literature describe as outputs (e.g., number of kilometers fenced; Hockings 2013); however, we preserve the terminology used in the network theory literature to avoid confusion (Borgatti & Halgrin 2011). Social outcomes that result in a desirable activity being conducted should ultimately lead to desirable environmental outcomes (Fig. 6.1; Eklund & Cabeza 2017).

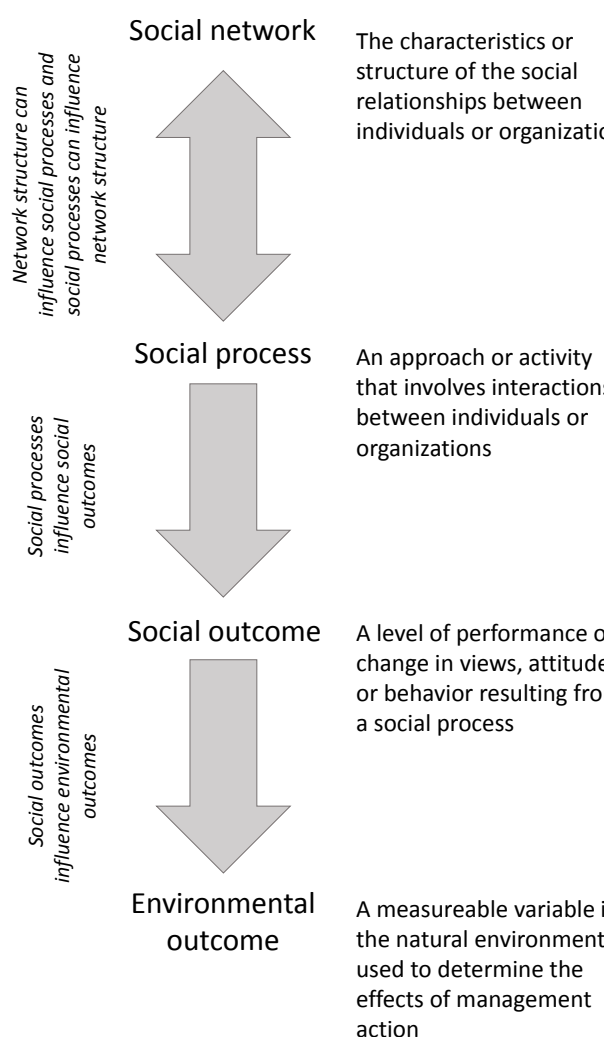


Figure 6.1. A conceptual diagram of a theory of change that links social networks, processes, and outcomes. Direction of arrow indicates direction of influence. Social networks may influence or be influenced by social processes (e.g., communication), leading to social outcomes (e.g., change in behavior) which may then influence environmental outcomes (e.g., fewer invasive species). Interventions that alter the social network may affect the change necessary to achieve desired social and environmental outcomes.

At the core of our theory of change is the concept that network structure is associated with particular social processes or outcomes, which paves the way for exploring how changes to the network may influence those outcomes (Valente 2012). There is evidence from other fields that network interventions – purposeful changes to social networks – can be used successfully to influence social processes and shape social outcomes (e.g., decreasing intentions to smoke [Valente et al. 2003], increasing social participation [Howarth et al. 2016], and improving local level adaptation to climate change [Serrao-Neumann et al 2013]). In a health context, a social outcome of lower rates of smoking is motivated by a desired health outcome (Valente et al. 2003), whereas in the context of NRM or biodiversity conservation, the desired outcome is a positive change in environmental or ecological condition (Koontz & Thomas 2006). For example, the decision of a landowner to enroll in a conservation program, influenced in part by their interactions with others (a social process), and the landowner's implementation of the actions prescribed in that program (a social outcome) will ideally enhance species abundance on the property (an environmental outcome; Fig. 6.1).

Given the evidence from other fields that social network data can be used to design interventions that shift attitudes and behavior toward desired outcomes (Latkin & Knowlton 2015; Valente 2012), we investigated how social networks have been studied and used in NRM to better understand or achieve desired social and environmental outcomes with the goal of the conservation of natural resources. Through an extensive search and review of social network research in the context of the NRM and conservation literature, we assess how the existing body of research is positioned, relative to our theory of change, to inform conservation efforts. To structure the diversity of concepts and approaches found in this literature, we offer a typology that organizes themes and outlines possible measures to address key elements within this theory of change. With the recent expansion in SNA research, this review is timely to consolidate learnings, reveal knowledge gaps, and provide direction for research that is needed to advance social network concepts in environmental management and biodiversity conservation.

Methods

We searched the published literature to identify studies that used SNA (the calculation of metrics to quantify elements of network structure) in the context of the conservation and management of natural resources, particularly by private individuals or through collective action to manage communal resources. Our aim was to review the use and findings of SNA in NRM to determine what lessons can be drawn from this literature about the influence of social network characteristics on social and environmental outcomes, and whether the lesson could inform initiatives to promote more effective biodiversity conservation by individuals with direct, on-ground management potential.

Search criteria

Using Scopus and Web of Science online databases, encompassing natural and social sciences, we searched articles published in all years through 15 January 2018, which scanned for search terms used in article titles, abstracts, and key words. We used “social network” and “network analysis” as key search terms, because “social network analysis” tended to overly restrict the results. Several terms covering various resource conservation and management situations served to balance the breadth and precision of search results. Specifically, we searched for “social network*” AND each of the following terms in turn: biodiversity, conservation, “eco* manage*”, “eco* service*”, “natural resource manage*”. We then searched for “social network*” AND enviro* AND each of the following: agri*, agro*, fish*, forest*, marine, rangeland, soil, water, wood*. We searched “network analysis*” AND each of the following terms in turn: “eco* manage*”, “eco* service”, “natural resource manage*”. We then searched for “network analysis*” AND social AND each of the following: agri*, agro*, biodiversity, conservation, fish*, forest*, marine, rangeland, soil, water, wood*. Finally, we searched for “egocentric network” to capture any remaining relevant articles.

Selection criteria

NRM is a broad field with numerous research foci and scales of inquiry, and the study of social networks within NRM is similarly diverse. To enable comparison among or generalizations across studies given the wide range of objectives and methods used in the literature, we retained studies from the search results if they met all of the following criteria:

(1) used social network analysis (whether qualitative or quantitative) as part or all of the data analysis to better understand a population of interest, (2) provided sufficient methodological details, and (3) represented people or organizations in the network nodes, some or all of whom were local-level actors with direct ability to manage resources. Additionally, studies had to (4) focus on natural resource governance, management or conservation, with the aim of improving biodiversity conservation or sustainable resource use. This criterion served to exclude studies that focused on resource management for the primary purpose of increasing productivity or financial capacity, along with a range of other research foci such as energy consumption or food security.

Data extraction and synthesis

We synthesized the reviewed articles at 2 levels. At a broad level, we included all relevant articles and provide an overview of the research field along with progress towards validating the theory of change (Fig. 6.1) and use of network interventions. To that end, we extracted details from the 85 studies including publication year, location, conceptual framework, data collection methods, network features, and general conclusions. We categorized the studies according to broad methodology, i.e., whether they described the structure of one or more networks or subgroups using network measures (“Descriptive”), compared across multiple networks or subgroups that displayed different processes or outcomes (“Compare across groups”), or compared one or more networks or subgroups across multiple time periods (“Compare across time”). Using the theory of change (Fig. 6.1), we then classified studies as addressing social process, social outcome, or environmental outcome. Although few articles used these specific terms, the intentions were discerned from the stated goals or analyses (e.g., to what were the researchers trying to correlate network characteristics). Although all studies included aspects of social process (e.g., in measuring interactions between people), within the theory of change classification we were particularly interested in the proportion of studies that moved beyond social process in the analysis. To provide further distinction in the types of social processes examined in the studies, we categorized all studies into 4 themes based on study objectives and analyses: flow of information or resources, social learning, social influence, and collaborating. These themes help to distinguish among appropriate measures in the typology discussed below.

The variability in study design and analyses across the reviewed studies resulted in a wide array of network metrics calculated and prevented meta-analysis of SNA findings. However, for a subset of sufficiently similar studies we undertook a finer scale analysis, summarizing the network metrics used to characterize the network. Studies within a management context and focused on private or communal resources were included in the subset.

Typology of processes and outcomes

In line with the theory of change, we created a typology that deconstructs social processes, social outcomes, and environmental outcomes into themes and options of measures within each. The goal of this typology was to help classify the types of themes being discussed in the literature, and provide illustrative examples and possible measures that could help researchers identify or better target the element of the theory of change their studies address. This is not intended to be an exhaustive list but rather offer suggestions of how the themes could be quantified for analysis and provide guidance for researchers new to the subject.

Results

Our searches initially returned 4,781 articles (see Appendix L for the number of articles per search term). We retained 572 articles based on reading the titles and abstracts; further reading confirmed 85 articles were relevant and were retained for data extraction and synthesis. The 85 reviewed articles (full list, extracted data, and categorizations are in Appendix M) were published between 1992 and 2018, with 86% published during or after 2010, indicating SNA is a relatively nascent research area within conservation and NRM fields of study. Research was conducted in 35 countries on local- to international-scale issues related to marine, coastal, or terrestrial resources. Network theory was the primary framework for one-quarter of the studies, while the remainder used SNA as an analytical tool within other frameworks, such as diffusion of innovations or social capital. Therefore, SNA was often one of several analytical tools used within a study. Analyzes occurred for single whole networks (55% of studies), 2 or more distinct whole networks (31%), or multiple separate egocentric networks (14%).

Actors (types of nodes) included individuals who were in direct control of on-ground work or decisions (e.g., farmers, fishers) and organizations or other stakeholders in positions to influence resource use and management through creating policy or programs but were not themselves direct managers. Forty-seven percent of studies focused on direct-only actors while 53% of the studies included both direct and indirect actors. Questions used to elicit information on the number and type of connections between actors (network ties) varied considerably. Three of the more common types of ties can be generalized as “with whom do you exchange information or knowledge” (29% of studies), “with whom do you communicate” (24%), or “with whom do you collaborate” (15%). The number of connections within a network was determined by various methods or combination of methods. Most approaches relied on an individual’s ability to freely recall their interactions, with or without prompts by the researcher, while others used rosters as a recognition method. Furthermore, the number of ties were either all-inclusive, bounded by an upper limit (“list up to 5 people...”) or time period (“within the past 2 years...”), or reduced according to the strength of connections (e.g., limiting analysis to strong ties). Network data in most studies were collected through commonly used qualitative or mixed method approaches, such as semi-structured interviews, participant observations, or focus groups to aid with interpreting the network connections and context.

Most studies (64%) used SNA to characterize a type of social process, whereas fewer studies attempted to link SNA results with social outcomes (29%) or environmental outcomes (7%; Table 6.1). It should be noted that 6 of the 54 studies classified as characterizing social process did so within a system that was considered successful or unsuccessful in some manner (e.g., lack of collective action); however, as no clear description or supporting evidence was provided for this potential outcome measure, they remained in the social process category. Categorizing the studies by general methodology (Fig. 6.2) showed 58% used descriptive methods, primarily to characterize social processes (47 studies; e.g., describing the structure of social networks to understand flow of information) or social outcomes (2 studies; e.g., describing a single network that reached a particular outcome as a group). Fewer studies (34%) compared across separate networks or subgroups within a single network (Fig. 6.2), the majority of which attempted to correlate network metrics with differing social (e.g., land use decisions [Kittredge et al. 2013]) or environmental outcomes (e.g., tree species richness [Isaac 2012]) (Table 6.1). Seven studies characterized networks

across more than one time point to assess network dynamics (Fig. 6.2), with 4 of the studies using participant recall to determine network connections for the earlier time periods and 3 studies collecting data at each time period.

Table 6.1. Examples from reviewed studies of social processes (grouped into one of four themes), social outcomes, and environmental outcomes. Number in parentheses is number of reviewed studies categorized per theme and outcome. Full citations and all reviewed studies are in Appendix M.

Themes of social process Example research findings from reviewed articles	
• Flow of information, knowledge, or resources (13 studies)	
Social process (n=8)	Relative to local farmers, migrant farmers have larger networks, more connections across distinct community groups, and more knowledge about pro-environmental management practices, which makes them well-positioned to exchange information about such practices (Isaac et al. 2014).
Social outcome (n=4)	Communication patterns in a fishing community show deep-sea fishers occupy central positions in the knowledge network, but their lack of awareness of declining fish stocks in the area means ecological information is not being passed through the network, which may explain the community's lack of collective action towards rectifying their unsustainable use of resources (Crona & Bodin 2006).
Environmental outcome (n=1)	Rates of shark bycatch suggest one ethnic group of fishers are employing better shark bycatch avoidance behaviors than other groups, but the lack of information-sharing ties between groups appears to limit the diffusion of such behaviors to other groups (Barnes et al. 2016).
• Social learning (11 studies)	
Social process (n=4)	Scientists and managers who work on “fish and fire” management issues show a lack of social interaction, illustrated by the limited number of bridging ties between the groups, which may limit the opportunity for generation of new knowledge, learning, and innovation (Fischer et al. 2014).
Social outcome (n=6)	The networks of landholders who adopted the practice of field-edge habitat plantings had ties to other landholders and agencies that provide technical support, whereas networks of non-adopters included only one of those groups, suggesting the importance of multiple learning pathways (Garbach & Long 2017).
Environmental outcome (n=1)	Comparing several cultural groups living off rainforest habitat suggests sustainable use of resources (using measures of forest health), correlate with social networks that include people who are important sources of social support and also sources of knowledge (Atran et al. 1999).
• Social influence (25 studies)	
Social process (n=13)	Stakeholders in a forest management planning process show a disconnect between their perceived level of influence and actual power as determined by their communication activity (i.e., the number of incoming and outgoing ties of each stakeholder in the network [Paletto et al. 2016]).
Social outcome (n=9)	Stakeholders' opinions about land management are less influenced by their particular organizational affiliation or category (e.g., “conservationist” versus “farmer”), and more by whom they speak with on a regular basis (Prell et al. 2010).
Environmental outcome (n=3)	Both cooperation within local networks, and access to new ideas through external, bridging connections, are needed for successful adoption of agricultural practices that are demonstrated to improve land use and diversity (Isaac & Matous 2017).

Themes of social process	Example research findings from reviewed articles
• Participating, cooperating, collaborating (36 studies)	
Social process (n=29)	Social network analysis illustrates collaborative connections among coastal management practitioners, and suggests that decentralized networks, with well-positioned individuals who can facilitate information and resource exchange, may strengthen the process of ecosystem-based management (Smythe et al. 2014).
Social outcome (n=6)	Assessing ecosystem-based management outcomes stemming from different planning processes shows that: 1) collaborative networks with similar overall network characteristics can achieve different outcomes, and 2) networks with different characteristics can achieve similar outcomes. Supporting the notion that different causal pathways can contribute to accomplishing desirable ecosystem-based management (Bodin et al. 2016).
Environmental outcome (n=1)	Labor-exchange networks help maintain close connections among swidden farmers, which limits new pioneer settlements into pristine areas and slows overall rates of deforestation (Downey 2010).

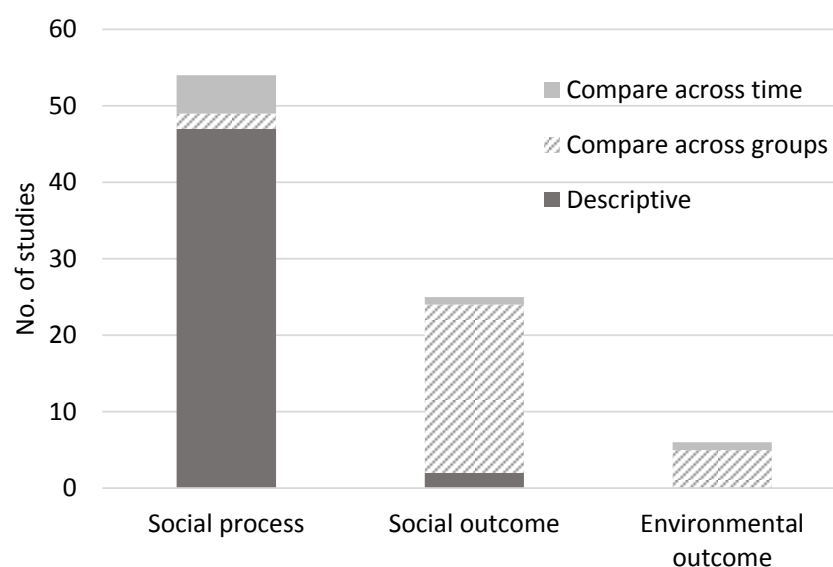


Figure 6.2. Number of reviewed studies (N=85) within each methodology category (Descriptive, Compare across groups, Compare across time) and grouped by whether they focus on social process, social outcome, or environmental outcome.

Only 4 studies assessed networks before and after an intervention, such as establishing a bush fire planning procedure (Brummel et al. 2012) and providing mobile phones to Ethiopian farmers to examine the impact on information-seeking activity (Matous & Todo 2015). Although interventions were rarely evaluated, many authors (39 studies) commented on how altering the networks may improve structural characteristics (e.g., increased connectivity) and thus possibly the outcomes. Suggested alterations included establishing new projects (Berdej & Armitage 2016), involving influential individuals as stakeholders in

management decisions (Prell et al. 2009), or actively creating new connections among existing network nodes (Vance-Borland & Holley 2011).

There were 39 studies (46%) in the subset addressing both a management context and privately owned (e.g., famers; 24 studies) or common pool (e.g., fishers; 15 studies) resources. Table 6.2 illustrates the variability in network metrics used by this subset, distinguishing between egocentric or whole networks (as the metrics differ) and the 4 social process themes of Table 6.1. For whole networks, metrics are also grouped by whether they provide information about general connectivity in the network, insights about overall structure (e.g., cohesion, existence of subgroups), or the positions of actors relative to others. Studies using egocentric network analysis, which characterized separate networks of multiple individuals, consistently investigated the influences of network size or type of alter against process or outcomes (Table 6.2). Type of alter includes attributes of the people or organizations to which an individual is connected. Eleven of these egocentric studies compared network metrics between differing social or environmental outcomes. Studies using a whole network analysis approach reported on or tested 36 different network measures collectively (Table 6.2). Eleven of these studies compared measures between networks or subgroups that displayed differing outcomes, yet were still quite variable in their approaches and measures used (Appendix M). Relatively common metrics included network density (which indicates the extent to which all actors are connected), calculations of ties within versus between groups (which indicates tendency towards group closure), and betweenness centrality (which indicates actors who can control the flow of information), along with network size and type of alter (Table 6.2). These common metrics are also reflected in the full set of reviewed studies, with network size, type of alter, and density used in 78%, 66%, and 48% of studies respectively (Appendix M). While the individual research contexts generally explain the diversity of measures used, the variability we observed in this subset, along with inconsistent use of terms and definitions (e.g., variable nomenclature, written description rather than mathematical formulae), made it difficult to identify patterns that could assist in highlighting the most informative network measures.

Table 6.2. Network metrics used in studies (n=39) examining the management of resource by private individuals or communities.

Egocentric network (12 studies)		Flow	Learning	Influence	Collaboration	
11 private, 1 communal		(0 studies)	(2 studies)	(10 studies)	(0 studies)	Total
	ego-network size (degree)		2	10		12
	type of alter ¹		2	10		12
	tie strength ²			4		4
	density			3		3
	efficiency			1		1
	cliques			1		1
	two-step neighborhood			1		1
Whole network (27 studies)		Flow	Learning	Influence	Collaboration	
13 private, 14 communal		(5 studies)	(7 studies)	(7 studies)	(8 studies)	Total
connection	network size ³ (reported)	3	2	2	6	13
	network density		6	2	2	10
	average degree	1		2	3	6
	average path length		1		2	3
	network diameter		1		1	2
	double two-step paths		1			1
	geodesic distance	1				1
	line-connectivity		1			1
	network centralization			1		1
	tie strength ²				1	1
community structure and/or subgroups	type of alter	5	7	5	6	23
	ties within vs between groups ⁴	4	3	1	2	10
	# of components			2	3	5
	modularity	3		1	1	5
	reciprocity		2		2	4
	transitivity		1	1	2	4
	block models (cutpoints)		1		1	2
	cycles (dyads, triads)		2			2
	hierarchy				2	2
	network efficiency				2	2
	clustering coefficient				1	1
	core-periphery				1	1
	factions			1		1
	k-core				1	1
	network betweenness				1	1
	network heterogeneity				1	1
actor positions	betweenness centrality	1	2	5	2	10
	degree centrality	1	1	5	1	8
	closeness centrality		1	2	1	4
	eigenvector centrality ⁵			3		3
	indegree centrality		1		2	3
	outdegree centrality		2		1	3
	brokerage roles	1		1		2
	“key player” measures			1		1
	leverage centrality			1		1
	pair-dependency			1		1

¹ Includes measures of diversity, heterogeneity.

² Does not include articles that used tie strength as a means to exclude certain ties from the analysis.

³ Includes counts of nodes and/or counts of ties.

⁴ Includes various measures, such as E-I index and cross-boundary exchanges.

⁵ Include a single use of “alpha centrality”.

Discussion

SNA has gained prominence in NRM research in recent years and is seen as a “flexible tool that provides a different and useful perspective on complex social dynamics in relation to environmental management” (Salpeteur et al. 2017, p. 4). In this review, we set out to synthesize how SNA has been used in NRM studies and its relevance to the decisions and actions of private individuals or communities in conserving natural resources. This body of literature has grown rapidly over the past 10 years and has captured a diverse range of case studies with equally diverse objectives, methods of data collection, nodes and ties of interest, network metrics, outcome variables, and analytical approaches. While this case study approach offers a rich set of baseline data and contexts, the lack of an overarching methodological framework limits the advancement of learning beyond context-specific scenarios.

To consolidate theory about how social networks can influence attitudes and behaviors (Borgatti & Halgin 2011), we developed a theory of change that links social networks and social processes as a precursor to social outcomes, which in turn can influence environmental outcomes (Fig. 6.1). This connects the concept of one’s actions being influenced by others in their networks (Borgatti & Halgrin 2011) with the concept of one’s actions then influencing environmental outcomes (e.g., Eklund & Cabeza 2017). This theory of change provided a valuable framework with which to assess how well the current literature supports the theoretical basis for focusing on SNA within NRM. Using the theory of change, we were able to distinguish among the reviewed studies where the objectives focused primarily on interactions between people (social processes), the decisions or actions made by individuals because of those interactions (social outcomes), or further associating network metrics with environmental measures (environmental outcomes). While elements of this theory of change are often discussed or implied by the studies, there has been little attempt to validate the causal relationships implied, leaving a large gap in demonstrating whether network interventions can be used to promote desired outcomes in resource conservation and management.

Using social network analysis to address social process

The dominant focus in the reviewed studies was on social processes, which is understandable given that is the immediate link to social networks. Processes examined in the studies could be grouped into the themes of information flow, social learning, social influence, and aspects of collaboration (Table 6.1). The authors of these process-oriented studies often used SNA to establish baseline information about and assess social connections within social-ecological systems, looking for potential strengths or weaknesses in the network, or to explore the value of SNA as a tool to understand the connections among actors. Many examined resource governance processes, such as communication among key actors, in line with the concept that promoting an effective governance system will support conservation outcomes (e.g., Berdej & Armitage 2016). Yet a descriptive approach still leaves unanswered the question of whether changes in governance influence the attitudes and behaviors of those who directly use the resources (i.e., social outcomes), or influence the quantity or quality of the resource itself (i.e., environmental outcomes; Koontz & Thomas 2006).

The majority of process-oriented studies used descriptive methods to visualize the links between individuals and organizations of interest (Fig. 6.2), and often in only a single network. Some studies looked at differences in subgroups within a network (e.g., Barnes-Mauthe et al. 2013) or compared network characteristics with randomly generated networks (e.g., Maciejewski et al. 2016) to further understand connections within the system. This descriptive approach is an essential starting point in understanding the diversity in network structures across differing contexts and gathering baseline information of a particular system, but it offers little in the way of contrasting network characteristics where processes differ. Several studies, however, compared network data for 2 or more time points (Fig. 6.2) to either assess network dynamics over time (e.g., García-Amado et al. 2012) or understand the effect of an intervention on connecting otherwise unconnected individuals (e.g., Brummel et al. 2012), which we discuss in more detail below.

Using social network analysis to understand social outcomes

Nearly one-third of the studies progressed along the theory of change to address specific social outcomes relative to network characteristics and associated social processes (Fig. 6.2). They addressed social outcomes such as acquiring new ecological knowledge (Crona & Bodin

2011), manufacturing traps that are more environmentally-friendly (e.g., Cavalcanti et al. 2013), or to deciding to enroll in a conservation program (e.g., Kittredge et al. 2013). Assessing social outcomes requires additional data beyond that of network connections and representing situations in which a decision or action was desired, so as to demonstrate that a clearly defined and measurable outcome was or was not attained (e.g., adopting a management practice or not). Data are needed from more than one network or from more than one time period to contrast outcomes across different contexts (e.g., Sandström & Lundmark 2016). The majority of studies that centered on social outcomes used comparative methods to determine whether correlations existed between network characteristics and differing outcomes (Fig. 6.2), in which they contrasted separate networks, subgroups within a single network, or separate groups of egocentric networks. While the results were informative within the individual case studies, the heterogeneity we observed in research objectives, methods, and use of network metrics (e.g., Table 6.2) made it challenging to generalize the findings. Furthermore, while new knowledge or adopting best management practices were assumed to have a positive relationship with environmental outcomes, this was rarely tested and often not made explicit, leaving the reader to infer the possible links.

Using social network analysis to understand environmental outcomes

Demonstrating the link between network structure and environmental outcomes in the theory of change requires yet another dataset, one that explicitly includes environmental measures, possibly a longer time series of measurements to capture lags in ecological change, and sufficient data to disentangle factors influencing the change (Koontz & Thomas 2006). Only 6 studies measured environmental variables (Table 6.1) to relate back to network characteristics in systems, including farmers, forest owners, and fishers in both private and communal systems (detail in Appendix M). These studies used comparative methods to test for associations between individual or group behavior and environmental outcomes. Even within this small number of studies there was a diverse array of methods and contexts that limit generalization of findings. Nonetheless they offer examples of correlating social networks with environmental outcomes providing some test of the theory of change.

Recommendations for improving the value of SNA research

The limited use of interventions (e.g., before-and-after studies) among the reviewed studies not only precludes our ability to learn about the causal relationships in the theory of change but also how to design successful network interventions, as has been done in other fields such as health programs (Latkin & Knowlton 2015). Conservation biology is often criticized for failing to evaluate the outcomes of ecological interventions and therefore missing the opportunity to learn about how to improve effectiveness (Ferraro & Pattanayak 2006), and it would be regrettable to repeat this pattern with network interventions. We suggest taking advantage of opportunities to learn from conservation programs or initiatives that are about to be established (e.g., collecting data before and after the intervention), which strive to create the social outcomes hypothesized to improve environmental outcomes (Fig. 6.1). Likewise, the large number of reviewed studies that suggested particular changes to network structures, as a means to possibly improving connections and outcomes, provide a great opportunity to follow up and test these hypotheses. Research focus can be directed to where critical network attributes are already known from previous SNA research (e.g., testing the use of influential individuals on program uptake; Prell et al. 2009). We also encourage studies to assess multiple time periods after an intervention to consider the longevity of changes observed. We appreciate that experimental interventions in social networks will have limitations (e.g., due to cultural sensitivities; Matous & Todo 2015); but in many cases experimental designs are feasible, such as implementing before-and-after studies where interventions (via organizational outreach or implementing conservation programs) are already planned. Action research is another option, in which the researchers and research purposefully become involved in change, through engaging with people or groups and creating space for social learning and problem-solving (Patton 2002). For example, Westerink et al. (2017) actively created connections between farmers and public officials, which built trust among the groups and led to the creation of adaptive management agreements intended to improve biodiversity and water quality. Although time- and effort-intensive, knowledge gains may be worthwhile, and journals could encourage the publication of these studies, rather than more descriptive studies of social processes.

Longitudinal studies with data collected at multiple time points would also improve understanding of how networks may evolve over time or whether changes in social

processes or outcomes post-intervention are sustained. Descriptive studies of a single point in time provide important baseline information about existing relations among people or entities that can be used for targeting interventions (Valente 2012). However, this static representation fails to capture the shifting nature of networks, in which interactions and relationships form or end over time (Matous & Todo 2012). Many authors of the reviewed articles recognized that the lack of longitudinal studies is a significant gap in the existing literature that must be remedied to better understand causality (Crona & Bodin 2011), effectiveness of interventions (Kocho-Schellenberg & Berkes 2015), network evolution (Sandström & Lundmark 2016), and lasting changes in behavior or other outcomes (Cavalcanti et al. 2013).

Our assessment of SNA metrics used within the studies reveals a clear need to critically assess the value of the diversity of metrics used. While we observed that a small number of metrics are commonly used in NRM contexts, the diversity we found across studies precludes generalization. We also observed that the lack of clear justification and description of metrics calculated (i.e., reporting equations) in many studies made it difficult to assess whether the diversity arose from meaningful differences or variable terminology. While this diversity provides enormous flexibility in the ways networks can be assessed, it is important to evaluate whether the evolution of analytical methods and network metrics is the result of a positive and natural advancement, or a product of lack of clarity and the proliferation of SNA software packages. This is particularly important for whole network approaches, where there is greatest flexibility in the types of metrics that can be calculated. We see a need to develop clearer guidance within NRM and conservation research about the most appropriate and meaningful network metrics to test in studies with different contexts and objectives. Therefore, reporting standards are required to ensure studies provide a clear justification for the metrics used in a study and how they were calculated to avoid confusion associated with trends in nomenclature and genuine progress in the development of new metrics as the field continues to mature.

With the aim of assisting researchers to orient their studies in relation to the theory of change, we present a typology (Table 6.3) of processes and outcomes to distinguish the wide array of research avenues and where their study fits in relation to testing the validity of this theory of change. We hope the recommendations we present will encourage authors to

conduct studies that build the evidence base on which conservation practitioners can design effective interventions in social-ecological systems. An example of the type of studies required can be seen in Crona et al. (2017), whose theory of change in the context of understanding leadership and social capital in fisheries systems links network measures with social and environmental outcomes, and provides clear explanations of variables, metrics, and evaluation of those outcomes,. Since myriad other factors (e.g., individual characteristics, culture, climate) also contribute to changes in behavior or changes in ecological condition (Ostrom 2009), it will require a large and targeted evidence base to clearly demonstrate the role of social networks in influencing social and environmental outcomes. Such an evidence base can only be built through the types of studies we outline above.

Reviews of SNA in other research areas (e.g., online education [Cela et al. 2015], HIV prevention or treatment [Ghosh et al. 2017], project management [Zheng et al. 2016]) are not immune from similar shortcomings to the SNA research in this review. The relatively recent increase in the use of SNA is generating insights about social interactions, but there is often more emphasis on process-related benefits rather than outcomes (Zheng et al. 2016). Information on network characteristics are rarely used to design interventions or test whether interventions improve outcomes (Cela et al. 2015), and the lack of longitudinal studies limit causal determinations (Zheng et al. 2016). Another consistent trend among fields is the heterogeneity of objectives, methods, and analyses between studies precluding meta-analysis and making generalization difficult (e.g., Ghosh et al. 2017). Given that the use of SNA is nascent in the field of environmental management and conservation, learning the lessons from other fields should enable this research area to bypass many of the potential pitfalls and advance rapidly toward providing valuable evidence to design more effective conservation programs.

Table 6.3. Typology of themes within social process, social outcome, environmental outcome. Illustrative examples of specific topics of interest are provided for each theme, along with suggested measures to address each topic.*

Theme	Illustrative examples	Possible measures
<i>Social process</i>		
• Flow of information, knowledge, or resources	<ul style="list-style-type: none"> - Distribution of information among individuals - Accessing funding opportunities 	<ul style="list-style-type: none"> - Number of sources of information to which an individual is connected - Number of direct and indirect pathways between an individual seeking funding and someone who is a source of funding
• Social learning	<ul style="list-style-type: none"> - Engagement and sharing among individuals - Gaining insights into others' beliefs or actions 	<ul style="list-style-type: none"> - Proportion of connections in a network where individuals have identified each other (reciprocated) as links - Number of different types of people or organizations to which an individual is connected
• Social influence	<ul style="list-style-type: none"> - Individuals who can exchange information with multiple types of people or organizations - Individuals with potential to initiate change in a group 	<ul style="list-style-type: none"> - Identify individuals with the largest numbers of connections to people in different groups - Proportion of people in a network to whom one individual is directly versus indirectly linked
• Collaborating (including participating, cooperating)	<ul style="list-style-type: none"> - Involvement in a management planning process - Coordinating activities with a common goal 	<ul style="list-style-type: none"> - Identify individuals with the lowest number of connections to the rest of the group (e.g., terminal nodes) - Proportion of people in a network to whom one individual is directly or indirectly linked
<i>Social outcome</i>³		
• Choice (e.g., adoption of or change in behaviors, attitudes, or beliefs)	<ul style="list-style-type: none"> - Change in attitude - Change in land management practices 	<ul style="list-style-type: none"> - Responses from 2 or more points in time to attitudinal questions by individuals socially connected to each other - Responses of individuals from 2 or more points in time about their adoption of new management practices
• Performance (e.g., achievement or access to resources)	<ul style="list-style-type: none"> - Management performance - Access to funding 	<ul style="list-style-type: none"> - Reported satisfaction of individuals after implementing a management activity - Number of funding grants received by an organization

Theme	Illustrative examples	Possible measures
<i>Environmental outcome</i>		
• Species level	<ul style="list-style-type: none"> - Change in demographics - Change in behavior 	<ul style="list-style-type: none"> - Rates of juvenile mortality across 2 or more breeding seasons - Number of daily foraging events for a period of time
• Community level	<ul style="list-style-type: none"> - Change in species diversity - Change in resource availability 	<ul style="list-style-type: none"> - Species richness and species evenness at 2 or more points in time - Presence of ephemeral water sources at 2 or more points in time
• Landscape level	<ul style="list-style-type: none"> - Change in landscape connectivity - Change in dispersal patterns 	<ul style="list-style-type: none"> - Habitat patch size and inter-patch distances at 2 or more points in time - Number of successful dispersal events at 2 or more points in time

*Content influenced by: Noss 1990; Schusler et al. 2003; Bodin & Crona 2009; Borgatti & Halgin 2011; Prell 2012.

Conclusion

Studies of SNA within NRM have improved our understanding of the important role key individuals can play in transmitting ideas and information through a network, and potentially influencing the decisions and actions of others. Descriptive studies and focus on social processes have advanced our knowledge base, but as the field continues to develop it is important to validate causal relationships and build the evidence base for the links between observations about network structure and desired outcomes. More targeted research in the future could yield important insights into how to structure conservation programs aimed at engaging resource users to ensure they achieve desired social and environmental outcomes that can be sustained long-term. The bulk of SNA research in NRM is less than 10 years old and expanding rapidly, so now is an opportune time to review progress, identify strengths and weaknesses in the existing evidence base and find ways to enhance the ability for the conservation community to learn from future research. This review is not intended as a critique of individual studies; rather as an opportunity to identify ways to build a more rigorous evidence base to demonstrate the extent to which social networks can play a role in achieving desired environmental outcomes.

Chapter 7: General discussion

Conservation covenants are agreements in perpetuity with the goal of protecting biodiversity values on private lands. Maintaining those values over time requires ongoing stewardship. Given the popularity of covenanting programs worldwide (e.g., Figgis 2004, Pidot 2005, Chiavari & Lopes 2015), it is important to understand the stewardship of covenanted landholders. Factors that influence pro-environmental decision-making with regards to land management have often been studied in the context of agriculture and focused on initial uptake of short-term agreements (e.g., Lastra-Bravo et al. 2015). Although strides have also been made in understanding uptake of conservation covenants (e.g., Kabii & Horwitz 2006, Brain et al. 2014), few studies have looked beyond the initial agreement to the actualization of management actions long-term (Stroman & Kreuter 2015). To fill this gap, I investigated the perspectives of landholders with conservation covenants on their properties in Australia, to understand their views about covenants, the management of their properties, and the challenges they face. Using a mixed methods approach, this study is the first to examine both the detailed perspectives and national patterns of covenanted landholders in Australia. It provides insight into how conservation outcomes are being achieved and maintained on the properties, the current state of covenanting programs, and recommendations to make the programs more effective.

Drawing on the conceptual framework developed by Mills et al. (2017) to explain sustained pro-environmental behavior, I investigated the willingness, ability, and engagement of a range of landholders within a covenanting context. Placing covenanted landholders (i.e., covenantors) in relation to these three elements enabled me to identify the greatest challenges to covenanting programs that may prevent landholders from achieving positive environmental outcomes on their properties. Additional insights gained through interviews with staff from within covenant providers, whose role it is to oversee the programs and support covenantors, helped to further contextualize the landholder perspectives.

Willingness

Overall, covenantors are positively disposed towards covenants and undertaking management activities on their properties, with most covenantors motivated by protecting

the natural values on their properties (Chapter 3). The intrinsic motivations to covenant and manage indicated by many covenantors, and their positive opinions about covenanting, are a strong foundation for maintaining those actions long-term (Ryan & Deci 2000). There is a small portion of covenantors who are dissatisfied with their covenant and/or with their covenant provider; they tend to be successive owners, who were not involved in negotiating the covenant, or landholders required to covenant under existing regulations. Given that participation in this study was voluntary and I was unable to follow up on non-responses, these findings may in fact underestimate dissatisfaction if non-respondents consist of a larger portion of dissatisfied or disengaged covenantors. As covenanted properties are sold and the pool of successive owners grows, it will be important to consider how landholder willingness may shift over time.

Ability

Most covenantors are actively managing their properties and focused on controlling pest species, although their activities rarely go beyond the minimum required of all landholders (Chapter 4). Covenantors face a variety of limitations to their ability to manage, such as time constraints, lack of money and knowledge, or influences from the surrounding landscape. Challenges are similar regardless of the type of covenantor, although successive owners and those who do not live on the properties have less knowledge of the property and its management needs, and often have less time to undertake the required management. Covenantors are becoming less physically able as they age and more financially constrained as they retire. Lack of resources were common barriers to the ability of landholders, exacerbated by fluctuating levels of funding from government bodies. While covenantors still manage to achieve their minimum requirements with the resources available, and some are finding creative ways to stretch those resources, the potential activities could increase and biodiversity outcomes improve if these barriers were reduced.

Engagement

Covenantors engage with a variety of sources when seeking information and advice about their management activities (Chapter 5). These sources reveal the diverse networks within which landholders are embedded and their level of involvement in those networks.

Absentee owners are using fewer face-to-face sources due to their distance from the covenanted property, and successive owners, who are still learning about their properties, want more access to sources overall. While willingness and ability have often been the focus of research into landholders' pro-environmental behaviors (Mills et al. 2017), there is increasing evidence that engagement with support networks can serve to bolster those elements (e.g., Leventon et al. 2017), particularly with regards to social networks (Chapter 6). These networks create opportunities for landholders to acquire resources (e.g., financial or technical support) and bolster their motivation (e.g., Kittredge et al. 2013). Covenantors show a desire for professional advice and peer learning that is targeted to their local conditions, but numerous barriers to accessing these sources exist between individual and institutional levels.

Intersections among the elements

Examining each of these elements in isolation suggests that the situation for covenants is positive overall – more covenantors are willing, able, and engaged than not. However, Mills et al. (2017) show that the longevity of action is seen at the nexus of the three elements, thus it is important to understand how covenantors are situated in relation to all three. Using the conceptual diagram provided by Mills et al. (2017; Chapter 1, Fig. 1.1), it is possible to consider where covenantors are positioned, which elements are strongest, and what changes are needed to shift landholders towards sustainable action (the center of the diagram).

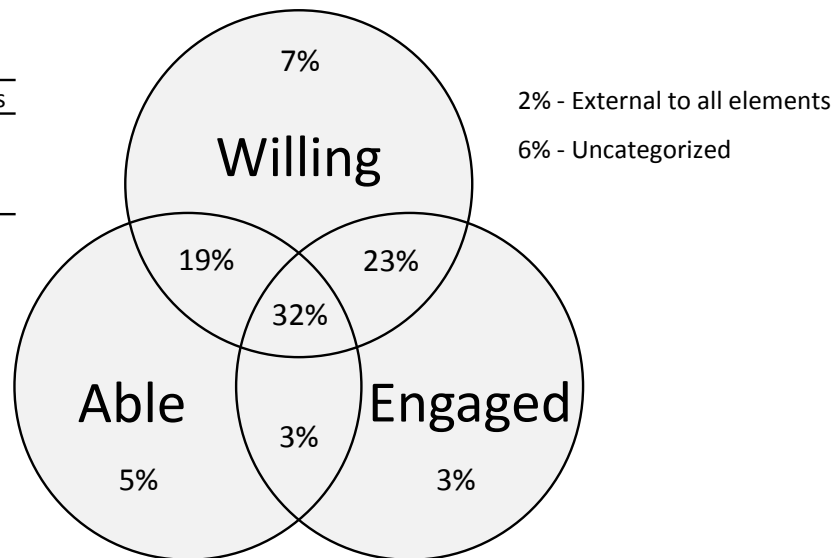
Using landholders' responses to survey questions about willingness (i.e., satisfaction with covenanting; Chapter 3), ability (i.e., management challenges; Chapter 4) and engagement (i.e., seeking information; Chapter 5), I estimated where covenantors are positioned relative to the different elements. Covenantors were categorized as *willing* if they indicated satisfaction (or neutral) with both the covenant and the covenant provider (Chapter 3); they were categorized as *unwilling* if they indicated dissatisfaction with the covenant, the provider, or both (i.e., the 'dissatisfied' groups in Chapter 3). Covenantors were categorized as *able* if they selected less than three management challenges or selected the option of 'no challenges' (Chapter 4); they were considered *unable* if they selected three challenges, the maximum possible (Chapter 4). Challenges were not ranked because they can interact with

one other (e.g., physical ability can compensate for lack of money if people do the work themselves, or money can be used to pay contractors if landholders are not physically able). Finally, covenantors were categorized as *engaged* if they sought and used at least one-third (n=7) of the total possible sources of information listed in the survey; they were categorized as *unengaged* if they either did not seek information or they used less than one third of sources (Chapter 5). Using these coarse classifications, each covenantor was assigned a specific position within the diagram (Fig. 7.1). Covenantors with zero elements (i.e., they were unwilling, unable, and unengaged) were positioned outside of the diagram. If covenantors did not respond in one or more of those survey sections, their positions could not be determined but they were included as *uncategorized* to calculate overall percentages (Fig. 7.1).

Most covenantors (81%) display willingness to participate and continue with management activities. However, fewer covenantors have the ability (59%) to manage or engage (61%) with sources of management support (Fig. 7.1A). One-third of the covenantors report all three elements (Fig 7.1A) and are thus well-positioned to sustain their commitment and management action long-term. Encouragingly, an additional 45% of covenantors display two of the three elements (Fig 7.1A), suggesting targeted support could make a significant difference to empowering these covenantors. Successive owners are less likely to achieve more than one of the three elements than original owners, highlighting the consistent trend seen across the individual elements. Notably, the largest discrepancy between original and successive owners is the proportion of successive owners who achieve all three elements (18% relative to 34%; Fig. 7.1B). The differences between original and successive owners, and the additional challenges faced by covenantors as they age (Chapter 4), or who do not live on the covenanted property (Chapters 4 and 5), suggest growing risks to the longevity of covenanting programs that will need to be managed into the future.

A

All respondents	
Willing	81%
Able	59%
Engaged	61%

**B**

	Original signees	Successive owners
Willing	84%	72%
Able	61%	49%
Engaged	65%	43%

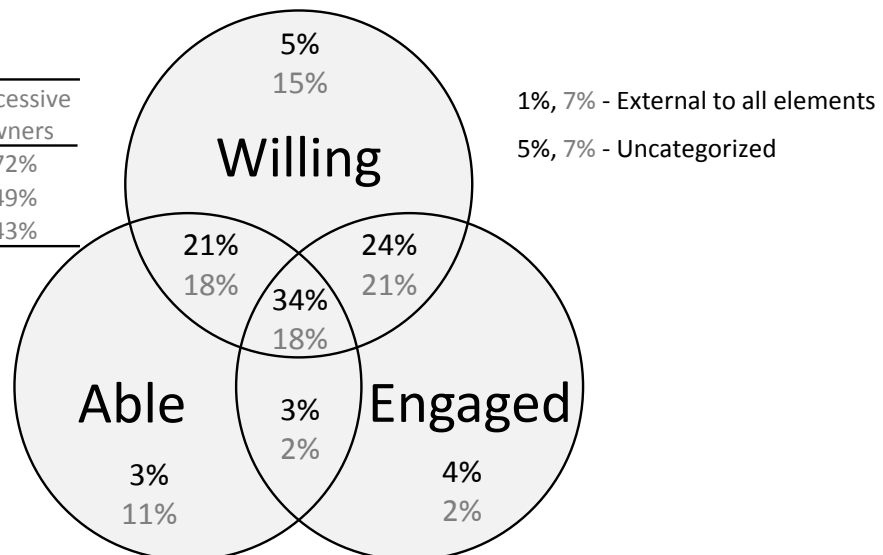


Figure 7.1. Position of (A) all survey respondents and (B) original signees versus successive owners, relative the conceptual diagram of desired willingness, ability, and engagement to sustain their commitment to covenant obligations and management actions. ‘External to all elements’ refers to covenantors categorized as unwilling and unable and unengaged; ‘uncategorized’ refers to covenantors with missing responses in the survey. Diagram adapted from Mills et al. (2017).

Although one-fifth of covenantors (19%) who are willing and able to manage the property engaged less with support networks (Fig. 7.1A), this lack of engagement with information and advice may not reflect a lack of interest in effective management. Some covenantors reported being satisfied with the knowledge or resources they already have and thus had no need to engage further (Chapter 5). Likewise, covenantors who considered their properties to be in good condition, where not much action is needed, also had minimal information requirements (Chapter 5). A lack of engagement is not always a barrier to management

action; rather engagement serves to sustain management action long-term (Mills et al. 2017) and inform landholders of the best management strategies (e.g., Pannell et al. 2006). However, a lack of engagement can slow the flow of information to covenantors regarding improvements in management practices (Morrison et al. 2015) or new funding opportunities, and slow the flow of information from the covenantors to the covenant provider about property conditions (Rissman & Sayre 2012) that could trigger the need for updates to management plans, both of which can impact on-ground outcomes. Land management is a dynamic process, thus engagement needs to be ongoing as conditions change and management plans become out-dated.

The extent of individual engagement in natural resource management (NRM), and the potential benefits that arise from those social connections, has seen much scholarly interest in recent years (Chapter 6). However, my review of social network research within the context of NRM shows there is still progress to be made in understanding the impacts of networks on environmental outcomes (Chapter 6). Social networks appear well-suited to generate social outcomes but there is a need to move beyond that to understanding the link between social and ecological outcomes. Currently, studies that intervene in social networks are lacking (Chapter 6), leaving a critical gap in our ability to design interventions that promote better social and ecological outcomes. The variability of engagement among covenantors presents an ideal setting to test interventions, e.g., how might the building of networks for covenantors with limited connections change their behavior.

Nearly one-quarter of covenantors (23%) are willing and engaged but lack the ability to undertake management (Fig. 7.1A). They may be intrinsically motivated and connected to support networks but limited by other factors such as lack of money, time or physical ability. Without ability, the degree of willingness may not matter (Mills et al. 2017), although ideally their engagement with support networks could ultimately introduce them to resources to help increase their ability (Chapter 6). Furthermore, ability is complex and context specific, with different factors interacting and trading-off (e.g., money to hire a contractor can compensate for physical constraints). Although respondents selected their top challenges to management, they did not indicate the impact of those challenges on their ability, thus the proxy I used may underestimate the number of landholders with limited ability. Only 12% of covenantors indicated they have no challenges (Chapter 4, Fig. 4.3), suggesting a worse-case

scenario of 88% of covenantors with limited ability. There is a need to better understand which challenges pose the greatest barrier to the most people, and/or which barriers impact different types of covenantors, to design efficient solutions. The main challenges covenantors see as limiting their ability to manage – lack of money, time, or knowledge (Chapter 4) – are frequently reported by protected area managers (e.g., Cook & Sgrò 2018) and landholders considering uptake of non-binding environmentally-friendly practices (e.g., Race et al. 2012). Cost-effective options to help resolve some of these challenges could include landholders supporting one another through coordinating and integrating management action across multiple tenures (e.g., Maciejewski et al. 2016).

Recommendations

This study provides a snapshot of circumstances and perspectives that may enable or prevent covenantors achieving sustainable management action. Where landholders are positioned within the framework is not static and will move in line with their changing circumstances. With targeted support and encouragement, many covenantors can move towards the nexus of the key elements where sustained action is most likely to occur (Mills et al. 2017), and thus ongoing conservation outcomes. However, the findings from this study suggest multiple risks in the future positions of covenanted landholders. For example, successive owners, who need more support to bolster their willingness and engagement (Chapters 3 and 5), will increase as a proportion of the cohort. Similarly, absentee owners and older landholders need more support to assist with their management ability (Chapter 4). At present, resourcing to support covenantors have declined, with no indication that funding will keep pace with the number of covenants, let alone the challenges covenantors face.

To maintain or enhance conservation outcomes on covenanted properties, covenant providers are best placed to support the landholders, and arguably, by representing the other party to the agreement, have an obligation to do so. While additional funding directed to covenantors could help increase their ability, additional and consistent resources for the covenant providers – in line with the continued increase in covenanted properties – would provide additional options to increase their capacity to bolster the ability and engagement of covenantors. Given covenantors' desire to connect with covenant providers, local experts,

and other covenanted landholders (Chapter 5), the providers themselves could play a larger role in facilitating these connections.

Achieving biodiversity outcomes can be accomplished more effectively and efficiently when properties are considered within a landscape context rather than managing them in isolation (Goldman et al. 2007; Rickenbach et al. 2011). Interviewees revealed examples of cross-boundary management (Chapter 5), driven by landholders or coordinated through management agencies, in which covenantors are coordinating management actions and sharing resources across multiple properties, but findings suggest it is relatively limited. This support for cross-boundary management occurs through several pathways, such as regional NRM organizations and Landcare. An additional role of covenant providers could be in better promoting and enabling cross-boundary management.

Future directions

This research into the perspectives of covenanted landholders and covenant providers has highlighted important knowledge gaps that must be filled to ensure that the long-term benefits of conservation covenants are realized. While this study focused on the management actions of covenantors, it was beyond the scope of this study to establish the links between those actions and on-ground conservation outcomes (e.g., ecological improvements). Future work should focus on three key topics, each of which should be coupled with assessments of ecological outcomes.

- Conditional covenants: Two states in Australia, Western Australia (WA) and South Australia (SA), require conditional covenants to offset development impacts (e.g., property subdivision). As my findings suggest dissatisfaction is higher in those states, more research is needed to understand the views of landholders who do not voluntarily enter into covenants. This is particularly important as most scholarly attention to-date has been focused on voluntary or incentive-based covenanting programs, rather than encompassing non-voluntary approaches as well. Studies comparing various aspects of conditional covenants to voluntary covenants within WA and SA – such as property condition over time, expected versus actual management activities, ecological outcomes, and landholder perspectives – would

improve our understanding of the benefits and limitations of these types of covenants.

- **Change in ownership:** Given my findings highlight some differences in willingness, ability, and engagement between original signees and successive owners, more research is needed to understanding the processes involved and the impacts of changes in ownership. Of most value would be studies focused on: understanding why owners sell their properties (e.g., personal reasons or because of the covenant); the process owners go through in selling covenanted properties; what successive owners are (or are not) aware of when purchasing the property; and how covenant providers can better support successive owners and empower them to take ownership over the values and management of the property.
- **Outcomes of social networks:** Covenantors indicate a desire for more connections with other landholders and local experts. Yet it is unclear in what ways these social connections could best be bolstered and whether they ultimately translate into ecological improvements. Intervention studies could facilitate new connections among covenanted landholders (and/or with other entities) and assess the impacts of these larger networks or stronger connections on conservation outcomes. Approaches such as longitudinal studies (including before-and-after studies) should be used, looking at both social and ecological outcomes relative to new or altered connections among covenantors. Comparisons between the social networks of original and successive owners would also offer important insights into strengthening covenanting programs into the future.

As covenanting programs continue to mature, these new insights would help to ensure the longevity of desired outcomes. What is clear from my research is that covenanted landholders, who are offering societal benefit from their conservation actions, are largely shouldering the burden of delivering those benefits alone while the contributions of covenant providers, who represent the other party to the agreement, have declined over time. The variety of individuals who own and manage covenanted properties, and the diversity of their attitudes and capabilities, suggest a single approach to supporting conservation outcomes will not be sufficient. However, a renewed focus on improving connections among people and across landscapes should be fundamental to any approach.

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Appendices

Appendix A. Interview questions asked of landholders in Australia with conservation covenants on their properties. “O” indicates questions asked of original signees; “S” indicates questions asked of successive owners. [Chapter 2]

Appendix B. Interview questions asked of key informants who worked with covenant providers in Australia. [Chapter 2]

Appendix C. Questionnaire used for landholders in Australia with conservation covenants on their property. [Chapters 2, 5]

Appendix D. Covenanting program, property, and landholder characteristics of the interview and survey participants. [Chapters 3, 4, 5]

Appendix E. Covenanting program, property, and landholder characteristics of original signees and successive owners. Survey totals exclude land managers (n=13) and revolving fund participants (n=13). [Chapter 3]

Appendix F. Motivations to participate in conservation covenanting programs as described by interviewees. Percentages are per covenantor type (i.e., original signees [n = 65] and successive owners [n = 17]). Individual codes have been grouped by theme. Interviewees could be included in more than one code and more than one theme but are only counted one time per each. [Chapter 3]

Appendix G. Opinions about conservation covenants and covenanting programs as described by interviewees. Percentages are per covenantor type (i.e., original signees [n = 65] and successive owners [n = 17]). Individual codes have been grouped by theme. Interviewees could be included in more than one code and more than one theme but are only counted one time per each. [Chapter 3]

Appendix H. Program characteristics, property characteristics, and demographics for all survey respondents (n=317) who were included in analyses regarding sources of information and advice. [Chapter 5]

Appendix I. Results of Mann-Whitney U tests for differences in the use, value, and desired access of six sources of information between original signees and successive owners, resident and absentee owners, and covenantors who do or do not undertake management activities. [Chapter 5]

Appendix J. Barriers to acquiring land management information and advice as discussed by interviewees (n=82). Individual codes have been grouped by theme. Interviewees could be included in more than one code and more than one theme but are only counted one time per each. [Chapter 5]

Appendix K. Descriptions of social network measures most commonly reported in articles used in this review. Descriptions are from Hanneman & Riddle (2005) and Prell (2012). [Chapter 6]

Appendix L. Number of document results per search term in the Scopus and Web of Science databases. Numbers include documents that are repeated among search terms and between databases. [Chapter 6]

Appendix M. Titles, extracted details, and inductively-created categories for all reviewed articles (n=85). New columns continue on page 173 and 184.

Appendix A.

Interview questions asked of landholders in Australia with conservation covenants on their properties. “O” indicates questions asked of original signees; “S” indicates questions asked of successive owners.

1. **O & S:** Before we get into talking about your property, I’d like to learn a few things about you. (Prompts: What do you do for work? Do you have any history with land management or similar activities?)
2. **O & S:** Can you tell me a few details about your property and the portion of it that’s covenanted? (Prompts: How long have you had the covenant? Size of the property? Size of covenanted? Land use? Income earned from property? How frequently on property? How did you come to own it?)
- 3a. **O:** What motivated you to enroll your property in a conservation covenant? (Prompts: Can you tell me about how your property came to be covenanted? How did you find out about covenants as an option? What agency/trust did you work with to set up the covenant?)
- 3b. **S:** What motivated you to take on a covenanted property? (Prompts: With regards to purchasing/inheriting the covenant, can you tell me a bit about that process? How did you find out about the property? Was it important to you that the property was covenanted? How did you go about understanding the content of the covenant?)
- 3c. **S:** Do you feel like you had enough understanding of the conservation covenant to make an informed decision about whether or not to take on the property?
4. **O & S:** What characteristics of your property are you interested in protecting through the covenant?
5. **O & S:** What is your opinion about covenants as an option for conservation on private lands?
6. **O & S:** With regards to the covenant agreement for your property, what kind of goals for the property are specified in that agreement? (Prompts: Is there a management plan tied to the agreement? What activities do you do? How are those activities paid for?)
7. **O & S:** Do you or another party conduct any type of formal or informal monitoring on your covenanted property? (Prompts: Who does the work? Who pays for it? What is monitored? How often? If no, do you ever consider doing some kind of monitoring?)
8. **O & S:** What keeps you motivated about your property and the management activities on it?
9. **O & S:** Are your current activities on the covenanted property different than what you would do on it if it weren’t covenanted?
10. **O & S:** Would you recommend to friends or family that they put a covenant on their property?
11. **O & S:** For my next few questions I’d like to focus on who you communicate or interact with on topics related to your covenant. Who comes to mind with that? (Prompts: People, groups, materials? Any options at local or regional levels?)
12. **O & S:** Do you feel like your current networks are good enough to help you get the answers or information you need?
13. **O & S:** Has anything unexpected arisen (positive or negative) as a result of your having a covenant?
14. **O & S:** What are your future plans for the property?
15. **O & S:** What changes would you make to the covenanting program if you could?
16. **O & S:** Are there any other thoughts you’d like to mention or elaborate on?

Appendix B.

Interview questions asked of key informants who worked with covenant providers in Australia.

1. Can you tell me a bit about your background, what got you to the point of working with XX? (Prompts: What is your work history and/or academic background? How long have you worked with XX? What's your role at XX?)
2. Can you tell me a few things about the covenanting program, such as its origins, goals, how it might have changed over time, and so on? (Prompts: Are there certain characteristics of a property that you are looking for when deciding whether to move forward with a covenant there?)
3. How do you define a successful conservation covenant?
4. What kinds of management or monitoring objectives are set up for covenanted properties? (Prompts: Are the objectives defined in the covenant agreement or in separate management plans? How are the objectives determined? Is it tailored to each property? Do the plans focus on specific management actions? Do the plans include a monitoring component? What do you do with monitoring information? Who does the work for management? For monitoring? Can the goals of the agreement change over time if needed?
 - a. If no management and/or monitoring, is there a desire within the agency/trust to develop those types of objectives? If yes – what are the limitations to doing so? If no – why not?
5. Do you think the current requirements placed on covenanted properties through the covenant agreements [or management plans] are sufficient for maintaining natural values long-term? (Prompts: If yes – how so? If no – what needs to change? Is there any kind of landscape-scale approach with management objectives across many or all covenants?)
6. Regarding the landowners themselves, what do you think are the key factors that encourage them to remain motivated about their covenanted property? Does this differ between original covenantors and successive ones?
7. What types of outreach/stewardship/education options are available to covenanted landowners?
8. For my next few questions I'd like to focus on who you communicate or interact with on topics related to covenanting mechanisms. Who comes to mind with that? (Prompts: People, groups, materials? Any options at local or regional levels? Any options to connect with staff at other covenant providers?)
9. Do you feel like your current networks are sufficient for exchange of ideas, information, and your ability to learn? (Prompts: Would you make any changes?)
10. In the context of the covenanting mechanism and related activities, has anything unexpected arisen (positive or negative) in the time you've worked here?
11. What kind of changes would you make to the covenanting program if you could?

Appendix C.

Questionnaire used for landholders in Australia with conservation covenants on their property.

Thank you for your interest in this survey!

The survey is intended for people who own or manage property in Australia with a permanent, legally-binding agreement on the land title for the purpose of protecting the property's natural values. This type of agreement can go by many names, with the most common ones being conservation covenant, conservation agreement, heritage agreement, or nature refuge.

For the purposes of this survey, the term 'conservation covenant' is used to encompass all the different names.

If you are awaiting final signatures for an otherwise-approved conservation covenant, you are still welcome to complete this survey.

The survey will take 20-30 minutes to complete. All responses are anonymous.

1. Is there a conservation covenant (conservation agreement, heritage agreement, nature refuge, or similar agreement) on the property you own or manage?

- ☐ Yes
- ☐ No [If selected, skip to Q35]

2. Which best describes your current situation with covenanted properties?

- ☐ I am the owner of 1 property with a conservation covenant on the title. [Continue to Q3]
- ☐ I am the owner of 2 or more properties with conservation covenants on the title. [Skip to Q4]
- ☐ I am the land manager of (but do not own) 1 or more properties with conservation covenants on the title. [Skip to Q7]

3. What is your connection to the conservation covenant?

- ☐ I am the original signee to the conservation covenant.
- ☐ I inherited the property, which already had a conservation covenant on title.
- ☐ I purchased the property, which already had a conservation covenant on title.
- ☐ I purchased the property through a revolving fund program, in which the conservation covenant was required for purchase but I was able to negotiate some of the details.
- ☐ Other, please specify _____

[If answered Q3, skip to Q6]

4. What is your connection to the first (earliest) conservation covenant?

- ☐ I am the original signee to the conservation covenant.
- ☐ I inherited the property, which already had a conservation covenant on title.
- ☐ I purchased the property, which already had a conservation covenant on title.
- ☐ I purchased the property through a revolving fund program, in which the conservation covenant was required for purchase but I was able to negotiate some of the details.
- ☐ Other, please specify _____

5. What is your connection to the second conservation covenant?

- ☐ I am the original signee to the conservation covenant.
- ☐ I inherited the property, which already had a conservation covenant on title.
- ☐ I purchased the property, which already had a conservation covenant on title.
- ☐ I purchased the property through a revolving fund program, in which the conservation covenant was required for purchase but I was able to negotiate some of the details.
- ☐ Other, please specify _____

For all subsequent questions, please answer them from the perspective of the covenanted property on which you spend most of your time.

6. Which statement best describes your oversight of the covenanted property?

- ☐ I manage it on my own
- ☐ I manage it with my partner
- ☐ I manage it as part of a group or association
- ☐ Someone else manages it for me

7. What type of covenant is on the property title? (Some common types are listed below)

- ☐ Nature Conservation Trust Agreement (NSW)
- ☐ Registered Property Agreement (NSW)
- ☐ Voluntary Conservation Agreement (NSW)
- ☐ Nature Refuge (QLD)
- ☐ Heritage Agreement (SA)
- ☐ Private Land Conservation Covenant (TAS)
- ☐ Landowner Agreement (BushTender, VIC)
- ☐ Trust for Nature Conservation Covenant (VIC)
- ☐ National Trust of Australia Conservation Covenant (WA)
- ☐ Nature Conservation Covenant (WA)
- ☐ Other, please specify _____

8. Is this covenanted property your full-time residence?

- ☐ Yes
- ☐ No

9. In an average year, how much time do you spend on the covenanted property?

Number of months	0	2	4	6	8	10	12

10. Please fill in these details about the covenanted property:

Size of property (specify acres or hectares) _____

Size of covenanted area (specify acres or hectares) _____

Year the property came under your ownership _____

Year the covenant was placed on the property title _____

State or Territory location of the covenanted property _____

Shire or Council location of the covenanted property _____

11. What is the primary use of the non-covenanted portion of the property?

- ☐ Conservation
- ☐ Ecotourism
- ☐ Hobby farm
- ☐ Primary production
- ☐ Recreation
- ☐ Residence
- ☐ The entire property is covenanted
- ☐ Other, please specify _____

12. Is there a management plan for the covenanted area?

- ☐ Yes, and it is current
- ☐ Yes, but it is not current
- ☐ No
- ☐ I do not know

13. Please clarify any details about the conservation covenant or property, if needed.

If you are a land manager, but not owner, of the covenanted property, please skip to Q15.

14. In your decision to establish the covenant or acquire the covenanted property, how important was each item below?

	Very important	Important	Neutral	Unimportant	Very unimportant
Physical characteristics of the property	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Protecting the natural values of the property	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Protecting the property from changes in land use	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Permanently protecting the property	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Providing benefits to the community (e.g., ecotourism, recreation, education)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Technical support for management of the property	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Understanding the covenanting obligations	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Using it as a vegetation, biodiversity, or carbon offset to generate money or credits	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Fulfilling regulatory requirements for changes in land use (e.g., subdivision, offset)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Financial incentive at the time of signing (e.g., payment for fencing)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Becoming eligible for land management grants	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Reduction in council rates	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Understanding the covenant's influence on the resale value of the property	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

15. What are your current views towards the conservation covenant and covenanted property?

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
I am satisfied with the existing conservation covenant	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am satisfied with my Covenant Scheme Provider (agency or organisation with whom the agreement is signed)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I understand the covenant and my obligations as a covenantee	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I intend to maintain the natural conditions in the covenanted area	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I would like to change some details in the conservation covenant if possible	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I would like to change some details in the management plan for the covenanted area	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I would like to remove the conservation covenant from the property title if possible	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I intend to sell the covenanted property as soon as possible	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I intend to sell the covenanted property within the next 10 years	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

16. In your opinion, how might the conservation covenanting program or process be improved?

17. What is the primary vegetation type in the covenanted area of your property? (E.g., grassland, Eucalypt woodland, rainforest)

18. Do you conduct any management activities within the covenanted area of your property?

☐ Yes [Continue to Q19]

☐ No [Skip to Q22]

19. In an average year within the covenanted area, how often do you implement each of the following activities?

	Once a day	Once a week	Once a month	Once a year	Once every 5 years	Never
Control of weeds or other unwanted plants	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Control of feral or other pest animals	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Revegetation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Build or maintain fences	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Reduce fire hazards	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Written record of management activities	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Written record of plants or animals seen or heard	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Take photo points	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Use remote wildlife cameras	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Repeated counts or measurements of plants or animals using a standardized approach	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other, please specify	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

20. Please clarify any details about your management activities, if needed.

21. What motivates you to conduct management activities in the covenanted area?
Select the top 3 reasons.

- ☐ Obligations within the covenant or management plan
- ☐ Obligations within funding agreements
- ☐ Enjoyment of the work
- ☐ Seeing the changes in the covenanted area as a result of my efforts
- ☐ Protecting or enhancing the natural values in the covenanted area
- ☐ Taking care of what's mine
- ☐ Talking with others (e.g., agency staff, landholders) about the property and activities
- ☐ Other, please specify _____

22. What challenges do you experience when trying to manage the covenanted area?
Select the top 3 reasons.

- ☐ I do not have enough time
- ☐ I cannot afford it financially
- ☐ I am not physically able to
- ☐ The activities do not interest me
- ☐ I am rarely on the covenanted area
- ☐ I am still learning about the covenanted area and management needs
- ☐ The issues or pressures arising from outside my property boundaries
- ☐ I do not experience any challenges with managing the covenanted area
- ☐ Other, please specify _____

23. In general, how often do you provide information or advice to other landholders about management activities on their property?

- ☐ Once a day
- ☐ Once a week
- ☐ Once a month
- ☐ Once a year
- ☐ Once every few years
- ☐ Never

24. In general, how often do you seek information or advice about management activities on the covenanted property?

- ☐ Once a day
- ☐ Once a week
- ☐ Once a month
- ☐ Once a year
- ☐ Once every few years
- ☐ Never [If selected, skip to Q27]

25. Describe the people with whom you communicate when you are seeking information and advice about land management activities on the covenanted property.

	How much do you value this resource?	How often do you use this resource?	Would you like more access to this resource?	
	Select from: 1- Not much 2 - Some 3- A great deal	Select from: 1 - Never 2 - Rarely 3 - Sometimes 4 - Often 5 - Always	Yes	No
Staff with the Covenant Scheme Provider	_____	_____	<input type="radio"/>	<input type="radio"/>
Staff with the Tasmanian Land Conservancy [seen only by covenantors in Tasmania]	_____	_____	<input type="radio"/>	<input type="radio"/>
Staff at state departments (other than your Covenant Scheme Provider)	_____	_____	<input type="radio"/>	<input type="radio"/>
Staff at regional offices (e.g., CMA, NRM, LLS)	_____	_____	<input type="radio"/>	<input type="radio"/>
Staff at local government offices (e.g., shire, council)	_____	_____	<input type="radio"/>	<input type="radio"/>
Staff with NGOs or non-profit or private orgs. (e.g., Greening Australia)	_____	_____	<input type="radio"/>	<input type="radio"/>
Academic researchers	_____	_____	<input type="radio"/>	<input type="radio"/>
Contractors	_____	_____	<input type="radio"/>	<input type="radio"/>
Local experts	_____	_____	<input type="radio"/>	<input type="radio"/>
Neighbors	_____	_____	<input type="radio"/>	<input type="radio"/>
Other covenanted landholders	_____	_____	<input type="radio"/>	<input type="radio"/>
Other, please specify	_____	_____	<input type="radio"/>	<input type="radio"/>

26. Describe the written sources you turn to or activities you get involved with when seeking information and advice about land management activities on your covenanted property.

	How much do you value this resource?	How often do you use this resource?	Would you like more access to this resource?	
	Select from: 1- Not much 2 - Some 3- A great deal	Select from: 1 - Never 2 - Rarely 3 - Sometimes 4 - Often 5 - Always	Yes	No
Newsletters	_____	_____	<input type="radio"/>	<input type="radio"/>
Online resources (e.g., agency websites, blog posts)	_____	_____	<input type="radio"/>	<input type="radio"/>
Other written material (e.g., books, manuals, articles)	_____	_____	<input type="radio"/>	<input type="radio"/>
Meetings of local Landcare groups	_____	_____	<input type="radio"/>	<input type="radio"/>
Meetings of conservation-focused groups (e.g., Conservation Management Networks, conservation landholder groups)	_____	_____	<input type="radio"/>	<input type="radio"/>
Interactive workshops or field days	_____	_____	<input type="radio"/>	<input type="radio"/>
Certification programs	_____	_____	<input type="radio"/>	<input type="radio"/>
Other, please specify	_____	_____	<input type="radio"/>	<input type="radio"/>

27. Please clarify any details about your information sources, if needed.

Responses to these last few questions will provide us with some information about your background and current context.

28. What is your gender?

- ☐ Male
- ☐ Female

29. What is your age?

- ☐ 25-34
- ☐ 35-44
- ☐ 45-54
- ☐ 55-64
- ☐ 65-74
- ☐ 75+

30. What is the highest degree or level of education you completed?

- ☐ Secondary school
- ☐ Trade course/certificate
- ☐ Advanced diploma
- ☐ Bachelor degree
- ☐ Postgraduate degree
- ☐ Other, please specify _____

31. What is the approximate annual income of your household?

- ☐ < \$25,000
- ☐ \$25,001-\$50,000
- ☐ \$50,001-\$75,000
- ☐ \$75,001-\$100,000
- ☐ >\$100,000

32. What is your current work status?

- ☐ Working full-time
- ☐ Working part-time
- ☐ Retired
- ☐ Other

33. What is your current occupation (or most recent occupation, if currently retired)?

34. Prior to your involvement with conservation covenanting, did you have any previous work with, or education in, land management or similar activities (e.g., agriculture, park ranger)?

- ☐ Yes
- ☐ No

35. Please use this space to provide additional comments about conservation covenanting, land management, or information resources.

Thank you for taking the time to complete this survey!

If you know other landholders with conservation covenants on their properties who may be interested in taking this survey, please pass the survey link on to them.

To see the survey results (available after April 2016), or for more information about this research, please visit connectandconserve.com.

Appendix D.

Covenanting program, property, and landholder characteristics of the interview and survey participants.

	Surveys ¹		Interviews			Surveys ¹		Interviews	
	Count	%	Count	%		Count	%	Count	%
<u>Program characteristics</u>					<u>Covenantor characteristics</u>				
<i>Signee</i>					<i>Resident</i>				
Original	242	73.6	61	74.4	Yes	172	52.8	45	54.9
Successive	61	18.5	13	15.9	No	154	47.2	37	45.1
Revolving fund	13	4.0	4	4.9	Total	326		82	
Land manager	13	4.0	4	4.9	<i>Work status</i>				
Total	329		82		Full-time	91	29.0	31	37.8
<i>State</i>					Part-time	90	28.7	16	19.5
NSW	66	20.1	19	23.2	Retired	110	35.0	35	42.7
QLD	10	3.0	--	--	Other	23	7.3	--	--
SA	23	7.0	20	24.4	Total	314		82	
TAS	58	17.6	17	20.7	<i>Age</i>				
VIC	121	36.8	26	31.7	25-34	6	1.9		
WA	51	15.5	--	--	35-44	15	4.8		
Total	329		82		45-54	56	17.8		
<i>Year covenant registered on title²</i>					55-64	117	37.1		
pre-1996 (>20 yrs)	22	7.4	9	11.0	65-74	103	32.7		
1996-2005 (11-20 yrs)	100	33.7	19	23.2	75+	18	5.7		
2006-2015 (≤10 yrs) ³	175	58.9	43	52.4	Total	315			
unknown	--	--	11	13.4	<i>Education</i>				
Total	297		82		Secondary school	44	14.1		
<i>Size of covenanted area (ha)²</i>					Trade course/certificate	35	11.2		
<20	95	37.3	23	28.0	Advanced diploma	36	11.5		
20-100	117	45.9	39	47.6	Bachelor degree	89	28.4		
>100-500	33	12.9	15	18.3	Postgraduate degree	109	34.8		
>500	10	3.9	5	6.1	Total	313			
Total	255		82		<i>Annual income</i>				
<i>Management plan</i>					<\$25,000	33	11.3		
Yes, is current	236	72.4			\$25,001-\$50,000	76	26.1		
Yes, is not current	27	8.3			\$50,001-\$75,000	60	20.6		
No	47	14.4			\$75,001-\$100,000	47	16.2		
I do not know	16	4.9			>\$100,000	75	25.8		
Total	326				Total	291			
<u>Property characteristics</u>					<i>Number of covenanted properties owned</i>				
<i>Year of property ownership</i>					1	275	87.0	71	91.0
pre-1996 (>20 yrs)	103	33.7			>1	41	13.0	7	9.0
1996-2005 (11-20 yrs)	111	36.3			Total	316		78	
2006-2015 (≤10 yrs)	92	30.1			<i>Previous experience with land management</i>				
Total	306				Yes	161	51.1		
<i>Generate income in from property⁴</i>					No	154	48.9		
Yes	86	26.5	18	22.0	Total	315			
No	239	73.5	64	78.0	<i>Active management</i>				
Total	325		82		Yes	290	88.7	81	98.8
					No	37	11.3	1	1.2
					Total	327		82	

¹ Not all survey responses were mandatory, thus the maximum sample size for any given question is 329.

² If covenantors owned >1 covenanted property: for surveys, covenant year and size are for the property where they spend most of their time; for interviews, are for the earliest-covenanted property.

³ Including through early 2016.

⁴ Includes hobby farm, primary production, ecotourism; could be either covenanted or non-covenanted portion of property.

Appendix E.

Covenanting program, property, and landholder characteristics of original signees and successive owners. Survey totals exclude land managers (n=13) and revolving fund participants (n=13).

	Surveys					Interviews				
	Original		Successive		Total	Original		Successive		Total
	Count	%	Count	%		Count	%	Count	%	
<u>Program characteristics</u>										
<i>State</i>										
NSW	49	86.0	8	14.0	57	19	100.0	0	0.0	19
QLD	9	90.0	1	10.0	10	--		--		--
SA	15	68.2	7	31.8	22	15	75.0	5	25.0	20
TAS	41	83.7	8	16.3	49	9	52.9	8	47.1	17
VIC	90	78.3	25	21.7	115	22	84.6	4	15.4	26
WA	38	76.0	12	24.0	50	--		--		--
<i>Year covenant registered on title</i>¹										
pre-1996 (>20 yrs)	12	60.0	8	40.0	20	7	77.8	2	22.2	9
1996-2005 (11-20 yrs)	72	77.4	21	22.6	93	20	100.0	0	0.0	20
2006-2015 (≤10 yrs) ²	139	88.0	19	12.0	158	37	86.0	6	14.0	43
unknown	--		--			1	10.0	9	90.0	10
<i>Size of covenanted area (ha)</i>¹										
<20	73	78.5	20	21.5	93	17	73.9	6	26.1	23
20-100	88	81.5	20	18.5	108	32	82.1	7	17.9	39
>100-500	21	75.0	7	25.0	28	12	80.0	3	20.0	15
>500	5	71.4	2	28.6	7	4	80.0	1	20.0	5
<i>Management plan</i>										
Yes, is current	180	82.9	37	17.1	217					
Yes, is not current	18	72.0	7	28.0	25					
No	34	75.6	11	24.4	45					
I do not know	8	61.5	5	38.5	13					
<u>Property characteristics</u>										
<i>Year of property ownership</i>										
pre-1996 (>20 yrs)	98	99.0	1	1.0	99					
1996-2005 (11-20 yrs)	89	85.6	15	14.4	104					
2006-2015 (≤10 yrs)	39	50.0	39	50.0	78					
<i>Generate income from property</i>³										
Yes	65	81.3	15	18.8	80	15	83.3	3	16.7	18
No	175	79.9	44	20.1	219	50	78.1	14	21.9	64
<u>Covenantor characteristics</u>										
<i>Resident</i>										
Yes	145	86.3	23	13.7	168	37	82.2	8	17.8	45
No	94	71.2	38	28.8	132	28	75.7	9	24.3	37
<i>Work status</i>										
Full-time	59	70.2	25	29.8	84	23	74.2	8	25.8	31
Part-time	70	81.4	16	18.6	86	11	68.8	5	31.3	16
Retired	87	85.3	15	14.7	102	31	88.6	4	11.4	35
Other	18	85.7	3	14.3	21	--		--		--
<i>Age</i>										
25-34	2	50.0	2	50.0	4					
35-44	7	53.8	6	46.2	13					
45-54	38	73.1	14	26.9	52					
55-64	89	80.2	22	19.8	111					
65-74	85	86.7	13	13.3	98					
75+	14	87.5	2	12.5	16					

(continued next page)

Appendix E. continued.

Appendix E continued.

	Surveys					Interviews				
	<u>Original</u>		<u>Successive</u>		Total	<u>Original</u>		<u>Successive</u>		Total
	Count	%	Count	%		Count	%	Count	%	
Education										
Secondary school	35	83.3	7	16.7	42					
Trade course/certificate	28	84.8	5	15.2	33					
Advanced diploma	32	91.4	3	8.6	35					
Bachelor degree	60	75.9	19	24.1	79					
Postgraduate degree	78	75.7	25	24.3	103					
Annual Income										
<\$25,000	28	87.5	4	12.5	32					
\$25,001-\$50,000	62	84.9	11	15.1	73					
\$50,001-\$75,000	46	86.8	7	13.2	53					
\$75,001-\$100,000	34	81.0	8	19.0	42					
>\$100,000	46	64.8	25	35.2	71					
Number of covenanted properties owned										
1	207	79.0	55	21.0	262	58	79.5	15	20.5	73
>1	35	85.4	6	14.6	41	7	77.8	2	22.2	9
Previous experience with land management										
Yes	123	82.0	27	18.0	150					
No	113	78.5	31	21.5	144					
Active management										
Yes	217	81.6	49	18.4	266	65	80.2	16	19.8	81
No	23	65.7	12	34.3	35	0	0.0	1	100.0	1

¹ If covenantors owned >1 covenanted property: for surveys, covenant year and size are for the property where they spend most of their time; for interviews, are for the earliest-covenanted property.

² Including through early 2016.

³ Includes hobby farm, primary production, ecotourism; could be either covenanted or non-covenanted portion of property.

Appendix F.

Motivations to participate in conservation covenanting programs as described by interviewees. Percentages are per covenantor type (i.e., original signees [n = 65] and successive owners [n = 17]). Individual codes have been grouped by theme. Interviewees could be included in more than one code and more than one theme but are only counted one time per each.

Motivations	% of interviews		Indicative quotes
	Orig.	Succ.	
Conservation	92%	76%	
Restrict other land uses	45%	0%	<ul style="list-style-type: none"> - "I wanted a covenant right from the beginning when I bought it, because I reckoned if I was doing all of this work, I wasn't gonna have it undone by the next owner putting sheep back on." (L04) - "I think the reason, though, that we put the covenant on, was because we've got 50 acres of rainforest there, and it borders the lake, so you can get some really nice views of the lake. So our thought was that it would be very enticing to just clear that rainforest so that you had views of the lake. And so it was to protect it, really." (L35) - "I just wanted to make sure it was secure. I thought, you know, that you can't rely on your children to conserve it, because land up here is worth a lot of money for a start. So we – myself and my husband – wanted to put into a conservation agreement." (L69)
Personal values	25%	53%	<ul style="list-style-type: none"> - "Every day I think, I'm not just an oxygen thief. Every day I think, this [covenant] is a good thing, it just is... So you have that sense of having done something good. And it doesn't matter if nobody notices because it's got nothing to do with anyone else... This is that lovely sense of, you know, I'm just doing it for myself mostly, because it's the right thing to do if you can." (L10) - "I suppose we're kind of lefty, greeny, tree-hugging, nature-loving, chardonnay-drinking, middle class wankers." (L24) - "So my interest in conservation had come from a very strong desire... to protect some of the important areas. I was involved in a lot of the forestry kerfuffles that were going on down here... So that idea of purchasing was always in my head for conservation." (L32) - "A lot of people thought that [covenanting] was a bad thing to do for the value of your property, and I felt that if everybody put money before the natural land that was left, then you know... there won't be any. It's money and capitalism, we've just destroyed it, and I was prepared to take that hit if that happened." (L60)
Ecological aspects	27%	18%	<ul style="list-style-type: none"> - "Well, we always knew we were going to use the land to restore the landscape and encourage wildlife, maintain the ecosystem. So there was never any doubt, really, [that we would covenant]" (L22) - "We found we had fawn-footed melomys and phascogales. And we have platypus in the river and we have koalas... We had all these rare and endangered animals, so I said, 'Why not try to go for a conservation agreement?'" (L29) - "I think the fact that it was relatively rare, the rainforest, I thought, 'ah, that's worth saving.'" (L58) - "We just wanted to create a national park type environment that backed on to those nature reserves... But in addition, [someone] spoke to us about it being a wildlife corridor... if you could bring the range to the creek, then that provided an excellent wildlife corridor." (L82)
Conservation ethic	20%	41%	<ul style="list-style-type: none"> - "If you don't look after these areas, they're just gonna disappear. I can show people where this has happened. That's why I'm doing it." (L08) - "I wanted to protect it. That's basically it... I've seen so much disappearing, even in Europe when I go back there, and the Congo, and [I thought] let's do what I can." (L25) - "I think we've been committed from a long time back to understand that we've lost so much, and this is about putting something back. It's only small, but it's about doing something to turn that around." (L75)

Appendix F. continued.

Protect in perpetuity	25%	12%	<ul style="list-style-type: none"> - "One of the things that I like about the covenants is basically we're custodians of the land, you know? We don't own it. Basically it's in perpetuity, it's gonna stay there. No one can touch those trees, no one can do anything." (L44) - "We decided to do it properly, for ourselves, permanently, and if we couldn't have got a conservation [covenant], we would have donated the property to some existing sanctuary... It's just a shrinking environment and you just see houses." (L59) - "I wanted to put a conservation stamp out here in this country as opposed to what everybody else might be doing, with a lasting covenant." (L71)
Love of land	18%	24%	<ul style="list-style-type: none"> - "I felt that this area is so beautiful – it's hard to see it now, because it's all burned – but it was paradise. The forest was cathedral. It was so beautiful. The mountains so close by." (L07) - "We love this place and – I mean, this is the longest we've ever stayed on one property." (L57)
Government inaction	9%	0%	<ul style="list-style-type: none"> - "[We] know the state of land clearance in Australia, in South Australia, and how easy it is to legally make little incisions into native vegetation. So we thought, once we're gone, we'd like to see this bit of land continue as it is." (L12) - "We could have given [the property] to the government, but we thought that they're actually so strapped for cash, they're not gonna look after it. It's just going to disappear. So we thought we'd keep it and look after it." (L48)
Management advice	5%	0%	<ul style="list-style-type: none"> - "We're living on it, we're going to look after it and all that, so we thought, 'Let's take out a [conservation covenant] and see what help and advice we might get.'" (L64)
Social	31%	24%	
Influence of others	15%	12%	<ul style="list-style-type: none"> - "I have to say, it's something I had planned to do a long time ago, and for one reason or another kept putting it off. The thing that provoked me into doing it ultimately, was a local botanist." (L19) - "I didn't even know about covenanted land. It's just my cousin, who's a big environmentalist here, said, 'You've got to buy this land,' cuz I said we were looking for something. A friend of hers had it, and they'd put the covenant on it... [My cousin] was a great lover of the bush and environment and so she was a very influential person, so it was very easy to go from someone who was very knowledgeable about preservation of the environment... and have her recommend buying this land." (L34) - "He said, 'Did you know you've got really biologically valuable rainforest in there?' And I said, 'No, I just know I got a bloody lot of blackberries.'... I guess just the bloke's personal passion, and then the other guy he introduced to me, he was pretty impassioned about this stuff. And I wandered through the bush with them and they're pointing out stuff I wouldn't have known was there... Yeah, I think their commitment [was motivating]." (L58)
For future generations	8%	12%	<ul style="list-style-type: none"> - "I wanted to leave some sort of legacy as well... to leave something for my kids, something significant." (L41) - "We put our money where our mouth is. We have a concern for the environment and the future of the environment and we just go, 'We've worked hard for what we've got, but can't take it with you, but we can leave something behind for future generations.'" (L46)
Community importance	8%	0%	<ul style="list-style-type: none"> - "And once again I said I'm not doing it for my personal gain, it's for the good of the community. Cuz these are very iconic wetlands, these ones. Everybody has been duck shooting on them or caught yabbies in them. Socially they're very important, I feel." (L08) - "But I think, you know, part of the motivation for us was really a social thing, getting involved with the local community. The people who started the Landcare group have a little winery down the road here, so they were sort of the nucleus of the social activity." (L72)
Family	2%	0%	<ul style="list-style-type: none"> - "Dad died in '77, so for me, at least, it was a link to dad and that was important. Dad's ashes are somewhere [on the property]." (L48)

Appendix F. continued.

Economic	34%	2%	
Incentives	29%	2%	<p>- “Although it was not the primary motivation, there was an additional incentive in that we got a rebate on the council rates. We got a rebate on land tax, which we were paying cuz we owned two properties... and there was a one-off tax deduction for reduction in value of the land as a result of having a covenant established. And that tax deduction is quite a few thousand dollars. It’s quite a lot of money, all in one go.” (L03)</p> <p>- “He [told] us that you can be paid for putting a covenant on your block by a developer. So what attracted us, really, was the whole offset scheme because you can basically get money for putting a covenant on your block... So it’s sort of no skin off our nose to put the covenant on it because we were just planning on leaving it like that anyway. But the way that we saw it was, with the offset money that we would get, it would actually help us pay off the mortgage for the land. So it was a no-brainer.” (L06)</p> <p>- “One of our other driving forces was the property value kept increasing, and of course our rates were increasing pro rata, and they were getting to be a bit of a problem... And of course, one way around that was to enter into the conservation agreement... So the conservation agreement became a very sensible thing to do. If the rates hadn’t forced us to it, we probably wouldn’t have done it. But the rates definitely forced us to it.” (L30)</p> <p>- “So I thought, yes, this is an opportunity because [the covenant provider] was willing to pay for the fencing. It ended up 6 kilometers of fencing, it wasn’t a minor thing.” (L56)</p>
Business mindset	6%	2%	<p>- “In terms of what motivated me to actually [covenant], though, was seeing an opportunity in the market to say this stuff is really worth doing. And I could see a business that could be developed doing it.” (L01)</p> <p>- “[We] saw the things you could do in tourism and so we sort of decided that [the B&B on the property] matched with the covenanting because – I mean, we’d have a maximum of four couples and people who are interested in this sort of experience of finding out about the environment.” (L55)</p>
Permission to build	2%	0%	<p>- “[We decided] that if we got permission to build on the block, we’d commit to taking out [a covenant] immediately, because we thought that would also help our case. We’re gonna [covenant] at some point, so let’s just put it up right at the start. [The covenant provider] was going to ultimately make the decision about whether we could build on the block. So it all just made sense as one of the things to be on the table right at the start is, we’ll commit to taking out a [covenant].” (L64)</p>
Property	0%	41%	
Property characteristics	0%	41%	<p>- “We were basically after acreage, because I’m noise sensitive, and just to get some peace and quiet... But when we saw this place and it already had the covenant on it, then I said, ‘Well, why not? That’s what we’re after.’” (L28)</p> <p>- “I wanted some land of my own that I could go and just be with nature, I suppose... So I didn’t purchase the property because it [had a covenant]. That was almost a bonus. And I do see it as a bonus. I don’t see it necessarily as a negative thing.” (L81)</p>

Appendix G.

Opinions about conservation covenants and covenanting programs as described by interviewees. Percentages are per covenantor type (i.e., original signees [n = 65] and successive owners [n = 17]). Individual codes have been grouped by theme. Interviewees could be included in more than one code and more than one theme but are only counted one time per each.

Opinions	% of interviews		Indicative quotes
	Orig.	Succ.	
Positive	82%	88%	
Land is protected	60%	59%	<p>- "I'd recommend them, myself, for people who love their property and want it to stay the way it is. It's really the only option that's available. It's not a guarantee, but it's better than anything else that's available." (L13)</p> <p>- "I think having more than 700 covenanted properties in [this state]... is a terrific contribution to the conservation of the state, because that's 700 people or more who've really got some kind of a commitment to conservation, and it is protecting lots of very precious sites. And a lot of them are quite remote... they're little treasures. It'll be great to have them going in perpetuity as conservation land." (L67)</p> <p>- "I think having nature is a resource for us as humans and as animals and birds and things, and the plant life is worth having. So I'm pleased, I suppose, that there is a scheme whereby that can go on in perpetuity. So it's my little creation of a little nature park." (L71)</p>
Social value	9%	29%	<p>- "I think covenants, a lot of the time, their impact is fairly minimal because they're protecting areas that are not suitable for farming, that aren't likely to be developed... I think their value is sort of community awareness and engagement. A sense that I'm participating in the process of managing and caring, rather than having it imposed on me. When it's my covenant, I feel more interested in managing it than if it's the rules that the council's imposed on me. I see that as the core of it... that reason of engagement and awareness, and that can translate into greater community support for environmental policies in other areas." (L31)</p> <p>- "Overall, I think it's a wonderful program because it actually helps people recognize the significance of what's left. There are a lot of really good people out there who want to save what there is." (L73)</p>
Increases support	11%	18%	<p>- "I think they're fantastic really, if only because it means that I don't have to pay rates on the land that's in the heritage area. I've got the property that gives me a great deal of pleasure and activity and all that sort of stuff, and I'm not making any money out of it and probably if I had to pay rates on it I might have to think of doing something that would earn me money on it, which I don't particularly want to do, so it's kind of nice to be able to be given an incentive to preserve a bit of natural habitat, and not have to pay a lot of money to do so." (L16)</p> <p>- "And the other reason why they're very important as a land owner is that, we get quite good financial support from other NGO's for doing our bush regeneration... We've had two really excellent grants from them to go towards the restoration of the rainforest. And they would not be interested in making grants if we were not covenanted and the property was not guaranteed to be kept in the shape that it is." (L52)</p> <p>- "[The covenant provider staff] was quite good with providing information... And they come around every 12 months or so and, I guess, reinforce your sense of what's going on." (L55)</p>
Good option (general)	11%	12%	<p>- "I think they're great. I really think they should be more publicized." (L28)</p> <p>- "I think it's a really great thing and I'd really like to see more people encouraged to take out covenants, but we understand that not everybody feels the same as we do." (L45)</p>

Appendix G. continued.

Creates wildlife corridors	9%	0%	<p>- "I like the way that the covenanted lands can be joined up. Our covenant joins up with a property over the road which is also covenanted. That's a big property that goes right down to the river. So that's probably about 4 kilometers of a swathe of land that's protected. That's great, I think." (L33)</p> <p>- "I think the property's filled a gap. Our national parks are island refugia and the species can't move. They can't move very well across highways and stuff... The covenanted areas are the only viable way to get connectivity between [certain] parks." (L68)</p>
Negative	29%	18%	
Concerns about effectiveness	17%	6%	<p>- "I think the aspiration of what heritage agreements could be, and what they are – I'd say a heritage agreement is only as good as the person who looks after it... that's what you're relying on. You're relying on the person that owns it to be kind of that way inclined, otherwise I don't think they're actually worth much at all. Not anymore. Because we just don't have the resources for people to go around and check up and work with the people and stuff." (L20)</p> <p>- "But from what I gather, basically they don't really have any teeth. I've just known... if someone comes and knocks trees down, there doesn't seem to be any way of doing anything about it. Or there's not penalties enough to stop people from doing that. People just do it and once it's done, it's done." (L35)</p> <p>- "If you're serious about doing something which is going to be around for a very long time, then one hopes that the covenant would be respected by future State Governments. I mean, that's the only concern that you might have is that in 50 or 100 years' time that things may change. So to what extent these covenants are rock solid and can never be taken off, is the only little, I suppose, nagging doubt one has." (L52)</p>
Lack of support	15%	12%	<p>- "We came into it with enthusiasm and now we don't particularly care for [the covenant]. We're still doing what we set out to do. But I'm disappointed because it's a huge missed opportunity in a sector that needs all the help it can get... But the reality is that it comes down to political will and leadership. There's grassroots in the literal sense, and that's us, but we fund it, we pay for it, no one helps us at all. Now, we haven't come into this asking for help, that's not – we're big people, we make decisions. But it costs landowners to do this, and it costs more than the government appreciates or wants to know." (L15)</p> <p>- "It takes such a blinking long time [to communicate with staff and update documents]. That is where people lose heart... And here I am, still waiting for my plan of management to come back, which is the whole rewritten thing. We need answers quicker." (L17)</p> <p>- "I've got two big beefs. One is that there's no education provided for the landowner. And the government goes on and on about what wonderful scheme they've got... And there's really nothing to check that they're being looked after, and there's nothing to support the people who own them, to look after them. At least not these days." (L79)</p>
Ambivalent	18%	24%	
Ambivalent	18%	24%	<p>- "It's the only option I know about." (L47)</p> <p>- "I don't really have much of an opinion either way. I'm not a great advocate of it, but I'm not against it. I don't know if it actually helps with conservation." (L56)</p> <p>- "Well, it doesn't actually do any harm, but the amount of good is minimal." (L79)</p>

Appendix H.

Program characteristics, property characteristics, and demographics for survey respondents (n=317) who were included in analyses regarding sources of information and advice.

Respondents			Respondents		
	Total	%		Total	%
<u>Program characteristics</u>			<u>Covenantor characteristics</u>		
<i>Signee</i>			<i>Resident</i>		
Original signee	236	74.4	Yes	165	52.5
Successive owner	58	18.3	No	149	47.5
Revolving Fund	12	3.8	Total	314	
Land manager	11	3.5	<i>Work status</i>		
Total	317		Full-time	89	28.6
<i>State</i>			Part-time	90	28.9
NSW	64	20.2	Retired	109	35.0
QLD	10	3.2	Other	23	7.4
SA	23	7.3	Total	311	
TAS	57	18.0	<i>Age</i>		
VIC	113	35.6	25-34	6	1.9
WA	50	15.8	35-44	14	4.5
Total	317		45-54	55	17.6
<i>Year covenant registered on title¹</i>			55-64	117	37.4
pre-1996 (>20 yrs)	21	7.3	65-74	103	32.9
1996-2005 (11-20 yrs)	97	33.7	75+	18	5.8
2006-2015 (≤10 yrs) ²	170	59.0	Total	313	
Total	288		<i>Education</i>		
<i>Size of covenanted area (ha)¹</i>			Secondary school	43	13.9
<20	91	36.8	Trade course/certificate	35	11.3
20-100	116	47.0	Advanced diploma	36	11.6
>100-500	30	12.1	Bachelor degree	88	28.4
>500	10	4.0	Postgraduate degree	108	34.8
Total	247		Total	310	
<i>Management plan</i>			<i>Annual Income</i>		
Yes, is current	229	72.9	<\$25,000	31	10.8
Yes, is not current	26	8.3	\$25,001-\$50,000	76	26.4
No	44	14.0	\$50,001-\$75,000	60	20.8
I do not know	15	4.8	\$75,001-\$100,000	47	16.3
Total	314		>\$100,000	74	25.7
<u>Property characteristics</u>			Total	288	
<i>Year of property ownership</i>			<i>Number of covenanted properties owned</i>		
pre-1996 (>20 yrs)	98	33.2	1	268	87.6
1996-2005 (11-20 yrs)	107	36.3	>1	38	12.4
2006-2015 (≤10 yrs)	90	30.5	Total	306	
Total	295		<i>Previous experience with land management</i>		
<i>Generate income in from property*</i>			Yes	161	51.6
Yes	83	26.5	No	151	48.4
No	230	73.5	Total	312	
Total	313		<i>Active management</i>		
			Yes	281	88.6
			No	36	11.4
			Total	317	

¹ If covenantors owned >1 covenanted property, covenant year and size are for the property where they spend most of their time.

² Including through early 2016.

³ Includes hobby farm, primary production, ecotourism; could be either covenanted or non-covenanted portion of property.

Appendix I.

Results of Mann-Whitney U tests for differences in the use¹, value², and desired access³ of six sources of information between original signees and successive owners, resident and absentee owners, and covenantors who do or do not undertake management activities.

Covenantors who do or do not undertake management activities.									
	Original signee			Successive owner			Mann-		
	Mean	SE	N	Mean	SE	N	Whitney U	Z score	p-value
Use									
Misc. written material	3.02	0.067	195	3.02	0.194	44	3981.50	-0.79	0.427
Local experts	2.43	0.071	195	2.29	0.175	41	3659.00	-0.90	0.369
Covenant provider	2.22	0.055	192	2.43	0.143	40	3318.00	-1.45	0.147
Workshops/field days	2.26	0.063	194	2.11	0.163	44	3807.00	-1.18	0.238
Neighbors	2.17	0.070	191	2.49	0.178	41	3320.50	-1.59	0.111
Landcare meetings	2.16	0.080	191	2.11	0.198	44	3930.00	-0.70	0.485
Value									
Misc. written material	2.34	0.047	184	2.39	0.104	38	3321.00	-0.54	0.589
Covenant provider	2.22	0.061	178	2.32	0.126	38	3182.50	-0.62	0.538
Local experts	2.12	0.057	179	2.29	0.133	35	2741.50	-1.25	0.212
Workshops/field days	2.09	0.054	181	2.08	0.126	40	3585.00	-0.10	0.918
Landcare meetings	1.87	0.061	168	1.92	0.142	37	3022.00	-0.28	0.779
Neighbors	1.77	0.057	172	2.00	0.136	35	2542.00	-1.56	0.120
More access									
Workshops/field days	0.60	0.038	169	0.64	0.081	36	2934.50	-0.39	0.694
Local experts	0.49	0.039	168	0.61	0.086	33	2445.00	-1.24	0.216
Covenant provider	0.45	0.038	172	0.51	0.083	37	2972.50	-0.73	0.467
Misc. written material	0.42	0.039	165	0.50	0.087	34	2575.50	-0.87	0.382
Landcare meetings	0.35	0.037	162	0.54	0.085	35	2276.00	-2.17	0.030*
Neighbors	0.25	0.035	155	0.39	0.086	33	2193.50	-1.66	0.098
	Resident			Absentee			Mann-		
	Mean	SE	N	Mean	SE	N	Whitney U	Z score	p-value
Use									
Misc. written material	3.06	0.085	140	2.97	0.090	117	7781.00	-0.74	0.462
Local experts	2.59	0.083	138	2.17	0.094	114	6125.00	-3.18	0.001*
Covenant provider	2.28	0.069	137	2.27	0.076	113	7685.50	-0.10	0.917
Workshops/field days	2.41	0.075	140	2.02	0.085	115	6199.00	-3.34	0.001*
Neighbors	2.20	0.088	134	2.25	0.090	115	7425.50	-0.52	0.606
Landcare meetings	2.41	0.104	138	1.76	0.084	114	5511.00	-4.28	0.000*
Value									
Misc. written material	2.35	0.058	130	2.38	0.058	109	7032.50	-0.11	0.913
Covenant provider	2.19	0.072	125	2.31	0.079	108	6143.00	-1.28	0.200
Local experts	2.21	0.066	130	2.06	0.078	100	5826.50	-1.44	0.150
Workshops/field days	2.12	0.065	132	2.04	0.073	105	6512.00	-0.86	0.392
Landcare meetings	1.99	0.076	124	1.71	0.072	96	4859.00	-2.49	0.013*
Neighbors	1.79	0.070	123	1.81	0.069	101	6018.50	-0.43	0.666
More access									
Workshops/field days	0.62	0.044	124	0.60	0.050	97	5875.50	-0.35	0.728
Local experts	0.49	0.046	118	0.54	0.050	99	5585.00	-0.64	0.521
Covenant provider	0.46	0.045	125	0.48	0.050	101	6191.00	-0.29	0.773
Misc. written material	0.44	0.046	117	0.46	0.051	98	5599.50	-0.34	0.733
Landcare meetings	0.33	0.043	120	0.45	0.052	93	4920.00	-1.76	0.079
Neighbors	0.25	0.042	110	0.31	0.048	94	4891.00	-0.85	0.393

¹ Use was based on a 5-point Likert scale, where: 1 = never, 2 = rarely, 3 = sometimes, 4 = often, 5 = always.

² Value was based on a 3-point Likert scale, where 1 = not much, 2 = some, 3 = a great deal.

³ More access was based on a binary response, where 0 = no and 1 = yes.

Appendix J.

Barriers to acquiring land management information and advice as discussed by interviewees (n=82). Individual codes have been grouped by theme. Interviewees could be included in more than one code and more than one theme but are only counted one time per each.

Barriers	% of interviews	Indicative samples
<i>Institutional barriers (34%)</i>		
Availability of staff or experts	28%	<ul style="list-style-type: none"> - "I've discovered very early on that the [name of covenant provider] – who really represent the minister as the other party to the covenant – just don't have the resources to provide us with timely or high-quality information or contacts." (L43) - "I think that's a big failing of the whole thing [the covenant program]. It's wonderful to have these things [covenants] declared and you can put up a sign if you want to... But then you feel a bit abandoned... I know this probably comes down to resources too, but there's not enough to pay the [covenant provider's] man to get in the vehicle and go and inspect a few places." (L45) - "He was a very well-regarded, fabulous scientist, did a lot of work on the [project]. And if he was here, I'd be picking his brains. So there's not that sort of person here." (L53) - "So the first visitor came out and he did take some lichen samples... but when I went back to the same department they couldn't recognize the staff member... He's moved on apparently. So people keep moving around." (L71)
Privacy policies	7%	<ul style="list-style-type: none"> - "When we moved here and we were trying to get around land management issues... we thought, 'Who are the other people doing this that we can talk to?' And there was no way we could know who the ones [covenantors] were in our neighbourhood. It was all secret – well, not secret, but you know, protection of information held at the Department and they couldn't tell anybody." (L67)
<i>Local barriers (29%)</i>		
Peer-to-peer connections	23%	<ul style="list-style-type: none"> - "What we don't have is a way to get other covenant owners together. This is what I found... I think what would be really beneficial would be a mechanism by which different covenant owners – and I live in an area with a lot of covenants – could share experiences and advice." (L31) - "Then again, I think, 'Is the support needed for connection, or am I the only one that really wants to push this and get it going?'... because if I didn't, nobody would. That's why the gathering came up, because I could see nobody else would do it." (L17) - "... there's a move afoot to fire up our local Landcare group again, and everybody's looking at me to take it on again. And I don't want to do it, but it needs doing, so we're probably going to be having discussions over the next few months to see how we can possibly make it get up and work. Because it didn't last time, and a few of us wore ourselves out trying to make it work and it was just a fizzer." (L23)
Relevancy	10%	<ul style="list-style-type: none"> - "I don't personally fit with [the other covenanted landholders]. I haven't got the same interest in, you know, this grub and all this sort of stuff. And I haven't got the land management issues that mostly they talk about [in meetings]... so I don't really need to go. I socially don't fit, so that's okay. Doesn't worry me. They're a really nice group of people, a really good organization. They had about 40 people turn up for the eucalypt identification. So we went through all of that, but I already knew the four that I've got." (L41) - "I mean the [name of local group] and the council occasionally have things like that [e.g., seminars] for other reasons, like bush fire safety, or maybe control of weeds, but it's very infrequent. It might be one every five years on something. There'll be something on bushfires every year cuz that's such a big issue. But there's not much in terms of conservation and things like that." (L64)

(continued next page)

Appendix J. continued.

Barriers	% of interviews	Indicative samples
<i>Personal barriers (34%)</i>		
Time constraints	18%	<ul style="list-style-type: none"> - "And of course, working full time, it's difficult to put a lot of time in [to landholder groups]." (L27) - "I've got other things going on. I have a business in this part of the world, as well, which keeps me quite busy. I'm doing other things. So for the amount of time I've got to put into this... I'm not sort of out seeking more involvement at the moment because I just don't have the time or capacity to do much more and get involved in much more than I am already." (L52)
Distance	16%	<ul style="list-style-type: none"> - "We don't know many people out there [near the covenanted property] because we don't live out there, we only visit on the weekends. So we've met our neighbors once or twice, but you hardly see people. It's hard to get to know people when you're not going out very often. So maybe when we move out there we'll start to get to know other people that do have covenants." (L06) - "But this is... a remote and isolated area. For me to get down the mountain takes 45 minutes. So for people to come out and visit, even from the nearest town, you're looking at over 2 hours each way, and you have to have a 4-wheel-drive. So we don't have much contact with anybody because if you're living in a remote area that isolation, aside from the computer, is part of the deal." (L10)
Misc. (e.g., technology, health, money)	7%	<ul style="list-style-type: none"> - "If the internet was better, that probably would make it easier to do online stuff." (L39) - "I'm low key with that at the moment because I have to have a back operation. So I'm not participating in anything very much at the moment until that's done." (L29)
<i>No specific barriers mentioned (34%)</i>		

Appendix K.

Descriptions of social network measures most commonly reported in articles used in this review. Descriptions are from Hanneman & Riddle (2005) and Prell (2012).

Network Level	Measure	Description
Egocentric network	Size	Number of actors (alters) an ego is tied to. Egocentric network size and density often used to assess how social networks might affect individual behavior, attitudes, performance or beliefs.
	Density	Extent to which an ego's alters are tied to one another (if data is available for alters). Can be used to determine structural holes and brokerage.
	Type	Based on actor attribute data (e.g., age, job title). Can be used to assess similarities and differences between ego and alters (e.g., homophily, the portion of ties where ego and alters share the same attributes).
	Strength of ties	Typically expressed with valued data (e.g., frequency of contact). Strength increases as frequency, emotional intensity, and mutual confiding or reciprocity increase.
Whole network	Size	Number of nodes in a network.
	Density	Proportion of ties in a network that are actually present (vs all potential ties that could exist); the extent to which all individual actors are linked together. Values can be influenced by network size, centralization, or presence of subgroups.
	Degree centrality	Number of immediate contacts an actor has in a network, regardless of tie direction. Measures an actor's level of involvement or activity in the network. Use of directed ties can give measures of in-degree (number of ties received by an actor from others, suggesting prestige or importance) and out-degree (number of ties given by the actor to others, suggesting influence).
	Betweenness centrality	Calculates how many times an actor (A) sits on the shortest path between other pairs of actors; actor A is thus in a position of connecting the other actors. Suggests important actors in a network, e.g., those with power.
	Centralization	Measures the extent to which one actor in a network is holding all the ties of that network; low values indicate a more even distribution of ties among all the nodes, suggesting a more cohesive (interconnected) network.
	Ties within vs between groups	Calculating the number of ties within a group (e.g., nodes sharing the same attribute) relative to the number of ties extending outside of the group; aka, E-I (external-internal) index. Indicates tendency towards group closure.
	Component	Consists of a subgroup of actors, in which all the actors are connected to each other by at least one path. Shows the extent to which all actors are embedded in the same structure.

Hanneman R.A., Riddle M. (2005) Introduction to social network methods. University of California, Riverside, California, USA. <<http://faculty.ucr.edu/~hanneman/nettext/>>.

Prell C. (2012) Social network analysis: history, theory, and methodology. SAGE Publications Ltd, London, United Kingdom.

Appendix L.

Number of document results per search term in the Scopus and Web of Science databases. Numbers include documents that are repeated among search terms and between databases.

Search terms	No. of returns per database		Total
	Scopus ¹	Web of Science ²	
"social network"			
AND biodiversity	125	54	179
AND conservation	454	212	666
AND "eco* mange"	48	15	63
AND "eco* service"	61	35	96
AND "natural resource manage"	108	97	205
AND enviro* AND agri*	213	50	263
AND enviro* AND agro*	37	12	49
AND enviro* AND fish*	86	31	117
AND enviro* AND forest*	104	35	139
AND enviro* AND marine	62	16	78
AND enviro* AND rangeland	7	1	8
AND enviro* AND soil	26	5	31
AND enviro* AND water	196	66	262
AND enviro* AND wood*	22	4	26
"network analysis"			
AND "eco* mange"	68	26	94
AND "eco* service"	79	83	162
AND "natural resource manage"	72	94	166
AND social AND agri*	197	128	325
AND social AND agro*	53	41	94
AND social AND biodiversity	44	55	99
AND social AND conservation	169	162	331
AND social AND fish*	118	113	231
AND social AND forest*	149	108	257
AND social AND marine	65	54	119
AND social AND rangeland	6	7	13
AND social AND soil	19	14	33
AND social AND water	163	116	279
AND social AND wood*	31	21	52
"egocentric network"	225	119	344
Total	3,007	1,774	4,781

¹ Scopus database searches for terms in Article title, Abstract, Keywords

² Web of Science database searches for terms in Title, Abstract, Author Keywords, Keywords Plus

Appendix M.

Titles, extracted details, and inductively-created categories for all reviewed articles (n=85). New columns continue on page 173 and 184.

Details extracted from articles								
#	Authors	Title	Journal	Country	Conceptual framework	Research goal or objective	Data collection methods	Sample population(s)
1	Alexander, S.M.a b , Armitage, D.a b , Charles, A.c	Social networks and transitions to co-management in Jamaican marine reserves and small-scale fisheries	(2015) Global Environmental Change, 35, pp. 213-225	Jamaica	social networks, co-management	comparative analysis of the social network structures associated with transition to co-management	questionnaires, focus groups, semi-structured interviews, document review, participant observation; name generator with free-recall, also name interpreter for subset of respondents	3 Special Fishery Conservation Areas (one network per SFCA)
2	Alexander, S.M., Armitage, D., Carrington, P.J., Bodin, Ö.	Examining horizontal and vertical social ties to achieve social–ecological fit in an emerging marine reserve network	(2017) Aquatic Conservation: Marine and Freshwater Ecosystems, 27 (6), pp. 1209-1223	Jamaica	social networks, social-ecological fit	(1) examine extent to which horizontal and vertical social ties bring local and national actors together to collaborate, coordinate, and share knowledge; (2) assess extent to which different attributes and features of multilevel social networks enhance or inhibit particular aspects of social-ecological fit	sociometric survey, semi-structured interviews; recognition method (choose from list of actors), new actors could be added, name interpreter questions	one network in one location
3	Arora, S.	Farmers' Participation in Knowledge Circulation and the Promotion of Agroecological Methods in South India	(2012) Journal of Sustainable Agriculture, 36 (2), pp. 207-235.	India	social networks, innovation systems	analyze farmers' participation in local circulation of knowledge about agroecological methods	interviews; free recall, no max limit	one network in one location
4	Atran, S.a, Medin, D. Ross, N., Lynch, E., Coley, J., Ek', E.U., Vapnarsky, V.	Folkeology and commons management in the Maya lowlands	(1999) Proceedings of the National Academy of Sciences of the USA, 96 (13), pp. 7598-7603	Guatemala	social networks, folkeology	analyze social networks in relation to cognition to track lines of ecological learning and information flow within and between cultures.	interviews; free recall, max of 7 names, in order of priority	3 cultural groups in one municipality (one combined ego network per group)
5	Baird, J.a , Jollineau, M.a b , Plummer, R.a c , Valenti, J.b	Exploring agricultural advice networks, beneficial management practices and water quality on the landscape: a geospatial social-ecological systems analysis	(2016) Land Use Policy, 51, pp. 236-243	Canada	social networks, advice network	(1) query the individuals, organizations, and other sources of information agricultural producers turn to for advice when making decisions about land management practices, and in particular BMPs; (2) probe the characteristics of this advice network; and (3) link the advice network of individuals spatially and incorporate water quality data	in-person surveys; name generator and interpreter approach, max of 10 names	egocentric networks in one location
6	Barnes, M.L.a b c d , Lynham, J.e f , Kalberg, K.c , Leung, P.a	Social networks and environmental outcomes	(2016) Proceedings of the National Academy of Sciences of the United States of America, 113 (23), pp. 6466-6471	USA (Hawaii)	social networks, principle of homophily	examine how social networks relate to shark bycatch; tested the hypothesis that homophily-driven social network segregation can result in divergent behaviors that have important implications for ecosystem health	in-person interviews; free recall, max 10 names, assign values	one network in one location

7	Barnes-Mauthe, M.a , Arita, S.a b , Allen, S.D.c , Gray, S.A.a , Leung, P.S.a	The influence of ethnic diversity on social network structure in a common-pool resource system: Implications for collaborative management	(2013) Ecology and Society, 18 (1), art. no. 23	USA (Hawaii)	social networks, ethnicity	examine network homophily, network structure, and cross-scale linkages to infer characteristics of representation, cooperation, and communication in an ethnically diverse competitive pelagic fishery	structured survey; nominate 5-10 individuals	one network in one location
8	Beilin, R.a , Reichelt, N.T.a , King, B.J.a , Long, A.b , Cam, S.b	Transition landscapes and social networks: Examining on-ground community resilience and its implications for policy settings in multiscale systems	(2013) Ecology and Society, 18 (2), art. no. 30	Australia	social networks, social resilience	(1) what does institutional capacity building look like in the context of CBNRM and (2) if made visible, what does knowing how social connectivity operates in these complex transition landscapes contribute to the actions of landscape stewards, managers, and agency policy makers?	telephone interviews, focus groups; free recall, no max limit	2 Landcare groups from different locations (one combined ego network per group)
9	Berdej, S.M.a , Armitage, D.R.b	Bridging organizations drive effective governance outcomes for conservation of Indonesia's marine systems	(2016) PLoS ONE, 11 (1), art. no. e0147142	Indonesia	social networks, bridging organizations	investigate the influence of bridging organizations on governance outcomes for marine conservation	questionnaires, semi-structured interviews; free recall, no max limit	2 marine protected areas (MPAs) (one network per site)
10	Bodin, O., Crona, B.I.	Management of Natural Resources at the Community Level: Exploring the Role of Social Capital and Leadership in a Rural Fishing Community	(2008) World Development, 36 (12), pp. 2763-2779	Kenya	social networks, social capital	(1) assess selected aspects of community social capital; (2) identify potentially influential actors; and (3) assess if lack of community social capital and important leadership characteristics, individually or in combination, may explain the lack of collective action	semi-structured interviews; no specifics about network data collection	one network in one location (same as Crona & Bodin 2006, Crona & Bodin 2010, 2011)
11	Bodin, O.a , Sandström, A.b , Crona, B.c	Collaborative Networks for Effective Ecosystem-Based Management: A Set of Working Hypotheses	(2016) Policy Studies Journal, . Article in Press.	Sweden	social networks, ecosystem-based management	comparative case study of five regional multi-actor collaborative processes; evaluate a set of hypotheses specifying how certain patterns of collaborations among actors affect their joint ability to accomplish ecosystem-based management (EBM)	survey, interviews; recognition method (choose from list of actors), new actors could be added	5 regions (same management planning processes) (one network per region)
12	Borg, R.a , Toikka, A.b , Primmer, E.c	Social capital and governance: A social network analysis of forest biodiversity collaboration in Central Finland	(2015) Forest Policy and Economics, 50, pp. 90-97	Finland	social networks, social capital	analyze the structure of a cooperative network for forest conservation using SNA tools and survey data	questionnaire; recognition method (choose from list of actors), new actors could be added	one network in one location
13	Brummel, R.F.a , Nelson, K.C.b , Jakes, P.J.c	Burning through organizational boundaries? Examining inter-organizational communication networks in policy-mandated collaborative bushfire planning groups	(2012) Global Environmental Change, 22 (2), pp. 516-528	Australia	social networks	investigate interorganizational communication networks existing before, developed during, and maintained after a policy-mandated collaborative planning process	surveys, semi-structured interviews; report presence or absence of communication with each of the other planning participants	3 bushfire groups (one network per group)

14	Calvet-Mir, L., Maestre-Andrés, S., Molina, J.L., van den Bergh, J.	Participation in protected areas: A social network case study in catalonia, Spain	(2015) Ecology and Society, 20 (4), art. no. 45,	Spain	social networks, stakeholder analysis	(1) assess communication network structure associated with the park; (2) compare the informal communication network between stakeholders with the formal participatory bodies of the park; and (3) select participants for later analyses aimed at assessing the adequate governance structure of the park	nonparticipant observation, document review, semistructured interviews, online/telephone questionnaire; free recall, no max limit	one network in one location
15	Cárcamo, P.F.a b , Garay-Flühmann, R.c , Gaymer, C.F.d e	Collaboration and knowledge networks in coastal resources management: How critical stakeholders interact for multiple-use marine protected area implementation	(2014) Ocean and Coastal Management, 91, pp. 5-16.	Chile	social networks, stakeholder analysis, ecosystem-based management	investigate the structure and properties of inter-organizational social networks involved in the use and management of natural resources	questionnaire; free recall, no max limit	one network in one location
16	Cavalcanti, C.a , Engel, S.a , Leibbrandt, A.b	Social integration, participation, and community resource management	(2013) Journal of Environmental Economics and Management, 65 (2), pp. 262-276.	Brazil	social networks, cooperation behavior	investigate whether (1) individual level of social integration in a social network plays an important role for cooperation during an environmental program, (2) fishermen who participated in the development of the environmental program cooperate more during its implementation	survey, observation, public goods game; free recall, max of 3 names	8 communities (one network per community, but data merged for regression analysis)
17	Chiffolleau, Y.	Learning about innovation through networks: The development of environment-friendly viticulture	(2005) Technovation, 25 (10), pp. 1193-1204	France	social networks, adoption of innovation	use network sociology to link innovation and learning theories and highlight the diverse social practices contributing to changes and underlying learning processes	interviews, participant observation; explain links with each of the other co-op members, then with other persons in or outside the membership	one network in one location
18	Cox, M.a , Wilson, M.b d , Pavlowich, T.c	The challenges of local governance: Gear-based fragmentation in the Dominican fishery of Buen Hombre	(2016) Marine Policy, 63, pp. 109-117.	Dominican Republic	social networks	examined the relationship between fishing pressure and various social and technological attributes of the local fishermen; (explain individual fishermen behavior via stat analysis, examine how behavior relates to social structure with SNA)	semi-structured interviews, participant observation; fixed recall name generator, max of 5 names	one network in one location
19	Crona, B; Bodin, O	What you know is who you know? Communication patterns among resource users as a prerequisite for co-management	(2006) Source: ECOLOGY AND SOCIETY Volume: 11 Issue: 2 Article Number: 7	Kenya	social networks	investigate if lack of collective action to remedy the unsustainable use of resources may be attributed to the structures of the social networks in the community	questionnaires via personal interviews; recall method, no max limit	one network in one location (same as Bodin & Crona 2008, Crona & Bodin 2010, 2011)
20	Crona, B.a , Bodin, O.b	Power asymmetries in small-scale fisheries: A barrier to governance transformability?	(2010) Ecology and Society, 15 (4)	Kenya	social networks, power	explore the interaction between informal power structures and knowledge-sharing networks to examine whether the way in which these are linked creates barriers for transformability	questionnaires via personal interviews; recall method, no max limit	one network in one location (same as Bodin & Crona 2008, Crona & Bodin 2006, 2011)

21	Crona, B.a , Bodin, O.b	Friends or neighbors? Subgroup heterogeneity and the importance of bonding and bridging ties in natural resource management	(2011) Social Networks and NRM: Uncovering the Social Fabric of Environ'l Governance, pp. 206-233.	Kenya	social networks	explore to what degree the existence of cohesive subgroups can help explain why a community experiencing resource declines has not come together to alter unsustainable practices	personal interviews; recall method, no max limit, and simplified recognition method	one network in one location (same as Bodin & Crona 2008, Crona & Bodin 2006, 2010)
22	de Nooy, W.	Communication in natural resource management: Agreement between and disagreement within stakeholder groups	(2013) Ecology and Society, 18 (2), art. no. 44	Australia, Finland, Estonia, USA, Mediterranean, international	social networks, social contagion theory	aims to show that the effect of interpersonal communication on agreement among stakeholders in natural resource management depends on context: stakeholder group, overall network structure, and type of management system	open interviews, review policy documents, online survey; recognition method (choose from list of actors), max of 5 names	6 management systems (one per country + 2 intern'l) (one network per system)
23	Díaz-José, J.a , Rendón-Medel, R.b , Govaerts, B.c , Aguilar-Ávila, J.b , Muñoz-Rodríguez, M.b	Innovation Diffusion in Conservation Agriculture: A Network Approach	(2016) European Journal of Development Research, 28 (2), pp. 314-329.	Mexico	social networks, diffusion of innovations	analyse diffusion of CA innovations through a network approach, by addressing two questions: (i) Which CA innovations have farmers adopted and where did they learn them? (ii) Who are the key innovators in the network and what roles do they play in the diffusion of CA practices?	surveys, semi-structured interviews (w/subset); free recall, no max limit	one network in one location
24	Downey, S.S.	Can properties of labor-exchange networks explain the resilience of swidden agriculture?	(2010) Ecology and Society, 15 (4)	Belize	social networks, panarchy theory	use SNA to analyze farmer labor-exchange networks within a chronosequence of five Q'eqchi' Maya villages where swidden agriculture is used. Can changes in the structure of Q'eqchi' labor networks increase socioecological resilience?	surveys; free recall, max of 10 names	5 villages (spatially contiguous but with different settlement dates) (one network per village)
25	Ernstson, H.a b , Sörlin, S.b c , Elmqvist, T.a b	Social movements and ecosystem services - The role of social network structure in protecting and managing urban	(2008) Ecology and Society, 13 (2), art. no. 39	Sweden	social networks, social movement theory	focus on how and why it has been possible for the Ecopark movement to generate protective capacity for a green area and how this in turn has influenced its management	surveys, interviews, participant observation; recognition list of organizations	one network in one location
26	Fischer, A.P., Vance-Borland, K., Burnett, K.M., Hummel, S., etc	Does the Social Capital in Networks of "Fish and Fire" Scientists and Managers Suggest Learning?	(2014) Society and Natural Resources, 27 (7), pp. 671-688	USA	social networks, social capital, organizational learning	examined patterns of social interaction among federal scientists and managers for evidence of social capital and the opportunity for organizational learning regarding the problem of how to manage fish habitat in fire-prone areas	online survey; free recall, no max limit	one network in one location (covering multiple states)
27	Fischer, A.P.a , Vance-Borland, K.b , Jasny, L.c , Grimm,	A network approach to assessing social capacity for landscape planning: The case of fire-prone forests in Oregon, USA	(2016) Landscape and Urban Planning, 147, pp. 18-27	USA	social networks, social capital	(1) To what extent are organizations with different management goals and geographic foci interacting with each other around the problem of wildfire risk? (2) What do these patterns of interaction suggest about	semi-structured interviews; free recall, limited to within previous 5 years	one network in one location

	K.E.d , Charnley, S.e					opportunities for cooperation on landscape planning?		
28	Fliervoet, J.M.a , Geerling, G.W.a b , Mostert, E.c , Smits, A.J.M.	Analyzing Collaborative Governance Through Social Network Analysis: A Case Study of River Management Along	(2016) Environmental Management, 57 (2), pp. 355-367	The Netherlands	social networks	shed some more light on the issue of shifting from government to governance and describe the complexity of the current collaborative and cross-boundary interactions between governmental and non-governmental actors concerning environmental management	survey; recognition method (choose from list of actors), new actors could be added	one network in one location
29	Galik, C.S., Grala, R.K.	Conservation program delivery in the southern U.S.: Preferences and interactions	(2017) Journal of Environmental Management, 198, pp. 75-83.	USA	social networks	Which types of practitioner organizations are most and least central in the practitioner network? Which organizations within the network are turned to most often by those landowners who are the ultimate recipients of conservation programs in the area?	online and mail surveys; free recall and frequency of contact, no max limit	one network in one location
30	Garbach, K., Long, R.F.	Determinants of field edge habitat restoration on farms in California's Sacramento Valley	(2017) Journal of Environmental Management, 189, pp. 134-141	USA	learning pathways (social, technical, experimental)	investigate drivers of adoption of field edge habitat plantings in California's Sacramento Valley	mail and online surveys; recognition method, choose up to 5 types of contacts out of list, and rate them (methods not entirely clear)	egocentric networks in one location
31	Garbach, K., Morgan, G.P.	Grower networks support adoption of innovations in pollination management: The roles of social learning, technical learning, and personal experience	(2017) Journal of Environmental Management, 204, pp. 39-49	USA	social networks, diffusion of innovation, learning	analyze the roles of grower characteristics, knowledge systems, and communication networks and their respective roles in supporting adoption of three innovative management practices that can support diverse pollinators	mail and phone surveys; name-generator and name interpreter questions, max of 5 names	one network in one location
32	García-Amado, L.R., Pérez, M.R., Iniesta-Arandia, I., et al	Building ties: Social capital network analysis of a forest community in a biosphere reserve in Chiapas, Mexico	(2012) Ecology and Society, 17 (3)	Mexico	social networks	analyze the social network of a forest community to understand social capital, decision-making, and collective action in forest-based common pool resource management	semi-structured interviews, participant observation; does not mention any bounds on the network question	one network in one location (biosphere reserve)
33	Guerrero, A.M.a b , Bodin, Ö.c , McAllister, R.R.J.d , Wilson, K.A.a b	Achieving Cross-Scale Collaboration for Large Scale Conservation Initiatives	(2015) Conservation Letters, 8 (2), pp. 107-117.	Australia	social networks	seek to better understand how stakeholders interact in a large-scale conservation initiative through analyzing the conservation social network	semi-structured interviews, online survey; free recall, no max limit	one network in one location
34	Gonzalez Gamboa, V., Barkmann, J., Marggraf, R.	Social network effects on the adoption of agroforestry species: Preliminary results of a study on differences on adoption patterns in Southern Ecuador	(2010) Procedia - Social and Behavioral Sciences, 4, pp. 71-82. Cited 3 times.	Ecuador	social networks, diffusion of innovations	analyse the results of a preliminary qualitative study on ethnic, socio-cultural and socio-structural factors that potentially influence the adoption of smallholder agroforestry options	semi-qualitative interviews; free recall? Only included ties from within past 3 months in data analysis	one network in one location

35	Hauck, J.a b , Schmidt, J.a , Werner, A.c d	Using social network analysis to identify key stakeholders in agricultural biodiversity governance and related land-use decisions at regional and local level	(2016) Ecology and Society, 21 (2), art. no. 49	Germany	social networks, stakeholder selection	present the results of stakeholder identification and analysis of (a) actors at regional and local levels, (b) actors from other affected policy sectors, and (c) the vertical and horizontal interplay between actors at different levels and from different policy sectors	interviews; free recall, no max limit	2 networks in one location (regional vs local)
36	Hirschi, C (Hirschi, Christian)	Strengthening Regional Cohesion: Collaborative Networks and Sustainable Development in Swiss Rural Areas	(2010) ECOLOGY AND SOCIETY Volume: 15 Issue: 4 Article Number: 16	Switzerland	social networks, social capital, sustainable development	aims to make both a theoretical and empirical contribution to a better understanding of integrative and network-oriented forms of policy making and natural resource management as a potential contribution to enhancing sustainable development	standardized questionnaire sent by mail; recognition method (choose from a list of actors)	2 sites (park projects)
37	Holmes, TQ; Head, BW; Possingham, HP; Garnett, ST	Strengths and vulnerabilities of Australian networks for conservation of threatened birds	(2017) ORYX Volume: 51 Issue: 4 Pages: 673-683	Australia	social networks	focus on the social networks of key participants and seek to determine how such networks may influence the effective management of biodiversity protection schemes for threatened birds	interviews; free recall, no max limit	6 networks (one per threatened species)
38	Ichinkhorloo, B., Yeh, E.T.	Ephemeral 'communities': spatiality and politics in rangeland interventions in Mongolia	(2016) Journal of Peasant Studies, 43 (5), pp. 1010-1034	Mongolia	social networks, social capital, trust	examine development projects that intended to create trust through the formation of new institutions, and analyze their interactions with existing social networks with which they overlap but do not coincide; explicate why rangeland interventions based on CBNRM may not create trust and social capital	interviews; free recall, no max limit	2 groups from different locations (but only 1 group for SNA)
39	Isaac, M.E.a , Erickson, B.H.a , Quashie-Sam, S.J.b , Timmer, V.R.a	Transfer of knowledge on agroforestry management practices: The structure of farmer advice networks	(2007) Ecology and Society, 12 (2), art. no. 32	Ghana	social networks	(1) determine structure of informal farmer advice networks, (2) used farmer attributes to characterize the structural configuration, (3) investigate the practical consequences of a core-periphery structure on farming information and formation of social capital, (4) determine variability and consistency among the distinct advice networks	interviews; name-generator technique, no max limit	4 communities (one network per community)
40	Isaac, M.E.a b	Agricultural information exchange and organizational ties: The effect of network topology on managing agrodiversity	(2012) Agricultural Systems, 109, pp. 9-15.	Ghana	social networks, diffusion of innovations	comparative analysis between networks with and without access to agro-organizations to examine the effects of network diversity on farm management practices	semi-structured interviews w/individuals from orgs, interviews with farmers; name-generator technique, no max limit	2 sites, with and without access to agro-organizations (one group of egonetworks per site)
41	Isaac, M.E.a b , Anglaaere, L.C.N.c , Akoto, D.S.d , Dawoe, E.d	Migrant farmers as information brokers: Agroecosystem management in the transition zone of Ghana	(2014) Ecology and Society, 19 (2), art. no. 56	Ghana	social networks, social-ecological memory	chart the role of migrant farmers and the type of agroecosystem management practices embedded in information networks in the forest-savanna transition zone	semi-structured interviews; name-generator technique, no max limit	3 communities (one network per community)
42	Isaac, ME; Matous, P	Social network ties predict land use diversity	(2017) REGIONAL ENVIRONMENTAL	Ghana	social networks	aims to correlate agrarian network structures with land use diversification and land use	interviews; name-generator technique	egocentric networks in one location (plus one-

	and land use change: a case study in Ghana	CHANGE Volume: 17 Issue: 6 Pages: 1823-1833			change in order to chart the drivers and persistence of multifunctional agroecosystems		step and two-step alters of the initial egos)	
43	Keskitalo, E.C.H.a , Baird, J.b , Laszlo Ambjörnsson, Sectors E.a , Plummer, R.	Social Network Analysis of Multi-level Linkages: A Swedish Case Study on Northern Forest-Based Sectors	(2014) Ambio, 43 (6), pp. 745-758	Sweden	social networks, environmental governance	investigates the existence of user interactions and impacts in several forest-based sectors at a local level, as well as how they extend to regional, national, and international levels	semi-structured interviews; limited detail about network data collection, is just based on responses about interactions with different groups	2 sites (municipalities with different formal cooperation structures) (one network per site)
44	Kittredge, D.B.a , Rickenbach, M.G.b , Knoot, T.G.c , Snellings, E.d , Erazo, A.	It's the network: How personal connections shape decisions about private forest use	(2013) Northern Journal of Applied Forestry, 30 (2), pp. 67-74	USA	social networks	characterize and compare the individual egocentric networks that inform landowners' timber sale and conservation easement decisions. What is the role of informal egocentric social networks when it comes to reactive decisions owners make about their land?	in-person structured interviews; name generator questions using free recall with prompts (all contacts and then "influential")	2 groups of egocentric networks in one location
45	Knoot, T.G.a , Rickenbach, M.b	Best management practices and timber harvesting: The role of social networks in shaping landowner decisions	(2011) Scandinavian Journal of Forest Research, 26 (2), pp. 171-182	USA	social networks, decision science	Who are the others that landowners rely on when making decisions related to timber harvesting and BMP application? How do landowner experiences and egocentric networks compare when BMP application is voluntary versus when it is required as part of a forestry incentive program?	structured interviews, mostly by phone; name generator and name interpreter questions via free recall (for all contacts and then "influential")	2 groups of egocentric networks in one location
46	Kocho-Schellenberg, J.-E., Berkes, F.	Tracking the development of co-management: Using network analysis in a case from the Canadian Arctic	(2015) Polar Record, 51 (4), pp. 422-431	Canada	social networks, co-management	analyse changes over time in the management network involved in dealing with the Husky Lakes beluga entrapment issue, using Social Network Analysis (SNA)	participant observation, questionnaires, semi-directed interviews, document analysis, engagement of community research partners; free recall, no max limit	one network in one location
47	Kramer, D.B.a , Mitterling, A.b , Frank, K.A.c	Understanding Peer Influence in Hunter Harvest Decisions Using Social Network Theory and Analysis	(2016) Human Dimensions of Wildlife, 21 (5), pp. 414-426.	USA	social networks, theory of reasoned action	sought to understand the antlerless deer harvest decisions of individuals in private deer cooperatives	survey (completed at meetings, via mail, or online); name other members in the cooperative, no max limit	egocentric networks across 16 cooperatives
48	Kuzdas, C.a b , Wiek, A.b , Warner, B.b c , Vignola, R.a e , Morataya, R.d	Integrated and Participatory Analysis of Water Governance Regimes: The Case of the Costa Rican Dry Tropics	(2015) WORLD DEVELOPMENT Volume: 66 Pages: 254-268	Costa Rica	social networks, systems framework	use a recently proposed analytical framework to investigate: key governance actors, their water-related activities, and their roles in the water governance system; why actors do what they do with water; and how they relate to each other within the governing domains of water supply, delivery, use, and outflows	semi-structured interviews; free recall, no max limit	one network across 3 sub-basins
49	Lamb, J.N., Moore, K.M., Norton, J., Omondi, E.C., et al	A social networks approach for strengthening participation in technology innovation: lessons learnt from the	(2016) International Journal of Agricultural Sustainability, 14 (1), pp. 65-81.	Kenya and Uganda	social networks, innovation systems, participatory process	explores farmer support networks to improve participation in technological innovation and development	focus groups, surveys, workshops; specific network questions not stated, but seems no max limit	4 sites with differing agricultural potential

	Mount Elgon region of Kenya and Uganda							
50	Maciejewski, a , Cumming, G.S.	The relevance of socioeconomic interactions for the resilience of protected area networks	(2015) Ecosphere, 6 (9), art. no. 145	South Africa	social networks, socioeconomic interactions	explored different socioeconomic connections of protected areas and their role in the resilience of social-ecological systems	interviews; not much detail about how they asked for network data	2 adjacent provinces (one network per province)
51	Maciejewski, K., Baum, J., Cumming, G.S.	Integration of private land conservation areas in a network of statutory protected areas: Implications for sustainability	(2016) Biological Conservation, 200, pp. 200-206.	South Africa	social networks, connectivity	investigated the conservation relevance of the network of socioeconomic interactions between private land conservation area managers and the managers of private and statutory protected areas	semi-structured interviews; free recall, no max limit	one network in one province
52	Mannetti, LM; Esler, KJ; Knight, AT; Vance-Borland, K	Understanding Social Networks to Improve Adaptive Co-Governance with the #Khomani Bushmen of the Kalahari, South Africa	(2015) HUMAN ECOLOGY Volume: 43 Issue: 3 Pages: 481-492	South Africa	social networks, collective action	investigate the social network structure of the #Khomani Bushmen community to better understand their ability to manage plant resources collaboratively	face-to-face, semi-structured interviews; recognition and recall methods	one network in one location
53	Matous, P.a b	Social networks and environmental management at multiple levels: Soil conservation in Sumatra	(2015) Ecology and Society, 20 (3), art. no. 37	Indonesia	social networks, scale, co-management	examine how social networks are related to the adoption of soil conservation and productivity-enhancing practices by smallholder farmers	field observations and interviews, fixed-form, face-to-face administered questionnaire; free recall, no max limit	16 farmer groups across 2 locations (one network per group)
54	Matous, P.a b , Todo, Y.c	Exploring dynamic mechanisms of learning networks for resource conservation	(2015) Ecology and Society, 20 (2), 14 p	Ethiopia	social networks	measure (1) the dynamic mechanism by which agricultural information-sharing networks are formed among village inhabitants, and (2) the role of the network in the adoption of the practice of composting	fixed-form interviews; free recall, max of 20 names	network in one location at two time periods
55	Mbaru, EK; Barnes, ML	Key players in conservation diffusion: Using social network analysis to identify critical injection points	(2017) BIOLOGICAL CONSERVATION Volume: 210 Pages: 222-232	Kenya	social networks, diffusion of innovations	use social network theory and methods to present guidelines for selecting key players optimally positioned to successfully implement diffusion-related conservation objectives	interviews; recall methods, max of 10 names	6 networks (one per village)
56	Meek, Chanda L.	Forms of collaboration and social fit in wildlife management: A comparison of policy networks in Alaska	(2013) Global Environmental Change, Volume 23, Issue 1, February 2013, Pages 217–228	USA (Alaska)	social networks, institutions, congruence theory	compare two different institutions for reporting subsistence harvests of marine mammals; examine the effect of institutional form on policy processes and socially relevant outcomes, by employing a mixed methods approach to compare the implementation of two wildlife regimes in two towns	structured in-person surveys, analysis of policy documents, meeting observations, participant observation, semi-structured interviews; name-generator question, no max limit	2 networks in 2 villages (bowhead whale vs polar bear harvest assessment networks; both networks occur in both locations)
57	Morgans, C.L., Guerrero, A.M., Ancrenaz, M.,	Not more, but strategic collaboration needed to conserve Borneo's orangutan	(2017) Global Ecology and Conservation, 11, pp. 236-246.	Borneo	social networks	empirically evaluate the extent of collaboration between actors, determine whether social processes of trust and innovation are prevalent in the observed network configuration, and ascertain the relationship between	qualitative surveys and semi structured interviews (also used connections based on website hyperlinks b/n orgs); free recall?	one network in one location

	Meijaard, E., Wilson, K.A.				organisational attributes and perceptions of collaboration			
58	Mulvaney, K.K.a , Lee, S.b , Höök, T.O.a c , Prokopy, L.S.a	Casting a net to better understand fisheries management: An affiliation network analysis of the Great Lakes Fishery Commission	(2015) Marine Policy, 57, pp. 120-131.	USA and Canada	social networks, stakeholder engagement	aims to identify the complex aggregation of organizations that influence management and the key roles within the Great Lakes Fishery Commission (GLFC) for the flow of information	questionnaire (via email); name generator questions, including a fixed roster of organizations and options for free recall	one network in one location
59	Nuno, A.a , Bunnefeld, N.b , Milner-Gulland, E.J.a	Managing social-ecological systems under uncertainty: Implementation in the real world	(2014) Ecology and Society, 19 (2), art. no. 52,	Tanzania	social networks, management strategy evaluation (MSE)	used a management strategy evaluation (MSE) framework as a conceptual model to investigate the challenges and potential barriers to successful conservation implementation	semi-structured interviews; free recall, max of 10 names	one network (combined egos) in one location
60	Ogada, J.O., Krhoda, G.O., Van Der Veen, A., Marani, M., van Oel, P.R.	Managing resources through stakeholder networks: collaborative water governance for Lake Naivasha basin, Kenya	(2017) Water International, 42 (3), pp. 271-290.	Kenya	social networks, stakeholder analysis	use stakeholder analysis and SNA to analyze stakeholders’ social and structural characteristics based on their interests, influence and interactions in Lake Naivasha basin, Kenya	document reviews, participatory methods, interviews; free recall, no max limit	one network in one location
61	Omondiaage, H.A., Towns, D.R., Wood, J.K., Bollard-Breen, B.	Stakeholders and social networks identify potential roles of communities in sustainable management of invasive species	(2017) Biological Invasions, 19 (10), pp. 3037-3049.	New Zealand	social networks	identify stakeholders, determine the structure of their relationships through a social network analysis and examine how network structure could aid collaborative efforts towards invasive species management	online survey and interviews with subset; free recall, limited to within previous 12 months	one network in one location
62	Paletto, A.a , Hamunen, K.b , De Meo, I.c	Social Network Analysis to Support Stakeholder Analysis in Participatory Forest Planning	(2015) Society and Natural Resources, 28 (10), pp. 1108-1125	Italy	social networks, stakeholder analysis	build a nonsubjective method to identify and classify stakeholders, taking into account the relationships among them (social network analysis)	face-to-face interviews; free recall, no max limit	2 districts (one network per district)
63	Paletto, A.a , Balest, J.a , De Meo, I.b , Giacobelli, G.a , Grilli, G.c	Power of forest stakeholders in the participatory decision making process: A case study in northern Italy	(2016) Acta Silvatica et Lignaria Hungarica, 12 (1), pp. 9-22.	Italy	social networks, power	investigate the differences between stakeholders' perceived influence and real power in forest management	questionnaire via face-to-face interviews; free recall, no max limit	one network in one location
64	Paul, S., Jordán, F., Nagendra, H.	Communication networks and performance of four New Delhi city parks	(2017) Sustainability (Switzerland), 9 (9), art. no. 1551	India	social networks	aims at understanding the communication networks for four New Delhi parks, quantifying their structure by SNA and looking for the relationships between performance indicators and network properties	questionnaire, interviews; free recall, no max limit	4 networks (one per park)
65	Plummer, R.a b , Baird, J.c , Krievins, K.d , Mitchell, S.J.e	Improving river health: insights into initiating collaboration in a transboundary river basin	(2016) Inter'l Journal of River Basin Management, 14 (1), pp. 119-132.	USA and Canada	social networks	gain insights into the initiation phase of a collaborative conservation project in a large transboundary basin	questionnaire (in-person or telephone); free recall, no max limit	one network in one location

66	Prell, C.a , Hubacek, K.b , Quinn, C.b , Reed, M.b	Who's in the network? When stakeholders influence data analysis	(2008) Systemic Practice and Action Research, 21 (6), pp. 443- 458	England	social networks, social learning	discusses the authors' collaboration with stakeholders in an ongoing social learning project taking place in a National Park	focus groups and interviews, questionnaire; recognition method (roster of all partners' names)	one network in one location (same as Prell et al 2009)
67	Prell, C.a , Hubacek, K.b , Reed, M.b	Stakeholder analysis and social network analysis in natural resource management	(2009) Society and Natural Resources, 22 (6), pp. 501-518.	England	social networks, stakeholder analysis	use SNA to identify the role and influence of different stakeholders and categories of stakeholder according to their positions within the network, to enhance stakeholder analysis	focus groups and interviews (by phone); name generator questions (asked for each of 8 stakeholder categories)	one network in one location (same as Prell et al 2008)
68	Prell, C.a , Reed, M.b , Racin, L.c , Hubacek, K.d	Competing structure, competing views: The role of formal and informal social structures in shaping stakeholder perceptions	(2010) Ecology and Society, 15 (4)	England	social networks, institutions (formal and informal structures)	provide insights into the role of social structure (formal and informal) in general and highlight in particular the role social networks play in shaping stakeholders' views on land management	structured phone interviews; name- generator and name interpreter questions, no max limit	one network in one location
69	Ramirez- Sanchez, S.	Who and how: Engaging well-connected fishers in social networks to improve fisheries management and conservation	(2011) Social Networks and NRM: Uncovering the Social Fabric of Environmental Governance, pp. 119-147.	Mexico	social networks	focus on issues of who and how to involve fishers to improve fisheries management and conservation using network centrality measures and social network mechanisms	questionnaire; recognition method for community (choose from list of fishers), and name contacts (free recall) in 6 other communities	2 networks in one municipality, i.e., local (within community) and regional (among 7 communities) networks
70	Rathwell, K.J.a b , Peterson, G.D.b	Connecting social networks with ecosystem services for watershed governance: A social- ecological network perspective highlights the critical role of bridging organizations	(2012) Ecology and Society, 17 (2)	Canada	social networks	1. How are municipalities collaborating to address water quality management? a) with each other (in one-mode networks) b) with bridging organizations (in two-mode networks) 2. Are the activities and networks of tourist and agricultural municipalities different? 3. Do more connected municipalities engage in more water quality management activities?	structured interviews; first able to give open-ended answer, then asked to choose from a list of govt and nongovt organizations	one network across 2 watersheds
71	Rickenbach, M.	Serving members and reaching others: The performance and social networks of a landowner cooperative	(2009) Forest Policy and Economics, 11 (8), pp. 593-599	USA	social networks	(1) Is the local landowner cooperative a well- functioning organization in terms of effectively meeting members' needs? (2) From whom do members seek information when making land management decisions?	mail questionnaire; name-generator questions, no max limit, and measures of trustworthiness	egocentric networks in one location
72	Sagor, E.S., Becker, D.R.	Personal networks and private forestry in Minnesota	(2014) Journal of Environmental Management, 132, pp. 145-154	USA	social networks, diffusion of innovations	What are the attributes of forest landowners' information networks? How do those attributes vary in relation to ownership size, tenure, land management activities, and other landowner characteristics? How does satisfaction with the quality of information obtained vary with network attributes?	mail questionnaire; free recall name generator and interpreter questions, including noting up to 4 "most helpful" alters	egocentric networks in one location
73	Smythe, T.C., Thompson, R., Garcia- Quijano, C.	The inner workings of collaboration in marine ecosystem-based management: A social	(2014) Marine Policy, 50 (PA), pp. 117-125	USA	social networks, ecosystem-based management	SNA was used to investigate: What was the extent and nature of collaboration in the marine ecosystem-based management (EBM) planning process?	web-based survey; free recall for 'key people', no max limit	2 EBM planning efforts (one network per planning effort)

		network analysis approach						
74	Stein, C.a b , Ernstson, H.a c , Barron, J.a d	A social network approach to analyzing water governance: The case of the Mkindo catchment, Tanzania	(2011) Physics and Chemistry of the Earth, 36 (14-15), pp. 1085-1092	Tanzania	social networks, governance	demonstrate how to use a social network approach to analyse the structural characteristics that underpin the governance of water resources at the catchment scale	semi-structured interviews, group discussions and an organisational survey; recognition method (mark relations to listed organizations)	4 communities in one catchment (one network per community, and aggregated network)
75	Stoll, J.S.	Fishing for leadership: The role diversification plays in facilitating change agents	(2017) Journal of Environmental Management, 199, pp. 74-82	USA	social networks, institutional entrepreneurship	research focuses on the interplay between leaders and the natural environment, exploring how fishers' particular connections to fisheries facilitate leadership	phone and in-person survey; free recall, no max limit; also in-depth interviews with the SNA-selected leaders	one network in one location
76	Syme, GJ; Dzidic, P; Darnbacher, JM	Enhancing science in coastal management through understanding its role in the decision making network	(2012) Source: OCEAN & COASTAL MANAGEMENT Volume: 69 Pages: 92-101	Australia	social networks	aim was to systematically consider client uptake of science in a large scale multidisciplinary research program	scoping and formal interviews; asked to draw egocentric sociogram, no max limit	one network in one location
77	Unay Gailhard, İ.U.a , Bavorová, M.b , Pirscher, F.b	Adoption of agri-environmental measures by organic farmers: The role of interpersonal communication	(2015) Journal of Agricultural Education and Extension, 21 (2), pp. 127-148.	Germany	social networks, innovation adoption model, interpersonal communication	investigate whether contact frequency in interpersonal networks increases the innovativeness of organic farmers, which is expressed by adopting additional voluntary AEM.	face-to-face interviews; no detail about network questions	egocentric networks in one location
78	Vance-Borland, K.a , Holley, J.b	Conservation stakeholder network mapping, analysis, and weaving	(2011) Conservation Letters, 4 (4), pp. 278-288	USA	social networks, stakeholder analysis	investigate the applicability of applied SNA for conservation by first assessing the structural characteristics of a conservation stakeholder network and then communicating our results directly to the stakeholders	survey (via website, hard copy, face-to-face interview), follow up meetings after SNA; free recall, limited to within previous 2 years	one network in one location
79	Warriner, G.K., Moul, T.M.	Kinship and personal communication network influences on the adoption of agriculture conservation technology	(1992) Journal of Rural Studies, 8 (3), pp. 279-291	Canada	social networks, diffusion of innovation	extend understanding of the adoption of innovation process in farming as influenced by kinship relations	mailed questionnaire; name generator and name interpreter questions, max of 6 names	egocentric networks in one location
80	Weiss, K., Hamann, M., Kinney, M., Marsh, H.	Knowledge exchange and policy influence in a marine resource governance network	(2012) Global Environmental Change, 22 (1), pp. 178-188	Australia	social networks, adaptive governance	examine knowledge transfer and policy influence within a marine wildlife co-management network to: (1) compare overall network structure and actor characteristics; (2) investigate how power relations impact the social-ecological resilience of the network; and (3) contribute to a greater understanding of the relationship between knowledge, influence, and political power in the context of NRM	semi-structured interviews, follow up surveys to get network data; recognition method (choose from list of actors), new actors could be added	one network in one location
81	Woodward, E.a b	Social networking for aboriginal land management in remote northern Australia	(2008) Australasian Journal of Environmental	Australia	social networks	describe the range of social networks that deliver information and resources to an Aboriginal land management group, and	document reviews, semi-structured interviews, participant observation; no specifics about how network data was collected	one network in one location

82	Wyckhuys, K.A.G., O'Neil, R.J.	Role of opinion leadership, social connectedness and information sources in the diffusion of IPM in Honduran subsistence maize agriculture	(2007) International Journal of Pest Management, 53 (1), pp. 35-44.	Honduras	social networks, diffusion of innovation	examine the role of key individuals in facilitating the building of these networks assessed the composition of farmers' social networks and their importance in integrated pest management (IPM) diffusion	questionnaire with open-ended questions; free recall, max of 5 names	4 communities (with different levels of IPM training) (egocentric networks per community)
83	Yamaki, K.	Network governance of endangered species conservation: A case study of Rebutia Lady's-Slipper	(2015) Journal for Nature Conservation, 24 (C), pp. 83-92.	Japan	social networks	explore the governance of endangered species conservation by examining the relationship between governance performance and social network structure	semi-structured interviews; recognition method (choose from list of actors), new actors could be added	one network in one location (consisting of 2 formal institutions, Alpine Flowers Council and Rebutia Lady's-Slipper Program)
84	Yamaki, K.	Role of social networks in urban forest management collaboration: A case study in northern Japan	(2016) Urban Forestry and Urban Greening, 18, pp. 212-220.	Japan	social capital (comprised of social networks), public participation	elucidate the characteristics of collaboration by examining the role of social networks in urban forest management	questionnaire; free recall, max of 5 names	one network in one location
85	Yamaki, K.	Applying social network analysis to stakeholder analysis in Japan's natural resource governance	(2017) Journal of Forest Research, 22 (2), pp. 83-90	Japan	social networks, stakeholder analysis	aims at identifying relevant stakeholders who should be involved in decision making in Japan's natural resource governance using a stakeholder analysis with social network analysis (SNA) as a systematic tool	surveys; nominate 5-10 actors	2 networks (one per species)

Appendix M. continued.

Details extracted from articles								
#	Temporal scale	No. of networks	Node	Tie type	Network level	Network metrics	Intervention?	General conclusions related to SNA
1	single point	>1	fishers	sharing information about fishing	whole network	fragmentation, modularity, K-reach, degree centrality, network size (reported)	No (but results can provide guidance on how to target interventions)	findings are consistent with others that community cohesion and high social capital are important attributes contributing to successful co-management of fisheries; suggests transitions to co-management were supported by a combination of: (i) presence and position of park wardens; (ii) dense central core of network actors; and (iii) prevalence of horizontal ties and vertical linkages
2	single point	1	organizations affiliated with the governance of the national network of SFCAs	3 types: information sharing, management-oriented, collaboration	whole network	ties within and between groups, tie strength, density, in-degree centrality, betweenness centrality, type of alter, network size	No (but gives suggestions to possibly improve network structure)	suggest multilevel linkages have played greatest role in relation to enhancing fit in the context of recent lionfish invasion; yet long-term propensity of the multi-actor and multilevel networks to enhance social-ecological fit is uncertain due to weak social ties, lack of info sharing and collaboration, and limited financial resources
3	single point	1	farmers and experts (including NGO reps, pesticide dealers)	seeking and giving problem-solving advice about pest attacks	whole network	network size (reported), density (reported), outdegree centrality, indegree centrality; "knowledge circuits" (of 2 or more nodes with cyclic structure), type of alter	No	results show importance of an NGO resource person who acts as a bridge or broker between the development agency and its beneficiaries; few farmers acted as sources of knowledge; knowledge hierarchies exist, which limits transfer of local knowledge for AEM development
4	single point	>1	individuals in each cultural group	2 types: important people to your life (outside the household), seeking info about the forest	combined egocentric networks	density, degree of interconnectedness, type of alter	No	Itzaj: diffusely interconnected social and expert networks suggest multiple social pathways to assimilate and store information; Ladino: informal network links to Itzaj enable learning about the forest; different cultural groups subject to equal pressures on their common resources respond with different patterned behaviors and cognitions
5	single point	ego	agricultural producers + alters	communicating for information or advice when making land management decisions	combined egocentric networks	network size, diversity (type of alter) (asked about frequency for tie strength but doesn't seem to be incorporated in analysis)	No	role of regional actors was key to influencing land management decision making, specifically the adoption of certain BMPs (respondents with connections to regional actors implemented more BMPs than those without); 3D geovisualization (linking social networks to water quality) establishes a baseline dataset
6	single point	1	fishers (vessel owners and/or captains)	regularly exchanging important information about fishing	whole network	E-I homophily index (ties within vs between groups), type of alter, network size (reported), mean geodesic distance (reported), average degree (reported) (asked about tie strength [frequency], excluded ties of low freq)	No	results suggest that social affiliations (network ties, rather than ethnicity) are tied to fishing behaviors that can have a direct impact on ecosystems; segregated subgroups are influencing bycatch avoidance behavior, but behaviors are not diffusing from one group to another
7	single point	1	fishers (vessel owners and/or captains)	sharing information for fishing success	whole network	network size (reported), indegree, outdegree, homophily, density, # components, ties	No	lack of cohesion and trust across groups may substantially reduce the ability of fishers to mobilize and agree on and enforce social norms (key aspects of collaborative resource governance), but

					within vs between groups, k-cores, blocks & cutpoints, type of alter (asked about tie strength, not clear in analysis)		some bridging ties suggest potential; ethnic diversity can have significant impact on network structure
8 single point	>1	Landcare group members + alters	talking about NRM issues	combined egocentric networks	degree centrality (connectedness), modularity, type of alter, network size (reported)	No	SNA is useful tool for making visible the social mosaic within the landscape; evidence of diversity suggests more opportunity for action and greater knowledge flow; results suggest the presence of social resilience aspects of diversity and redundancy
9 single point	>1	organizations (including user associations, agencies, NGOs, businesses)	3 types: collaborating, sharing information or knowledge, receiving/sharing/ giving funding or resources	whole network	betweenness centrality, indegree centrality, type of alter, network size (reported)	No (but suggests bridging orgs can have influence)	central (bridging) orgs had many connections and tended to form the connections across others that were disconnected due to differences in location, sectors, values; some orgs better suited to certain types of ties; NP site more vulnerable to fragmentation b/c only one bridging org; bridging orgs add value to heterogeneous networks in conservation settings, important to governance
10 single point	1	villagers	communicating about important matters (support); exchanging information about natural resources (knowledge)	whole network	degree centrality, betweenness centrality, eigenvector centrality, number of components, ties within vs between groups, type of alter, network size (reported), average degree (reported)	No	Network measures indicate a potential for relatively high levels of social capital in the village, but that alone isn't sufficient to sustainably manage resources; community is highly dependent on one individual, decreasing network resilience
11 single point	>1	stakeholders (representing private landowners, commercial enterprises, NGOs, public authorities, publicly controlled foundations)	exchanging information and knowledge	whole network	density, connectedness, centrality, transitivity, type of alter, network size (reported) (asked about tie strength, excluded ties of low strength)	No (but gives suggestions for "weaving")	shows collaborative networks with similar overall network characteristics can perform differently, and networks with different network characteristics can perform similarly, thus suggests there are different causal pathways in which different network characteristics can contribute in accomplishing desirable EBM; all regions are affected by factors other than network characteristics
12 single point	1	organization staff who took part in the Siberian Jay Network activities	3 types: flow of info among orgs, inter-org trust, views of shared goals or interests	actor level and whole network	actor level: degree, centrality, brokerage; network level: centralization, core-periphery structure	No	results show ties of trust and of info exchange form the most dense network structures; in some cases trust was a requisite for the other relationships to take place; not having common goals does not hinder actors from cooperating; but private forest owners remained outside the network; short-term governance operates on trust
13 3 points (before, during, after a planning process)	>1	organizations important in the context of bushfire management	communicating about bushfire issues (at 3 points in time)	actor level and whole network	network level: size, density, average geodesic distance, centralization, betweenness; actor level: degree centrality, betweenness	Passive - looks at impacts of planning process on inter-organizational networks	legislatively mandated collaborative planning had the potential to enhance interorg'l communication networks, but contextual factors were important (e.g., conflict history, group size); although communication diminished after planning, a foundation was nevertheless set for future collaboration
14 single point	1	participants of the advisory committee (administrators, managers, employees, conservation groups, various sectors, etc)	communicating about issues related to policies and NRM in the park	actor level and whole network	network level: network size, number of components, density, indegree centralization; actor level: indegree centrality, betweenness centrality; dyadic reciprocity, type of alter, clusters	No (but selected stakeholders for future collaborations)	suggests communication network is not fragmented but is fragile because of the few ties between stakeholders, which reflect a lack of trust and little knowledge exchange; selected 12 stakeholders for future participatory processes based on SNA metrics
15 single point	1	stakeholders (org reps involved, interested, or	2 types: collaborating, exchanging info and	individual, subgroup, and	network level: density, diameter, average path length, degree	No (but method can help with	results indicate existence of a low flow of collaborative and exchange relations among different stakeholders; high presence of

		affected by the use and management of the area)	knowledge about natural resources; (also, perceptions of others' influence)	complete networks	centralization, betweenness centralization; subgroup : E-I index; individual : betweenness centrality, brokerage scores; tie strength, type of alter, network size	stakeholder selection)	fishermen orgs in the collaboration network; study is a first attempt to explore social networks in the area and offers clues on key stakeholders that should be present at the start of a formal planning process
16 single point (measured networks before enviro prgm was implemented)	>1	fishermen	friendships with people who participated in the enviro prgm meetings	whole network	degree centrality, closeness centrality, network size (reported)	Not measured (post-implementation of environmental program)	individual level of social integration and participation are significantly related to cooperation during the environmental program; suggestive evidence that social integration (et al) is positively related to actual use of Cofos; program had short-term impact on behavior change, but not long-term
17 two points* (unclear data collection for 2nd point)	1	members of a wine co-operative (volunteers and basic members)	2 types: professional/technical dialogues, exchanging advice (give and receive)	whole network	density, block models, ties within/between groups, type of alter, network size (reported)	No	both types of networks are important, enabling innovation and knowledge-seeking in different ways, creating "practices networks" that link people holding of specific points of view, technical, and social practices
18 single point	1	fishermen	fishing regularly together (undirected)	whole network	network size, average degree, clustering coefficient, network heterogeneity, type of alter, network size (reported)	No (but gives suggestions to possibly improve network structure)	there is a lack of bridging ties and strong leadership to connect different fishing subgroups (such ties could lead to informal social pressures to lighten the environmental pressure on the reef)
19 single point	1	head of household	exchanging information and knowledge about the status and extraction of natural resources	whole network	modularity, ties within and between groups, type of alter	No	occupation is a strong determinant of group cohesion; identifies correlation between distribution of LEK held by resource users and the social network for communication of resource related knowledge and information
20 single point	1	head of household	2 types: exchanging gear (high-value goods) and knowledge about the status and extraction of natural resources	whole network	gear network : in-degree centrality; knowledge network : degree centrality; blockmodeling, type of alter	No	results conform to, and support, argument that individuals with influence in one area also tend to be influential in transmitting opinions in other areas; identified opinion leaders are potentially highly influential in shaping ecological knowledge, and collective action within and beyond communities (could end up being positive or negative); additional data suggests the salience of potential opinion leaders is relatively low
21 single point	1	head of household	2 types: exchanging ecological information (LEK), discussing important matters	whole network	modularity, ties within and between groups, type of alter	No	appears to be significant amount of both bonding and bridging social capital in the village for LEK, but less so for social support network; deep-sea fishers have potentially influential positions for exchanging LEK
22 single point	>1	stakeholders (fishermen, govt officials, scientists, ecologists, etc.)	frequently discussing fishery management issues	whole network (per system)	network centralization, network heterogeneity, network autocorrelation (for knowledge and value statements), type of alter	No	Network autocorrelation indicates stakeholders tended to adopt the knowledge and values of their most frequent communication partners in other stakeholder groups while they tended to move away from those of their ingroup communication partners
23 single point	1	farmers	learning about CA and GAMP practices	whole network	density, network centralization, transitivity, modularity, # of components, betweenness centrality, leverage centrality, alpha centrality, "key player" measures (harvest, diffuse)	No (but method can help with stakeholder selection)	identified both formal and informal relationships in the network, along with key stakeholders; results indicate that farmers learn mainly from other farmers, and that the importance of information sources differs depending on the type of practices they use

24 single point (but 2 points for for one village)	>1	farmers	receiving help to chop or plant a field	whole network	hybrid reciprocity, hierarchy, efficiency, # of components	No	proposes a graduated-sanction model of reciprocity in which farmers avoid labor obligations to marginally reduce the productivity of those perceived as violating the forest commons; hierarchical labor relationships and low reciprocity help prevent overexploitation of the forest common
25 single point	1	social movement organizations (defined in text) that are active in park protection	exchange of advice on cultural/political or nature/ecological issues regarding the park; regular collaboration with other orgs; personal friends in other orgs	whole network	density, degree centrality, betweenness centrality, core-periphery, structural equivalence (block models); tie strength, type of alter, network size (reported)	No	newly formed and more politically active organizations played an active role in creating and sustaining the Ecopark movement; resources of and connections b/n core and periphery members help link politics of park with its ecosystems; core-periphery structure facilitates collective action; but seems network structures that facilitate ecosystem protection also hinder collaborative management
26 single point	1	federally employed scientists and managers focused on "fish and fire" issues	3 types: collaborating with, seeking knowledge, interacting with	whole network	density, average degree, centralization, cross-boundary exchange, block-modeling, brokerage, type of alter, network size (reported)	No (but briefly suggests possible interventions)	network consists of separate subgroups of scientists and managers with few bridging ties among them (limited social capital); high bonding capital among scientists but not among managers; suggests "gatekeeper" role of scientists in which they can enable or constrain info flow b/n groups; lack of interaction may limit opportunity for exchange of explicit knowledge and generation of new knowledge
27 single point	1	organizations concerned with wildfire risk	2 types: working with (planning, funding, or implementing), obtaining info or expertise	whole network	network size, average indegree, block-modeling, type of alter	No	suggests bonding social capital is not as strong across the network as a whole as it is within subnetworks of similar orgs; little evidence of structural conditions enabling cooperation on the shared problem of wildfire risk at a broad scale; suggests mismatch b/n spatial scales on which landscapes and humans function
28 single point	1	organizations (governmental orgs, NGOs, businesses, knowledge institutions, and associations of farmers)	2 types: interactions for flood protection (blue network), interactions for nature objectives (green network)	actor level, actor-groups, and whole network	network level: density, degree centralization, cross-boundary exchange; group level: group exchange, density; actor level: degree centrality, betweenness centrality, tie strength (via frequency), type of alter	No (but suggests bridging orgs can have influence)	while there is a lot of collaboration, there is also still a lot of hierarchical government; government organizations control and occupy central positions; shows consequences of discontinuing bridging organizations
29 single point	1	conservation practitioner organizations (org-to-org and landowner-to-org)	frequency of contact with conservation practitioner orgs (ties from orgs and ties from landowners)	whole network	network size (reported), tie strength, average path length, betweenness centrality, type of alter	No	low average path lengths estimated between conservation practitioner organizations suggest a well-connected network; orgs with most frequent contacts are potentially best positioned to coordinate activity in the region
30 single point	ego	landholders (farmers & landowners, diversity of farming practices)	exchange information about field edge management	egocentric networks	network size, type of alter	No	networks of adopters included both fellow LHs and agencies, networks of non-adopters included either LHs or agencies; other LH characteristics also predictive of adoption; social learning through peer-to-peer info exchange can serve as a complementary and reinforcing pathway with technical learning that is stimulated by traditional outreach and extension programs
31 single point	1	specialty fruit growers	sharing information on pollination management	combined egocentric networks	average path length, network diameter, network density, type of alter	No	results suggest that different types of information brokers can be important for practices at distinct stages of adoption; other LH characteristics also predictive of adoption

32	single point (but multiple points for coffee groups)	1	household heads within one ejido*	5 types: assisting with different productive activities - coffee, palm, ecotourism, authorities, and general all-purpose	whole network	network size (reported), transitivity, network indegree centrality, network betweenness, core-periphery, # of components, hierarchy, efficiency, type of alter	No	despite power asymmetries and internal conflicts, the ejido facilitates an effective management of common pool resources (seemingly b/c of strong consensus on benefits of conservation) but does not guarantee its long term success; core actors have been key for social learning; subgroups bring heterogeneity to the network but also prompted "us and them" attitudes, hindering collective action; market requirements shape different types of networks (e.g., bridging vs bonding ties)
33	single point	1	organizations and landowners	collaborating about 3 types of land management activities (all types, revegetation, invasive animal control)	whole network (sampled)	configurations (star, closed, within-scale, cross-scale, scale-bridging), type of alter	No (but gives suggestions to possibly improve network structure)	all: coordination of plans and actions b/n stakeholders operating at property or subregional scale may be challenging given there are fewer within-scale interactions at these levels; reveg: coordination across scales may be difficult, although there is potential to increase bridging roles; invasive: coordination of activities is less likely to occur at the subregional level, but capacity for cross-scale coordination is strong
34	single point	1	community leaders (opinion leaders) (only 10 nodes in this first-phase study)	contact between informants that occurred at least 1x in the last 3 months	whole network	betweenness centrality, degree centrality, factions, type of alter	No	did not find that the interviewed Saraguro households plant trees on their farms more often than the Mestizo-colonos; results suggest spatial proximity in terms of access may override ethnic influences in social network terms
35	single point	>1	stakeholders relevant in context of agricultural biodiversity governance (including farmers)	regional: influencing biodiversity in the agricultural landscapes; local: influencing land-use and management decisions	whole network	degree centrality, betweenness centrality, type of alter	No (but stakeholder groups identified in the analysis were invited to subsequent workshop)	high importance of farmers can be attributed to the fact that farmers make the final land-use and management decisions that can affect biodiversity
36	two points (before/after project*)	>1	organization and agency reps involved in the projects	collaborating closely	actor level and whole network	network level: tie strength, network density, network centralization; actor level: (dyads and triads) reciprocity, transitivity	Passive - looked at relationships before and after project implementation	network B: project led to higher cohesion of a formerly quite heterogeneous and loosely connected actors at local level, project intensified and stabilized the interactions and strengthened ties b/n some sectors; network T: core group of actors already highly cohesive before project started but overall has become denser, strengthened ties b/n govt levels
37	single point	>1	individuals involved in spp management (members of recovery teams or directly involved in recovery of the spp)	stakeholder interaction (e.g., communication, meetings, field days; including frequency and strength)	whole network	centrality, density, reachability, betweenness centrality, # of components, network size, mean geodesic distance, centralization	No	networks varied substantially, from sparse and small to large and complex; presence of a recovery team within a network provided focus, encouraged coordination of actions and facilitated the flow of information within the network and beyond
38	single point	1	herders	sharing information important for livelihood and resources (to get at trust)	combined egocentric networks	reach centrality (closeness), brokerage, betweenness centrality, network density, type of alter	Not measured (post-implementation of CBNRM program)	shows trust and cooperation exist but not necessarily within the communities that the CBNRM projects are trying to create (thus the project-created ones are not likely to persist)
39	single point	>1	farmers (who practice agroforestry)	seeking advice about farm practices and management	whole network	density, degree centrality, closeness centrality, betweenness centrality, type of alter	No	relatively small, dense group of farmers was sought by the larger farming community for advice on farming practices; core members may act as bridging links to outside sources; both farmer-derived and formal sources of info flowed from farmer to farmer via informal network ties

40 single point	ego	producers and staff at agro-orgs + alters	accessing information	egocentric network (bounded to one step from interviewee)	network size, density, efficiency (based on type of alter)	No	suggests that individuals in open networks with few redundant ties are more likely to adopt agroforestry practices
41 single point	>1	farmers (one with an active farm who also plays a role in decision-making for farm management) + alters	seeking and exchanging information on agricultural practices	whole network	ego level: network size (ave. degree), betweenness, brokerage roles, type of alter; aggregated level: ties within/between groups	No	migrant farmers are well positioned to exchange information across settlement categories in the network and presumably act as influential forces for the diffusion of agroecosystem management practices
42 two points (one year apart) for the 40 initial egos	ego	producers (a resident with an active farm)	seek and exchange information on land and agricultural management practices	egocentric networks	outdegree, indegree, type of alter, two-step out-neighborhood, two-step in-neighborhood	No	an individuals' # of ties to institutions was positively related to their diversity of land use types & tree cover; producers with a higher # of institutional exchange partners tended to have higher diversity of land types; at the micro-scale, network dynamics are significantly related to land transformation; both direct and indirect connections to information exchange partners matter
43 single point	>1	stakeholders in 4 sectors (forestry, reindeer husbandry, tourism, environ'l protection) and authorities	interacting with different groups and actors	combined egocentric networks	density, degree centrality, cross-level interactions, type of alter	No (but shows how "model forest" can act as a bridge)	there exists a disconnect between some sectors, such as reindeer husbandry and others (forestry, authorities) in one municipality and forestry and tourism in the other; some actors play important bridging roles
44 single point	ego	private forest owners	communicating to or getting information about land management	egocentric network	network size (total contacts and just influentials), composition (type of alter)	No	network sizes vary widely among individuals, with smaller subset of influentials; influentials tend to be peer landowners, "local" sources of knowledge, and professionals, rather than relatives, friends, and neighbors; decision satisfaction higher for easement holders than timber harvesters
45 single point	ego	private forest owners (MFL enrollees and non-enrollees)	communicating to or getting information about land management	egocentric network	network size (total contacts and just influentials), network heterogeneity (based on type of alter), tie strength	No	both forestry experts and peers were important in networks; composition, size, and heterogeneity of the landowners' networks were associated with the application of BMPs for water quality as well as the landowners' experience with the process; presence of more forestry experts in networks was associated with higher BMP application ratings; suggests larger and more diverse network is not necessarily better
46 two points (1989, 2006)	1	reps of organisations that were officially involved in entrapment decision-making processes	communicating about a whale entrapment (formal and informal)	whole network	density, network centralization, eigenvector centrality, network size (asked about tie strength but doesn't seem to be used in analysis)	Passive - looked at relationships before and after project implementation	network size and level of connectivity b/n individuals increased from 1989 to 2006; members of lower level orgs became more influential and more likely to share info; increased communication went along with a more equitable distribution of decision making
47 single point (but 2 points for harvest data)	ego	members of deer cooperatives	socializing	egocentric network	number of alters and index of alters' harvest count (to get a "network influence covariate"), cliques, connectivity	No	offers some evidence that peer influence (i.e., egocentric networks) in deer cooperatives affect individual members' doe harvest behaviors
48 single point	1	2 types: organizations that affect and are affected by the water system; position in the	3 types: collaborating /coordinating, transferring resources,	whole network (two-mode)	whole network: size, density, centralization, cohesion; actor level: degree centrality,	No	water governance operated as a hybrid system, functioned through an institutional hierarchy with a mostly de-concentrated administrative scheme that fragmented as scale decreased; creative efforts of local leaders led to some positive governing

49 single point	>1	water system [not clearly described in text] farmers and community agents	exchanging info and knowledge obtaining agricultural information, consultation, and/or resources	whole network (per site)	betweenness centrality, type of alter betweenness centrality, average degree, type of alter	Yes (not before/ after testing, but collected SN data then brought the actors together in workshops to discuss findings)	outcomes, but there are some negative outcomes re: rural development introduction of SNA improved participatory research by building legitimacy for determining who participates, discouraging participatory attrition, & providing a meaningful forum for participation; thus SNA has promise for improving processes of participatory technology development in agriculture
50 single point	>1	managers and/or owners of protected areas	socioeconomic interactions	whole network	eigenvector centrality, network density, modularity, reciprocity, network diameter, network size (reported)	No	geographic proximity matters more than organizational membership in the formation of socioeconomic interactions; provincial and national PAs play important roles in the resilience of the EC and WC networks respectively while private PAs had minimal influence; metric results suggest redundant pathways for info flow (thus resilient)
51 single point	1	managers and/or owners of protected areas	interacting with other protected area managers (for economic or collaborative aspects)	whole network (sampled)	network density, transitivity, network diameter, path length, reciprocity, mean network degree, modularity, type of alter, network size (reported)	No (but gives suggestions to possibly improve network structure)	spatial arrangement of private areas influences clustering and mutual exchanges b/n managers; private areas appear to function as distinct subgroup within the broader conservation domain, with little overall coordination in their management objectives and fewer collaborative interactions
52 single point	1	plant collectors (Bushmen, ≠Khomani, other ethnicities)	2 types: acquiring knowledge of and discussing important matters (knowledge generation) about plant harvesting	entire network, subgroups, individual level	network: density, average degree, number of components (dyads, triads, clusters), fragmentation; subgroup: E-I index, cross-boundary exchange; individual: "key players", type of alter, network size (reported)	No (but gives suggestions to possibly improve network structure)	higher proportions of ties within groups than b/n them affects joint action due to poor exchange of info and knowledge; low levels of ties among actors, higher fragmentation, and overall low cohesiveness hampers opportunities for collective action and knowledge development; individual characteristics, such as gender and length of residence in the area, affect the acquisition and generation of plant knowledge
53 single point	>1	farmers	receiving information or advice about farming practices	actor level and whole network	number of links within and between groups (at household level), mean number of links within and between (collective level), reciprocity, type of alter	No	results support theories that communities of resource users need both internal and external links for sustainable environmental management; at the group level, reciprocal intra-group relationships seem to be a prerequisite for the widespread adoption of recommended practices
54 two points	1	households	receiving information or advice about farming practices	whole network	ensity, outdegree, reciprocity, three-cycles, transitivity, betweenness, double two-step paths, ties within vs between groups, type of alter	Active - donation of mobile phones to randomly selected households ("test whether [it] can support social learning")	extension agents were able to directly raise individual farmers' awareness of composting faster than information diffusion through the cliquish farmer-to-farmer learning network, but informal sharing among peers regarding experiences with the practice contributed to the actual change in farmers' habits; found evidence of behavioral influence spreading through the learning network; authors discuss possible interventions specific to the village
55 single point	>1	fishers who use traps (active trap fishing captains)	fishing with, and information exchange about fishing (weighted, undirected)	whole network	closeness centrality, betweenness centrality, degree centrality, eigenvector centrality, network size (reported), average degree (reported)	No (but method can help with stakeholder selection)	findings suggest that diverging from current strategies used to identify key players could produce more effective results; implementation of cons goals is highly context specific and cannot be generalized, thus inclusion and/or exclusion of certain stakeholders can and should be tailored to the specific conservation goal at hand

56 single point	>1	whale network: whaling captains; polar bear network: polar bear hunters (for subsistence); both: govt agencies	2 types: required harvest reporting (formal), seeking advice or information on harvest-related rules (informal)	whole network	density, degree centrality, type of alter, network size	No	co-management strategy of nested institutions with high levels of power-sharing (as with whaling) results in networks that regularly discuss issues and reinforce social norms (i.e., harvest reporting); polar bear hunters self-organize towards a central actor but neither that actor nor other local actors have authority for the reporting program, thus resulting in a network with lower social fit than the whaling network (based on congruence)
57 single point	1	not-for-profit, non-government conservation organizations (including direct and indirect action, see supp material)	working with (based on supp material)	whole network	configurations (openness and closure), reciprocity, type of alter, network size (reported)	No (but gives suggestions to possibly improve network structure)	significant over-representation of open-out-star configurations suggests a strong innovative capacity within the orangutan conservation sector; tendency for collaboration to occur b/n orgs performing capacity building roles and those undertaking direct action; levels of trust are not equally distributed b/n orgs
58 single point	1	affiliations of stakeholders (managers, researchers, citizenry, commercial and recreational fishing reps)	report to, collaborate or work with (formal); communicate with (informal)	whole network* (two-mode)	degree centrality, betweenness centrality, type of alter, network size (reported)	No	many respondents share formal/informal relationships with the same orgs and many orgs also share relationships with the same decision and policy makers; network size suggests many opportunities for information flow, but could also be a hindrance (e.g., conflict among groups)
59 single point	1	staff at organizations and universities + alters	3 types: exchanging information for advice and support, influencing policy, or implementation	whole network	network size, edge connectivity, density, mean geodesic distance, actor degree, eigenvector centrality, betweenness centrality, tie strength, type of alter	No (but results can provide guidance)	results show the importance of an international NGO in conservation activities, and the importance of few individuals within the NGO; reliance on a few individuals can help bind various groups but reduces network robustness
60 single point	1	stakeholders directly or indirectly influencing water mngmnt, sources, or flows (e.g., local user groups, universities, businesses, govt)	information exchange and knowledge transfer, or provision of tangible resources related to water resources mngmnt	whole network	tie strength, degree centrality, betweenness centrality, eigenvector centrality, density, E-I index, connectedness index, type of alter; reported- network size, density, network centralization, average distance	No	network is cohesive but w/ low level of interaction & association (low density), which could negatively affect flow of info & mobilization of resources; many weak ties could limit collaboration; not much homophily in network; identified possibly influential stakeholders
61 single point	1	individuals and organizations	2 types: general (seems to be any professional interaction), communication (w/in last 12 months)	whole network	reciprocity, network density, degree centrality, betweenness centrality, closeness centrality, eigenvector centrality	No (but gives suggestions to possibly improve network structure)	results revealed low density, high non-reciprocity, and high centrality among a few stakeholders in the network suggesting a non-cohesive network
62 single point	>1	stakeholders involved in the forest planning process	grant expenditure, implementing projects, providing services	whole network	network density, betweenness centrality, regular equivalence (blocks), tie strength	No (but method can help with stakeholder selection)	consideration of regular equivalence of the stakeholders and their personal capacity to diffuse the information and knowledge can help to balance number of stakeholders to involve in the future decision-making process
63 single point	1	stakeholders (institutions, organizations, associations)	professional relationship in the field of forest planning and management	whole network	indegree centrality, outdegree centrality, degree centrality, tie strength (but not clear how it was used in the analysis)	No	centralized network has advantage of rapidity and ease in decision-making and possibility to manage forests with a homogenous approach, but main disadvantage is the risk of low participation in decision-making and of de-empowerment of other stakeholders;

64 single point	>1	park managers	report/share issues regarding the park; most important authority	whole network	centre of gravity (CG), MaxS, compactness, network size	No (but gives suggestions to possibly improve network structure)	analysis of perceived influence vs real power could help decision makers better understand stakeholders' behavior networks having lower CG render greater satisfaction to the park keepers, owing to better communication b/n highest and lowest network levels; parks having stronger leadership (high MaxS) are able to meet visitor expectations for park development; compactness is helpful in providing a better-maintained park where visitors are more aware of their surroundings
65 single point	1	stakeholders in a conservation initiative (govt, orgs, First Nations, industry, private consultants, etc)	2 types: sharing information and collaborating in various phases of the initiative	actor level and whole network	network: size, density, centralization (including in- and out-degree); actor: degree centrality (including in- and out-degree), tie strength	No (but results can provide guidance for subsequent phases of project)	power manifested in the central position of the provincial government agency, the absence and under-representation of some stakeholder groups, and control of access to information from monitoring by government, which may inhibit prospects for collaboration; despite the network being fragmented, a group of strongly connected participants exist, which may enable future collaboration
66 single point	1	members of a partnership	communicating about upland management issues	whole network	betweenness centrality, degree centrality, structural equivalence, type of alter, network size (reported), tie strength (does not seem to be part of analysis)	No (but changed stakeholder selection based on 1st approach and group feedback)	2nd approach was an attempt to balance marginal actors with central ones and to optimise diversity in stakeholder categories; new proposed combination of participants (from 2nd approach) were more likely to be able to learn from each other
67 single point	1	stakeholders (groups and organizations), those who work, live, and play in the park	communicating about upland management issues	whole network	density, centralization, degree centrality, betweenness centrality, tie strength, network size (reported)	No (but results can inform future selection of stakeholders)	weak ties perform bridging roles and are needed to keep the network fully connected, but also suggests potentially vulnerable areas in network; consideration of centrality and homophily can help one distinguish whether an actor is linking across similar or dissimilar others
68 single point	1	advisory committee members + alters	communicating about land management issues	whole network	tie strength, Simmelian ties, type of alter, network size (reported)	No (but method can help with stakeholder selection)	supports argument that similarity in views coincides with the presence of social ties (informal) and presence of higher order dense structures (e.g., Simmelian ties); informal structures have greater influence on what stakeholders perceive than formal
69 single point	>1	fishers	obtaining trustworthy info on the status and location of fish	whole network	degree centrality, Bonacich's power-based centrality, network size (reported)	No (but method can help with stakeholder selection)	individual attributes not reliable indicators of fisher's capacity to spread ideas and influence adoption; but while well-connected individuals may have capacity to spread ideas, they may not be motivated to participate in conservation initiatives, therefore can't focus solely on centrality measures
70 single point	1	2 types: municipalities, bridging organizations (government orgs and NGOs)	collaborating about water quality management	whole network (one- and two-mode)*	network size, direct and indirect ties, type of alter	No (but gives suggestions to possibly improve network structure)	agricultural areas were less connected and less engaged in activities to improve water; bridging orgs are failing to bridge the agricultural-tourism divide, but rather they are connecting similar municipalities to one another; bridging orgs work the least with agri municipalities (who pollute water); differences in collaboration are related to differences in water management
71 single point	ego	private forest owners (members of a cooperative)	seeking information when making land management decisions	egocentric network	network size, type of alters, tie strength (based on trustworthiness)	No	data suggest that members are most reliant on professional perspectives in managing their woodlands; the cooperative may be reaching landowners who have no previous contact with resource professionals; weak ties (via participation in field days) may be important, but not tested in this study

72 single point	ego	private forest owners	receiving forest-related information	egocentric network	network size, network diversity (based on type of alter)	No (but suggests making more use of peer networks)	peers and public foresters are the most helpful sources of information for these landowners; landowners appear to prefer receiving info from a variety of sources rather than from a single authoritative source; the more different perspectives or pools of knowledge to which landowners have access, the more satisfied they are with their info networks
73 single point	>1	coastal management practitioners (managers, policy makers, scientists, advocates, citizens) actively engaged in planning process	“key people” worked with during plan development	whole network	network density, network centralization, degree centrality, betweenness centrality, type of alter, network size (reported)	No (but suggests SNA can be used as self-assessment tool, implying future change)	findings suggest collaborative marine EBM planning may be shaped by a few key actors who are well-connected or influential; highlights the role that non-governmental actors can play in influencing the processes; neither govt- nor university-affiliated scientists were well-connected or influential
74 single point	>1	organizations (that influence land, water or ecosystem management in the catchment) and village leaders	collaborating with	whole network	degree centrality, betweenness centrality, density, centralization, cohesive subgroup analysis, network size, type of alter	No	network is not well integrated across spatial and administrative scales; village leadership plays key role in water governance (based on this subset of villages); village-spanning ties are b/n upstream farming and downstream pastoralists; existence of subgroups may limit collaborative processes
75 single point	1	commercial fishers	go to w/ideas for improving the fisheries and/or help with problem solving related to fisheries management and governance	whole network	degree centrality, type of alter	No (but method helps determine leaders)	this research provides empirical evidence to suggest that fisher's diverse connections to fisheries are not decoupled from, but rather integral to the facilitation and maintenance of leadership in coastal communities
76 single point	1	stakeholders (that drive strategy and planning development in the region)	interacting with in order to fulfill their role	whole network	Regular Role Equivalences, Brokerage (5 types of roles), Key Player (via reach), network size, type of alter	No	suggests relative isolation of the research community and a limited number of brokerage roles undertaken by it; scientists and key coordinating group for the program had fragile connections with the decision making community
77 single point	ego	organic farmers	communicating with other farmers and participating in agricultural meetings	egocentric networks	network size (reported), tie strength, type of alter (formal vs informal info sources)	No	results indicate that other farmers are a frequent source of info, but the info gained from them is in general not valued, relative to formal sources, as highly important for adoption of AEM
78 single point	1	people working on sustainable natural resources issues	collaborating about sustainable natural resource projects or issues	whole network (sampled)	density, degree, reciprocity, diameter, path length, betweenness centrality, E-I index, cross-boundary exchange, bridging and peripheral actors	Not measured (authors actively fostered new relationships between respondents after data collection)	within-group cohesion, across-group collaboration, bridging actors, and peripheral actors were present, but could not assess whether the amount or quality of the various characteristics were sufficient for supporting sustainable NRM
79 single point	ego	farmers (adopters and non-adopters of conservation tillage)	seeking information and advice on farming matters	egocentric networks	network size, density (integration), diversity (based on type of alter), tie strength	No	some evidence that connectedness and integration is important for understanding adoption of conservation tillage; other factors in adoption decisions also important (age, education, belief in innovation effectiveness); positive (though small) connection b/n adoption of conservation tillage and farming with a family member (other than spouse)

80 single point	1	main institutional players involved in dugong and marine turtle management	2 types: exchanging knowledge relevant to dugong and marine turtle management, affecting legislative and management decisions of other actors	whole network	network: size, density, indegree centralization, outdegree centralization; actor: indegree centrality, outdegree centrality, betweenness centrality, type of alter	No (but gives suggestions to possibly improve network structure)	knowledge network is dense but highly decentralized; knowledge producers have low to moderate direct policy influence on other actors; many groups contribute knowledge, but communication gaps b/n some groups impede collaborative management; policy network reflects a centralized, hierarchical structure with a few key government agencies maintaining most of the influence and brokerage power; discrepancy b/n knowledge and policy influence potentially reduces the system's capacity to make evidence-based management decisions
81 single point	1	Aboriginal rangers, coordinator, institutions	communication flow	whole network	pair-dependency, centrality, type of alter	No (but gives suggestions to possibly improve network structure)	Coordinator was potentially a gatekeeper, in position to control info flow thru certain communication channels in a group; thus creating non-resilient network, since the Coordinator's leaving would create a 'structural hole', greatly reducing the social capital of the rangers
82 single point	ego	farmers	maintaining frequent contact (b/n farmers)	egocentric networks	network size, type of alter (info sources)	No	suggests a low level of diffusion of information beyond IPM training beneficiaries; but also shows higher levels of diffusion of certain types of IPM-related info in communities with high levels of social capital and which were frequented by outreach agencies
83 single point	1	core stakeholders involved in Rebutia Lady's-Slipper conservation	closely relating to about Rebutia lady's-slipper conservation activities	whole network	network density, network centralization, network heterogeneity (via cross-boundary exchange), type of alter, network size (reported)	No	high bonding capital of ALC correlates with the "good" performance of monitoring, patrolling, and education (all of which ALC implements); poor bonding and bridging capital of RLSP correlates with "poor" performance of policy-making (implemented by RLSP)
84 single point	1	govt agencies, organizations (NFRP and non-NFRP)	collaborating and exchanging information	whole network	in-degree centrality, type of alter	No (but new project created links between actors)	forest regeneration project fostered ties b/n National Forest (agency) and NFRP orgs (creating social capital) but not with all non-NFRP orgs; suggests coexisting but disconnected formal network initiated by National Forest and weak voluntary network formed by non-NFRP orgs, preventing info and knowledge sharing
85 single point	>1	stakeholders	closely doing activities or exchanging information with related to the spp conservation	whole network	degree centrality, betweenness centrality, Bonacich's centrality, core-periphery, factions, type of alter, network size (reported)	No (but gives suggestions to possibly improve network structure)	SLS case includes diverse group categories & all active key stakeholders in decision-making arena, while guards & half key stakeholders are excluded in RLS case; thus SLS decision-making arena is preferable to RLS case with respect to covering diverse & key stakeholders

Appendix M. continued. In ‘Methodology’ column, asterisk indicates an intervention study. In ‘Process theme’ and ‘Process or outcome measure’ column, SO = social outcome, EO = environmental outcome. In ‘Resource ownership’, TNR = tenure not relevant.

Inductively-created categories for synthesis								
#	Methodology	Theory of change	Process theme	Process or outcome measure	Node category	Context	Resource ownership	Subset for assessing network metrics
1	description	social process	participating etc	describing the system (considered a successful transition to co-management, but authors specifically state they're not measuring an outcome)	direct	governance	government	N
2	description	social process	participating etc	describing the system	direct and indirect	governance	government	N
3	description	social process	learning	describing the system	direct and indirect	management	private	Y
4	compare across groups	environmental outcome	community (process = learning, SO = develop new etc [choice])	EO = measures of forest health and productivity (e.g., species diversity, tree counts and coverage, soil composition); SO = measure of knowledge transmission (residual agreement)	direct	management	communal	Y
5	compare across groups	social outcome	take action [choice] (process = influencing others)	SO = land management practices (BMP adoption); EO = nutrient water quality sub-index value (baseline dataset; used as a visual example of possible future assessments)	direct	management	private	Y
6	compare across groups	environmental outcome	species (process = flow, SO = take action [choice])	EO = shark bycatch rates; SO = fishing behavior (inferred, not specifically measured here)	direct	management	communal	Y
7	description	social process	participating etc	describing the system (considered to have limited potential for collaboration)	direct	management	communal	Y
8	description	social process	flow etc	describing the system	direct and indirect	management	private	Y
9	compare across groups	social outcome	develop new etc [success] (process = influencing others)	SO = qualitative assessment of perceived impacts of each bridging organization (e.g., linking stakeholders)	direct and indirect	governance	government	N
10	description	social process	influencing others	describing the system (considered to be lacking in collective action; "collective action for sustainable management has not occurred, despite strong indications of declining fisheries and inshore habitat degradation, as well as increasing awareness of these problems among many fishermen and women"	direct	management	communal	Y
11	compare across groups	social outcome	desired condition [success] (process = participating etc)	SO = EBM assessment scores (assess to what extent the content of the management plans adhere to the principles of EBM [system thinking, specificity, and integration])	direct and indirect	governance	mix - TNR	N
12	description	social outcome	take action (but really a mix of all 3 categories) (process = participating etc)	SO = qualitative description of outputs: started forest nature management projects, conserved approximately 1000 ha, produced brochure	direct and indirect	governance	private	N
13	compare across time*	social process	participating etc	describing the system (networks existing or created before, during, and after a policy-mandated collaborative planning process)	direct and indirect	governance	mix - TNR	N
14	description	social process	flow etc	describing the system	direct and indirect	governance	mix - TNR	N
15	description	social process	participating etc (but also flow)	describing the system	direct and indirect	governance	government	N
16	compare across groups	social outcome	take action [choice] (process = participating etc)	SO = quantity of Cofos manufactured by each participant	direct	management	communal	Y
17	compare across time	social process	learning	describing the system	direct	management	private	Y

18	description	social process	participating etc	describing the system (considered to be lacking in collective action; "characterized by little collective-action to proactively conserve the resource")	direct	management	communal	Y
19	compare across groups	social outcome	develop new etc [choice] (process = flow etc)	SO = qualitative assessment of knowledge of species and ecological processes in the bay (local ecological knowledge)	direct	management	communal	Y
20	description	social process	influencing others	describing the system (considered to be lacking in collective action; "has not initiated any form of collective action to deal with documented inshore habitat degradation")	direct	governance	communal	N
21	compare across groups	social outcome	develop new etc [choice] (process = flow etc, also learning)	SO = qualitative assessment of knowledge of species and ecological processes in the bay, and qualitative assessment of collective action	direct	management	communal	Y
22	compare across groups	social process	flow etc	describing the system (looked at correlations b/n networks and responses to knowledge and value statements, but not specifically as outcomes)	direct and indirect	governance	communal	N
23	description	social process	influencing others	describing the system	direct	management	private	Y
24	compare across groups	environmental outcome	community (process = participating etc, SO = take action [choice])	EO = measures of field size (as proxy for forest exploitation); SO = farming behavior (via labor exchange)	direct	management	communal	Y
25	description	social outcome	desired condition [success] (process = participating etc)	SO = qualitative statements of "stopping small- and large-scale development" (see Table 3)	direct and indirect	governance	government	N
26	description	social process	learning	describing the system	direct and indirect	management	government	N
27	description	social process	participating etc	describing the system	direct and indirect	governance	private & government	N
28	description	social process	participating etc	describing the system	direct and indirect	governance	mix - TNR	N
29	description	social process	participating etc	describing the system	direct and indirect	management	private & government	Y
30	compare across groups	social outcome	take action [choice] (process = learning)	SO = adoption of field edge habitat plantings	direct	management	private	Y
31	compare across groups	social outcome	take action [choice] (process = learning)	SO = adoption of management practices that can support diverse pollinators	direct	management	private	Y
32	compare across time	social process	participating etc	describing the system (considered to be successful natural resource management)	direct	management	communal	Y
33	description	social process	participating etc	describing the system	direct and indirect	governance	private	N
34	compare across groups	social outcome	take action [choice] (process = influencing others)	SO = planting at least one of the listed tree species	direct	management	private	Y
35	description	social process	participating etc	describing the system	direct and indirect	governance	private	N
36	compare across time*	social process	participating etc	describing the system (networks existing before and after the implementation of park projects)	direct and indirect	governance	government	N
37	description	social process	participating etc	describing the system	direct and indirect	governance	mix - TNR	N
38	description	social process	influencing others	describing the system	direct	management	communal	Y
39	compare across groups	social outcome	develop new etc [choice] (process = learning)	SO = imitation of other farmers (binary variable) (and subsequent adoption of new practices)	direct	management	private	Y
40	compare across groups	environmental outcome	species (process = influencing others, SO = take action [choice])	EO = shade tree species richness (# of species, self-reported); SO = adoption of agroforestry practices (but estimated via ecol. measure)	direct and indirect	management	private	Y
41	description	social process	flow etc	describing the system	direct	management	private	Y

42	compare across time	environmental outcome	community (process = influencing others, SO = take action [choice])	EO = land use variables: on-ground measure of land use change (yr 1 & yr 2), # of land use types cultivated by producer (indicator of diversity), and area of land under tree cover; SO = farming behavior (inferred, not specifically measured here)	direct	management	private	Y
43	description	social process	participating etc	describing the system	direct and indirect	governance	mix - TNR	N
44	compare across groups	social outcome	take action [choice] (process = influencing others)	SO = decision (timber sale or conservation easement)	direct	management	private	Y
45	compare across groups	environmental outcome	community (process = influencing others, SO = develop new etc [choice])	EO = water quality condition assessment (i.e., ratings for BMP effectiveness at mitigating impact on water quality); SO = perceptions of harvest process & outcomes, ratings for BMP application	direct	management	private	Y
46	compare across time*	social process	participating etc (but also learning)	describing the system (networks existing before and after the implementation of park projects) (qualitative mention of "better communication and an improved capacity to solve problems" over time)	direct and indirect	governance	communal	N
47	compare across groups	social outcome	take action [choice] (process = influencing others)	SO = number of does harvested (# does harvested in year 1 by your peers influences # of does you harvest in year 2)	direct	management	communal	Y
48	description	social process	participating etc	describing the system	direct and indirect	governance	communal	N
49	description	social process	participating etc	describing the system	direct and indirect	management	private	Y
50	description	social process	flow etc	describing the system	direct	management	government	N
51	description	social process	participating etc	describing the system	direct	management	private & government	Y
52	description	social process	participating etc (but also learning)	describing the system	direct	governance	communal	N
53	compare across groups	social outcome	take action [choice] (process = learning)	SO = category of adoption of chemical and/or organic fertilizers (at household level), and proportion of farmers from each fertilizer adoption category (at collective level)	direct	management	private	Y
54	compare across time*	social outcome	take action [choice] (process = learning)	SO = use of compost; intervention = donation of mobile phones to randomly selected households (not a major focus of this study)	direct	management	private	Y
55	description	social process	influencing others	describing the system (considered unsuccessful; "little success has been made in terms of reversing resource depletion and stemming management conflicts")	direct	management	communal	Y
56	compare across groups	social outcome	desired condition [success] (process = flow etc)	SO = qualitative assessment of harvest reporting, and perceptions of policy effectiveness & legitimacy (questions of: is policy-making is fair, is it accessible to them as constituents, are the harvest reporting rules effective)	direct	governance	communal	N
57	description	social process	participating etc	describing the system (considered unsuccessful)	direct and indirect	governance	mix - TNR	N
58	description	social process	flow etc	describing the system	direct and indirect	governance	communal	N
59	description	social process	participating etc	describing the system	direct and indirect	governance	government	N
60	description	social process	flow etc	describing the system	direct and indirect	governance	mix - TNR	N
61	description	social process	participating etc	describing the system	direct and indirect	governance	mix - TNR	N
62	description	social process	participating etc	describing the system	direct and indirect	governance	mix - TNR	N
63	compare across groups	social process	influencing others	describing the system	direct and indirect	governance	mix - TNR	N

64	compare across groups	social outcome	desired condition [success] (process = flow etc)	SO = park performance indicators (for park managers - satisfaction with park management, # of problems in the parks)	direct	governance	government	N
65	description	social process	participating etc	describing the system	direct and indirect	governance	mix - TNR	N
66	description	social process	learning	describing the system	direct and indirect	governance	mix - TNR	N
67	description	social process	influencing others	describing the system	direct and indirect	governance	mix - TNR	N
68	compare across groups	social outcome	develop new etc [choice] (process = influencing others)	SO = ranking of views of five land management statements (authors argue that "similarity in views among stakeholders most likely emerge from the presence of a social tie")	direct and indirect	governance	mix - TNR	N
69	description	social process	influencing others	describing the system	direct	management	government	N
70	compare across groups	social outcome	take action [choice] (process = participating etc)	SO = implementation of water quality management activities	direct and indirect	governance	mix - TNR	N
71	description	social process	influencing others	describing the system	direct	management	private	Y
72	compare across groups	social outcome	take action [choice] (process = learning)	SO = number of management activities completed	direct	management	private	Y
73	description	social process	participating etc (also influencing others)	describing the system	direct and indirect	governance	communal	N
74	description	social process	participating etc	describing the system	direct and indirect	governance	communal	N
75	description	social process	influencing others	describing the system	direct	management	communal	Y
76	description	social process	influencing others	describing the system	direct and indirect	governance	government	N
77	compare across groups	social outcome	take action [choice] (process = influencing others)	SO = adoption of additional AEM by organic farmers (compared to contact frequency); rating of importance of information (compared to network ties)	direct	management	private	Y
78	description	social process	flow etc	describing the system	direct and indirect	governance	mix - TNR	N
79	compare across groups	social outcome	take action [choice] (process = influencing others)	SO = use of conservation tillage practices	direct	management	private	Y
80	description	social process	influencing others (but also flow)	describing the system (considered to be lacking in coordination among actors)	direct and indirect	governance	government	N
81	description	social process	influencing others	describing the system	direct and indirect	management	communal	Y
82	compare across groups	social outcome	develop new etc (but also take action) [choice] (process = influencing others)	SO = measures of agro-ecological knowledge and pest management behavior	direct	management	private	Y
83	compare across groups	social outcome	desired condition [success] (process = participating etc)	SO = measure of performance (based on interviewees' assessments of conservation activities, such as monitoring or habitat improvement)	direct and indirect	governance	mix - TNR	N
84	description	social process	participating etc	describing the system	direct and indirect	governance	government	N
85	description	social process	participating etc	describing the system	direct and indirect	governance	government	N

"I haven't meant to sound so down about it, about the actual [covenant] scheme, because it's such a life-affirming thing to do. I realize I've been a bit down on it because I just get so frustrated with its function, its dysfunction. A wasted opportunity... We live in one of the most beautiful spots on the face of the planet, you know. We've worked very hard for it, we've got to work hard to keep it... and we are doing that and we love it. But it's this dysfunctional functional thing... I don't want to romanticize it, but [the land] is beautifully harsh. And so you know you're alive. You know you're alive. Sit in the suburbs and watch tv? Not for us. You know you're alive. What else do you do? It's wonderful." (L15)

The Summer Day

Who made the world?
Who made the swan, and the black bear?
Who made the grasshopper?
This grasshopper, I mean-
the one who has flung herself out of the grass,
the one who is eating sugar out of my hand,
who is moving her jaws back and forth instead of up and down-
who is gazing around with her enormous and complicated eyes.
Now she lifts her pale forearms and thoroughly washes her face.
Now she snaps her wings open, and floats away.
I don't know exactly what a prayer is.
I do know how to pay attention, how to fall down
into the grass, how to kneel down in the grass,
how to be idle and blessed, how to stroll through the fields,
which is what I have been doing all day.
Tell me, what else should I have done?
Doesn't everything die at last, and too soon?
Tell me, what is it you plan to do
with your one wild and precious life?

—Mary Oliver, from *New and Selected Poems*, 1992