Environmental Management (2017) 59:477–489
DOI 10.1007/s00267-016-0807-y

Landowners' Perspectives on Coordinated, Landscape-Level Invasive Species Control: The Role of Social and Ecological Context

Rebecca M. Niemiec[1] · **Roger P. Pech**[2] · **Grant L. Norbury**[3] · **Andrea E. Byrom**[2]

Received: 2 May 2016 / Accepted: 19 December 2016 / Published online: 11 January 2017
© Springer Science+Business Media New York 2016

Abstract To achieve biodiversity gains, landowner engagement in coordinated invasive species control programs across private lands is needed. Understanding landowners' perspectives toward such coordinated control efforts is crucial to facilitating engagement. We conducted in person and mail surveys of 68 landowners in and adjacent to the area of a proposed invasive predator control program in New Zealand. We find that, similar to previous studies, landowners consider the potential socioeconomic and ecological benefits of invasive species control and express a strong desire to enhance native biodiversity. However, we also find that landowners take into account the complexity of the local social and ecological context in which a program will unfold in three ways: they consider (1) the level of contribution by other landowners and urban residents who are benefiting from collective control efforts; (2) the potential for the program to upset the local "ecological balance", leading to increases in other pests; and (3) the probability that the program will be successful given the likelihood of others participating and control tactics being effective. We suggest that managers of coordinated invasive species control efforts may benefit from devoting time and resources toward addressing beliefs about social and ecological context, rather than solely providing financial subsidies and information about control tactics or the impacts of invasive species.

Keywords Invasive species · Collective action · New Zealand · Private lands conservation

Introduction

Successfully combatting invasive species' impacts often requires the coordinated actions of diverse private and public landowners (Fiege 2005; Graham 2013; Klepeis et al. 2009). Facilitating these actions is particularly important as conservation efforts seek to enhance native biodiversity and the provisioning of ecosystem services at a landscape scale, i.e., at a scale that potentially includes private properties and public land with multiple land uses and types of habitat (Russell et al. 2015; Stokes et al. 2006). The recent Predator-Free New Zealand conservation movement, for example, has the goal of enhancing the nation's native biodiversity by engaging both private and public landowners in efforts to achieve widespread reductions in invasive rat (*Rattus* spp.), stoat (*Mustela erminea*), ferret (*M. furo*), and feral cat (*Felis catus*) populations throughout the country (Russell et al. 2015).

To achieve landscape-scale coordination of invasive species control, private landowners must be motivated to engage in control actions on their property (Graham 2013; Hershdorfer et al. 2007). To motivate such engagement, natural resource management agencies or organizations have often provided incentives such as subsidies for control supplies, education about invasive species impacts, and information about how to conduct invasive species control (Hershdorfer et al. 2007; McLeod et al. 2015). However, efforts to engage landowners are often limited in their effectiveness, evidenced by the fact that invasive species continue to plague landscapes despite widespread education and outreach initiatives (Aslan et al. 2009; Graham 2013).

✉ Rebecca M. Niemiec
rniemiec@stanford.edu

[1] Emmett Interdisciplinary Program in Environment and Resources, Stanford University, Stanford, CA, USA

[2] Landcare Research, PO Box 69040, Lincoln, New Zealand

[3] Landcare Research, PO Box 282, Alexandra, New Zealand

An understanding of landowner perspectives related to proposed landscape-level invasive species control efforts is thus necessary for more effective coordination by natural resource management agencies (McLeod et al. 2015).

A nascent literature has begun to examine the human dimensions of invasive species management that may help in the design of such coordination. The majority of these studies have focused on citizens' general attitudes toward invasive species management (Bremner and Park 2007; Fisher et al. 2011; Fischer and van der Wal 2007; Sharp et al. 2011). These studies have identified a variety of factors that may influence citizens' support of management programs, including knowledge of past invasive species programs (Bremner and Park 2007), environmental attitudes (Sharp et al. 2011) or values (Estevez et al. 2014), concern with control tactics (Estevez et al. 2014; Prinbeck et al. 2011), perceptions of threat posed by invasive species (Estevez et al. 2014; Sharp et al. 2011; Selge et al. 2011), and perceived human responsibility for the spread of the species (Selge et al. 2011).

Fewer studies have examined landowners' attitudes, actions, and perspectives related to coordinated control efforts that require actions by numerous landowners on their own private property, as well as on public lands (Aslan et al. 2009; Graham 2013; Yung et al. 2015). It is possible that landowner engagement in such coordinated efforts may be influenced by a variety of factors other than knowledge of and attitudes toward invasive species, the environment, and technical aspects of control. For example, coordinated control efforts pose a collective action problem because the engagement of a critical proportion of landowners is needed to achieve landscape-scale reductions in invasive species populations (Glen et al. 2016). Failure of one landowner to control on his/her property can thus reduce the effectiveness of neighbors' efforts (Epanchin-Niell et al. 2010; Hersh dorfer et al. 2007; Yung et al. 2015). A growing interdisciplinary body of research has identified various social and cognitive factors that might influence participation in collective action (Komorita and Parks 1994; Ostrom 2000; Simpson and Willer 2014); these factors may therefore play a role in landowners' decisions to participate in coordinated control of invasive species.

Literature on the social-psychological drivers of participation in collective action suggests that participation may be influenced by perceptions of injunctive social norms, outcome expectations, and perceptions of equity. Injunctive social norms are defined as perceptions of the extent to which significant others, such as family, friends, or neighbors, expect engagement in a behavior. Injunctive norms can motivate participation by indicating the possibility of praise for engaging, or social or material sanctions for not engaging, in the collective behavior (Ostrom 2000; Simpson and Willer 2014). Several recent studies have suggested that landowners' decisions to engage in invasive species control efforts may be related to their perceptions of social norms regarding invasive species control (Howell et al. 2014; Niemiec et al. 2016; Prinbeck et al. 2011).

The collective action literature also suggests that individuals may be influenced by their outcome expectations regarding the collective good, which encompass both self and collective efficacy. Collective efficacy refers to the belief that a group will achieve the collective outcome, while self-efficacy refers to the belief that one's own personal actions will have an effect on the eventual outcome (Bandura 1998; Chen 2015; Komorita and Parks 1994). Furthermore, research on the "sucker" effect suggests that individuals might be influenced by perceptions of equity and fairness among the group in achieving the collective outcome; in particular, individuals may feel demotivated to contribute if they feel that the burden of providing the collective good is not being shared equally among group members (Barr et al. 2011; Jackson and Harkins 1985; Kerr 1983). These collective influences may be important for coordinated control programs.

In our study, we sought to gain a more in-depth understanding of landowners' perspectives toward proposed coordinated efforts to control invasive mammalian predators across both private and public lands in the Hawke's Bay Region, New Zealand. We focus on Hawke's Bay as a case study because of the emergence of the recent Cape-to-City (C2C) program (http://capetocity.co.nz) in the region, which seeks to achieve reductions in invasive rats (*Rattus rattus*, *R. exulans*, and *R. norvegicus*), stoats, ferrets, and cats across 26,000 ha of private and public lands linking an eco-sanctuary on the Cape Kidnappers peninsula to the city of Hastings (population 73,000), just south of the city of Napier (population 52,000). The C2C program is a partnership between local government agencies, non-profit organizations, research institutions, and landowners, and if successful, will serve as a blueprint for the burgeoning Predator-Free New Zealand movement (Russell et al. 2015).

By examining landowners' perspectives on a proposed coordinated predator control program in New Zealand, our study also builds on the growing literature on citizen perspectives toward biodiversity conservation and invasive species in that country (Ginn 2016; Potts 2009; Seabrook-Davison and Brunton 2014). Previous literature has suggested that a love of nature is part of the New Zealand national identity (Ginn 2016; Russell et al. 2015); this love of nature has translated into significant government investment and public support for conservation and invasive species control (Seabrook-Davison and Brunton 2014). For example, New Zealand currently invests $200 million a year into the most comprehensive and integrated biosecurity system in the world, which seeks to prevent potential invasive species from coming into the country and manage

those already in the country (Barker 2010; Ginn 2016). Furthermore, previous literature has suggested that New Zealand citizens are generally aware of the threat posed by invasive predators to their native species and are supportive of efforts to control invasives to benefit native species (Russell 2014; Seabrook-Davison and Brunton 2014). However, despite this strong conservation ethic, Russell et al. (2015) identify several potential social barriers to achieving a Predator-Free New Zealand including public concern over the use of toxins for invasive mammal control and the appropriate form of management for pet and stray cats. Gaining a further understanding of these and other potential barriers to effective implementation of coordinated predator control programs on private lands is thus essential for maximizing landowner engagement.

Our study used a mixed methods approach to assess current landowner perspectives that might affect successful implementation of C2C and to serve as a benchmark for tracking changes in landowner perspectives as C2C evolves. We examine two related questions: What are prevailing beliefs, attitudes, and management practices related to invasive predator control among landowners in the region? What do landowners identify as the benefits and challenges associated with the proposed C2C program?

Case Study: Predator Control in the C2C Region of New Zealand

The area selected for the C2C project in New Zealand is a rural region in the Hawke's Bay, on the east coast of the North Island of New Zealand, consisting of 163 properties with a diversity of land uses. The area includes sheep and cattle farms, orchards, vineyards, and residential "lifestyle" properties bordering on the Hastings urban area (the "City" part of C2C). The area also includes remnant native vegetation, exotic timber plantations, and public reserves. Coordinated invasive species control efforts have been occurring in the area since 1991 in the form of the Possum Control Area (PCA) program, which seeks to achieve reductions in brushtail possum (*Trichosurus vulpecula*) populations across more than half a million hectares of private land. The brushtail possum is an invasive species that is an important wildlife vector for bovine tuberculosis as well as a direct threat to native biota due to herbivory and predation (Cowan 2005).

The PCA program in the C2C region is run by the Hawke's Bay Regional Council (HBRC), one of eleven regional councils in New Zealand that were created under the Local Government Act 1974. Regional councils were established to promote sustainable development and enhance the social, economic, environmental, and cultural well-being of communities. Regional councils are primarily responsible for environmental management, including the development of Regional Pest Management Strategies (RPMSs), under the Biosecurity Act 1993.

The PCA program was first developed in Hawke's Bay when a group of farmers at Omakere organized and worked with HBRC to coordinate possum control efforts due to their collective concerns about increasing possum populations. Under the RPMS, HBRC developed the PCA program, which provides subsidies to reduce costs of possum control for landowners once 75% of landowners (in terms of area) have agreed to participate. The council determines the boundaries of a PCA based on natural boundaries, or borders of existing possum control operations, and conducts initial knockdown control of possums. Once a PCA is established, landowners within the area are then bound to the conditions of the PCA, which means that they must continue to carry out control to maintain possum levels at a Residual Trap Catch of below 5% of the original possum population abundance. The PCA program therefore builds on community organization by providing skills, subsidies, and mandates to enhance the effectiveness of landowner control efforts across private lands. The program is strongly supported by landowners due to possums being vectors of bovine tuberculosis and feeding on productive pasture that could otherwise provide forage for livestock (Greer 2006).

While the PCA program has served as a successful model for enhancing possum control across private lands in New Zealand, the program has not yet been expanded to include other damaging invasive predators, such as stoats, ferrets, and feral cats, as is being planned for the C2C region. These species depredate native fauna and cats are vectors of toxoplasmosis, which can cause abortions in sheep (*Ovis aries*). The C2C program seeks to use a similar structure to the PCA program; specifically, if the majority of landowners in terms of area agree to the program, the council will employ pest control contractors to conduct initial knock-down control of invasive predators across private lands at no cost to landowners. Then, landowners will be asked to continue maintenance control of predators on their property, either themselves or by hiring a contractor at a subsidized rate.

Although disease transmission by possums and feral cats can affect the profitability of livestock production, most landowners do not have an economic incentive for controlling other invasive predators. The success of the C2C program will therefore depend on landowners' attitudes and beliefs regarding invasive predator control to protect native fauna, and the possibilities for such attitudes and beliefs being changed through targeted educational efforts or leveraged to enhance landowner engagement.

Methods

We delivered 300 surveys to all landowners and land managers in the proposed C2C area and within an adjacent

15-km buffer zone. Surveys were delivered and completed before any predator control efforts as part of the C2C program had begun. Three weeks after the initial mailing of the survey, we followed up with a reminder letter to enhance response rate (Dillman 2007). Respondents within the buffer zone were included for two reasons: first, these data were collected as part of a larger research study, which has the goal of examining how participation in the C2C program may affect attitudes toward invasive species and native flora and fauna over time. Therefore, those outside the C2C area could eventually provide a control group to compare attitudes with those inside the area. Second, if the program is successful, properties in the buffer zone may be the next step in expansion of the program; the perspectives of these landowners are therefore important in designing future programs. Because we sought to understand landowners' baseline perspectives toward the program before it began, we first conducted *t*-tests to confirm that there were no significant demographic differences between the two groups, then combined them and analyzed all responses together.

In designing the survey, we used a combination of qualitative, open-ended questions about landowner perspectives toward the C2C program, as well as quantitative closed-ended questions related to predator control. Closed-ended survey questions were developed from previous literature on citizen attitudes and beliefs toward invasive species and the broader literature on environmental behavior (Ajzan and Fishbein 1980; Corbett 2002; Howell et al. 2014; Hu and Gill 2015; Prinbeck et al. 2011).

Based on previous literature on the human dimensions of invasive species control (Howell et al. 2014; Hu and Gill 2015; Prinbeck et al. 2011), we included questions on landowners' attitudes toward predator control and the outcomes of predator control, their perceptions of social norms regarding predator control, and their perceived behavioral control related to predator control, which is defined as the perceived ease or difficulty of engaging in the behavior. We also included several questions related to the perceived unintended consequences of predator control, which we identified as potentially important factors influencing landowner decision-making from prior conversations with key community leaders and HBRC staff. These included perceptions that: (1) pets would be harmed in a widespread predator control program, and (2) control of stoats, ferrets, and feral cats would result in greater numbers of rabbits (*Oryctolagus cuniculus*), which are an agricultural pest. This last concern has been highlighted as a potentially prevalent barrier to rural landowners engaging in predator control in New Zealand (Norbury and Jones 2015).

Building on the collective action literature, we asked landowners questions related to their perceptions of self-efficacy and collective efficacy regarding predator control (Corbett 2002). We included questions about landowners' emotional connections to biodiversity, given McLeod et al.'s (2015) suggestion that emotional drivers may play an important role in invasive species management decisions and Drescher's (2014) finding that rural landowners often have strong emotional ties to their local environment. We also asked landowners about their current actions related to predator control, which predators they thought were most important to control, and which predators they thought were abundant on their property. Finally, we asked landowners about their experience with, and perceived effectiveness of, the PCA program, as we anticipated that their experience with past possum control efforts may influence their likelihood of engaging in the predator control program. We provide descriptive results of the prevalence of these beliefs and attitudes throughout the surveyed population.

We asked open-ended questions to prompt landowners to discuss their perspectives of, including the benefits and challenges associated with, the proposed C2C program. The questions included: "What do you think is the value, if anything, of widespread predator control efforts through C2C?"; "What do you think are some of the challenges, if anything, of conducting widespread predator control efforts in the region?"; and "What are your suggestions for improving predator control in the region?". Because this research was exploratory in nature, the open-ended questions allowed us to examine which factors landowners reported were most important to their decision-making and enabled us to explore in greater depth the nuances of landowners' perspectives toward coordinated control efforts. During in-person surveys, follow-up questions were asked to gain a more in-depth understanding of landowner responses. All interviews were transcribed verbatim.

Analysis of interviews and responses to open-ended questions took place in multiple iterative stages (Lofland and Lofland 1995). First, we read through all transcripts and responses to open-ended survey questions and assigned distinct data units, such as phrases, sentences, or exchanges, to a priori codes related to landowner decision-making. As a priori codes, we included the same theoretical constructs as covered by the closed-ended questions, including beliefs related to the unintended impact of the program on domestic pets and wild (invasive) rabbits and emotional connections to native biodiversity. We also included a priori codes related to social-psychological theories of collective action, including concerns about equity in contributions, as we hypothesized that landowners may be influenced by the need for collective action to control invasive species.

In the second stage of analysis, we iteratively developed emergent secondary and tertiary codes within these a priori codes to understand the nuances of perspectives related to each theoretical construct. For example, within the a priori code of equity in contributions, we found that landowners

cared about the contributions of both urban residents and of other landowners with regard to predator control. We assigned names to the emergent secondary and tertiary codes to ensure consistency in assigning data. We used NVivo (QSR International) for all coding and analysis of qualitative responses.

Results

Twenty-eight surveys were completed inside the C2C area and 40 were returned from the surrounding areas. This was an overall response rate of 23%, which is within the range of previous mail surveys about residents' attitudes toward invasive species control (Hu and Gill 2015). Nine of the 68 surveys were completed in person with the first author, 7 of which were inside the C2C area. In-person interviews lasted 25–60 min.

In the following sections, we first review the characteristics of the landowners surveyed and discuss the prevalence of various attitudes, beliefs, and current management practices associated with invasive predators among respondents. We then discuss findings from open-ended questions about the perceived value of and challenges associated with the proposed coordinated predator control program. In particular, we find that while landowners were supportive of a coordinated control program, particularly because of their strong emotional connections to native biodiversity, landowners also considered how the program may interact with their nuanced understandings of the local social and ecological context.

Landowner Characteristics

The majority of survey respondents (51) identified themselves as both landowners and land managers; 13 reported that they were landowners not involved in day-to-day management, and 4 reported they were land managers who do not own the land. Many of the respondents were sheep and beef farmers: 77% of survey respondents said that they had sheep farming on their land, 75% had beef farming on their land, 35% had forestry on their land, and 22% claimed to be lifestyle block owners. The sample of sheep and beef farmers represented a disproportionately high area compared with the entire C2C area and the Hawke's Bay region: sheep and beef farmers accounted for 96% of the total hectares reported by survey respondents, compared with 86% of total hectares in the C2C region and 47% in the greater Hawke's Bay Region. The sample also included a greater proportion of forestry blocks in terms of area: respondents with forestry blocks accounted for 27% of the total area reported by survey respondents, compared with approximately 9% of total hectares in the C2C area and 10% in the greater Hawke's Bay Region. Other land uses of survey respondents included deer farming, fruit production, vegetable production, and preserving native vegetation. Most (84.6%) respondents lived on their property full time and had lived on their property for many years: the average time living on or managing the property was 27 years.

The average property size of survey respondents was 518 ha, larger than the average property size in the entire C2C area (189 ha). Twenty-five percent of our sample included small lifestyle block owners, or owners of properties of less than 25 ha, compared with 36% in the C2C area. Property sizes ranged from less than 5 ha to over 800 ha, which closely captured the full range of property sizes in the C2C area.

The median age of survey respondents was 60, which was higher than the median age of 40.6 for the greater Hawke's Bay Region (as provided through New Zealand census data in 2013). Respondents were mostly male (83.3%) and were highly educated: 27% of respondents had completed a bachelor's degree or higher, compared with 13.7% of people in the Hawke's Bay Region. There were no significant demographic differences between landowners within and outside the C2C footprint.

Current Attitudes and Practices Related to Mammalian Predators

Survey respondents generally felt that stoats, ferrets, and feral cats posed a significant threat to native birds and other animals, and reported that they would like to see a return in native birds and other fauna (Fig. 1). About half of the respondents believed that feral cats posed an economic threat to farmers in the region, while less than half believed that feral cats posed an economic threat to their own livelihoods (Fig. 1).

Despite the widespread recognition that stoats, ferrets, and feral cats were a problem, only half of the respondents reported that they were currently engaging in efforts to control predators other than possums on their property (Table 1). The majority of respondents reported that their current efforts were limited to controlling predators around their household, with only 11 respondents claiming to control one or more of the predators on most or all of their property. In interviews, multiple respondents spoke about how their current predator control involves shooting a predator when they see one on their property. Only 18 respondents (26%) reported that they would be very or extremely likely to control predators on their property without the C2C program.

Respondents spoke about the need for the C2C program because they felt that if they tried to engage in predator control now, their efforts would make little difference to

biodiversity and other outcomes of interest without widespread commitment from other landowners. As one respondent said: "We could sit here killing the possums all we want to but if no one else was doing it, we just get more, wouldn't we?". There was a clear understanding of the need for a coordinated approach to ensure that desired outcomes, such as biodiversity conservation and reduction in toxoplasmosis, could be achieved.

While respondents recognized that widespread participation is needed to achieve positive economic and ecological outcomes, they did not believe predator control was currently widespread throughout the C2C area; for example, only approximately 30% of respondents moderately or strongly agreed with the statement that most landowners they knew were involved in predator control efforts on their property (Fig. 1). There appeared to be little social pressure

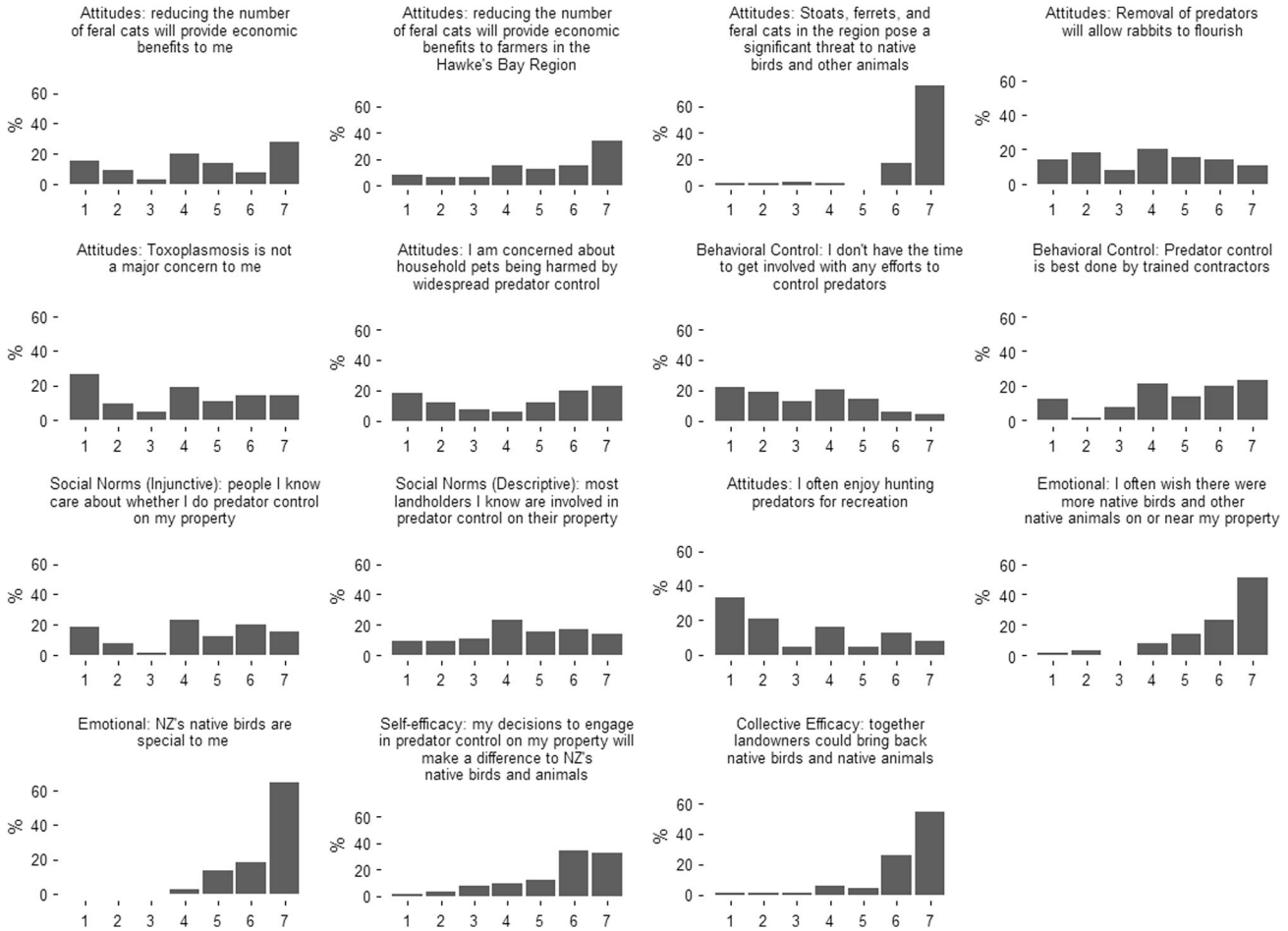

Fig. 1 Percentage of survey respondents who agreed or disagreed with statements about invasive mammalian predators (Likert scale in which 1 = strongly disagree, 2 = moderately disagree, 3 = slightly disagree, 4 = neither agree nor disagree, 5 = slightly agree, 6 = moderately agree, 7 = strongly agree)

Table 1 Number of survey respondents (out of $n = 68$) who: (a) believe that each predator is present on their property; (b) believe the predator to be one of the three most important species to control; and (c) are currently controlling the predator on their property

Mammalian predator	# Respondents who believe it to be on their property	# Respondents believing it to be one of the three most important to manage	# Respondents controlling it on their property
Rats	60	38	52
Mice	54	2	43
Hedgehogs	54	2	6
Ferrets	45	37	14
Stoats	45	50	15
Feral cats	59	57	27

on landowners to control predators, because less than 30% of respondents moderately or strongly agreed with the statement that others cared whether they engaged in predator control efforts on their property.

Other potential reasons for the current low levels of engagement were beliefs regarding the difficulty of controlling predators. Almost half of the survey respondents felt that predator control was best done by trained contractors, a perception that may be preventing respondents from engaging in control themselves (Fig. 1). Ten percent of survey respondents reported that they did not have the time to engage in predator control. As one respondent said: "if anyone should be doing predator control it should be us, but we just don't have … the time and technology to do it. It would be easier to pay someone else to do it".

Survey respondents believed that stoats (75%) and feral cats (85%) were the most important predators to control, followed by rats (57%) and ferrets (55%). Interestingly, rats and mice (*Mus musculus*) were the most commonly controlled predators other than possums, even though feral cats and stoats were seen as the most problematic (Table 1). This may have been due to the general perception of rats being a household nuisance or the perception that rats were relatively easy to manage compared with stoats or feral cats. One respondent said, "We are struggling with the stoats … we have expensive traps that don't seem to work. The subsidy did help". Another said: "I've heard cats are more difficult to catch". Alternatively, some respondents appeared to believe that stoats especially were not very abundant on their property (Table 1), which could be limiting their dedication to current control efforts.

Support for and Perceived Value of the C2C Program

Respondents were generally very supportive of, and willing to engage in, the C2C program; 87% of respondents reported that they would be very or extremely likely to participate in the initial knockdown for the C2C program (Fig. 2). Around half of the participants reported they would be very or extremely likely to hire a contractor to continue maintenance control on their property, and 43% of participants reported they would be very or extremely likely to continue maintenance control themselves (Fig. 2). Eighteen participants in total, and eight in the C2C footprint, reported that they would be only moderately, slightly, or not at all likely to continue maintenance control in any way after the initial knockdown. A Wilcoxon signed rank test indicated that landowners with small (<15 ha) property sizes were less likely to report being willing to hire a contractor for maintenance control than larger landowners ($z = -3.234$, $p = .0012$).

When asked about the value of conducting widespread predator control through the C2C program, respondents

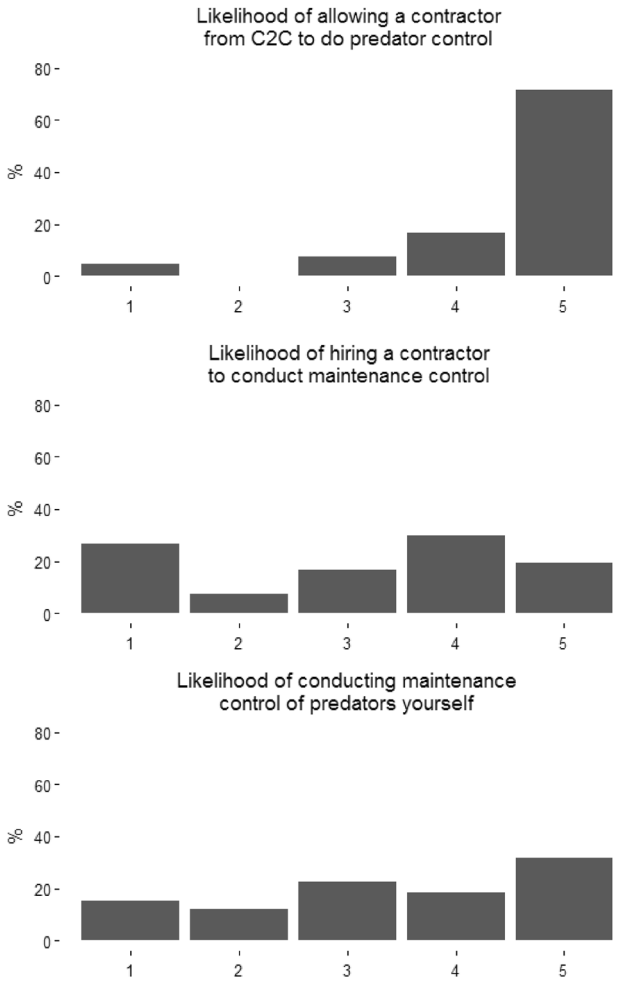

Fig. 2 Percentage of survey respondents expressing their likelihood of engaging in the C2C program by allowing a trained contractor to come on their property as part of the initial knockdown effort, hiring a contractor to continue maintenance control of predators after the initial knockdown, or conducting maintenance control themselves on their property after the initial knockdown. In the scale below, 1 = not at likely, 2 = slightly likely, 3 = moderately likely, 4 = very likely, and 5 = extremely likely

reported most often their desire to see a return in native birds and other fauna. More landowners ($n = 39$) reported the benefit to native birds than the economic benefits through a reduction in toxoplasmosis and other livestock diseases ($n = 19$) when asked their perceived value of C2C program. In addition, more than three quarters of landowners surveyed moderately or strongly agreed with statements that native birds were special to them and that they would like to see more of them, suggesting landowners have strong emotional connections to native biodiversity (Fig. 1). As would be expected given that cats are a vector of toxoplasmosis, which induces abortions in ewes, the majority of respondents who discussed economic benefits from the program reported having sheep farming as the primary or secondary activity on their farm (79%).

However, despite the desire to enhance native biodiversity and obtain economic benefits through coordinated control efforts, landowners appeared to be engaged in a complex decision-making process when asked about their perspectives on the C2C program. Landowners took into account not only biodiversity and economic benefits, but also the social and ecological context of the program. We discuss these additional considerations in the next section.

The Role of Social and Ecological Context

Our analysis of responses to open-ended survey questions revealed that landowners frequently discussed three factors in responses to open-ended questions, all of which were related to the social and ecological context. These three factors were initially identified through a priori codes as increases in rabbits, collective efficacy, and concerns over equity in contributions; however, our iterative process of creating secondary and tertiary codes enabled us to gain a more in-depth understanding of each construct beyond just the a priori code. For example, perceptions of the likelihood of program success, or collective efficacy, were influenced by perceived characteristics of other landowners, the invasive species, and the landscape. We also found that landowners were concerned about other landowners and urban residents not contributing their fair share with regard to predator control. Below we use quotes from written and oral surveys to provide evidence for these perspectives, and, when possible, supplement quotes with estimates on the prevalence of these beliefs from closed-ended questions.

Disturbing the "balance" in the ecosystem

One way in which landowners appeared to consider the complexity of the ecological context was through their expressed concern that the C2C program would disturb the "balance" in the local ecosystem. Many respondents, including the few who did not plan to participate in the program, reported concerns that predator control would result in increases in other unwanted pests. Almost a quarter of respondents were concerned that wide-scale predator control would allow rabbit populations to flourish (i.e., increase in abundance; Fig. 1); other respondents were concerned about potential increases in populations of rats and pūkeko (*Porphyrio melanotus*), a native swamphen, which is thought by some people to damage pasture. One respondent said: "If [we are] trying to get [the] balance right, if you get rid of stoats then could be more rabbits". Another respondent said that he was concerned about "an imbalance in the chain where the rabbits will cost a fortune to eradicate and will endanger an already enfeebled agricultural industry".

Most of these concerns (of upsetting the ecosystem balance) appeared to derive from respondents' own experience seeing increases in unwanted pests when engaging in control of invasive species on or around their property. One respondent spoke about how his own control of cats around his property led to a visible increase in rabbits. Other respondents connected the removal of possums through the PCA program to an explosion of the invasive blackberry weed (*Rubus fruticosus*), which they now must manage on their property. The perception that removal of predators would cause rabbits to flourish was positively correlated with the number of years landowners had owned or managed their property (Spearman's correlation coefficient (r_s) = .35, $p < .01$); this finding supports the idea that landowners' concerns about ecosystem balance may have derived from living in the area long enough to experience firsthand the unintended consequences of past invasive species control efforts.

Respondents spoke about how any efforts to proceed with widespread predator control should take careful precautions to prevent such unintended effects. One respondent summarized this position when he said: "It's a tricky one and it seems that if you try to get the balance right, as soon as you take away one of the predators the other one will come basically, so if you get rid of the stoats, suddenly there are rabbits. Yeah, this is sort of a weird little balance act […] it's got to be everything planned, because you start creating other problems taking one out and suddenly you might get stoats around". Another respondent wrote: "If we get rid of something, there can often be secondary fallback, could be rabbits, mice. Saw that with the blackberry. Need to have fallback plan to deal with any increases in other species". The quotes reflect landowners' concern that program managers may not be considering such unintended consequences when developing the program; landowners thus expressed a clear desire to see a plan for addressing these potential unintended consequences as the program unfolds.

Local social and ecological factors influencing program outcomes

Landowners also took into consideration how specific characteristics of the species, the local environment, and other landowners in the area might influence the extent to which the program is likely to be successful. While most survey respondents had relatively high perceptions of efficacy regarding landowners' collective ability to bring back native birds through widespread predator control (Fig. 1), when asked about the challenges associated with the

program, some respondents reported their concern that the C2C program would not be as successful as the PCA program. One respondent succinctly said, when asked about the C2C program: "I don't think it's going to be as successful as the possum [control program]".

The fear that the program will not be successful appeared to be influenced by two main factors. First, respondents spoke about how the perceived success of the program will depend on the likelihood that enough landowners will participate. In response to the question of the biggest challenge to achieving widespread predator control, seven different survey respondents were concerned that not enough landowners would participate. One respondent said: "everyone has to do it or it's pointless. If it were to occur it has to include everyone and they have to enforce it". Another spoke about how a key challenge will be "trying to get everybody on board, not every[one] has same goal, too lazy". Landowners appeared to have a strong awareness of the need for collective action for invasive species control, and how collective goals, such as increases in native bird populations, will only be achieved if enough others are involved.

Second, respondents' fear that the program would not be effective appeared to be influenced by their perceptions of characteristics of the predators and the landscape. Landowners spoke about the difficulty of the local terrain and how feral cats in particular may be difficult to control due the fact that they are "very wary and mobile". Perceptions of the difficulty of catching predators other than possums appeared to be influenced by stories they had heard about previous efforts to control cats at the nearby Cape Sanctuary reserve. One respondent said: "I don't know a lot about, I just heard that there is a great difficulty with cats at the cape, so it will be interesting, if it is easy as opossums [sic], it would be amazing but maybe it's not going [to] be as easy".

Finally, perceptions of landowners' collective efficacy in reducing predator populations (Table 1) were significantly and negatively associated with the time landowners had lived on their property (Table 1; $r_s = -.373$, $p < .01$), perhaps because those living in the area longer had more experience with the difficulty of trying to control predators. Alternatively, landowners living in the area for longer may have had experience with others failing to continue maintenance control during the PCA program, which could have reduced their trust in other landowners.

Concerns about equity in contributions to predator control

When asked about the C2C program, some respondents appeared to judge the extent to which other people would fulfill their responsibilities to engage in control efforts. Respondents discussed their concerns that it was unfair that others, especially urban residents, may not contribute equally to widespread control efforts.

One respondent spoke about the need to expand responsibility for predator control to urban people when he said: "I also do suggest that they should spread the cost of any extended piece of predator control, let's call it, across the community at large, there [could be a] fee per household, covered that way, so farmers didn't pay anymore to get bird numbers up than what anybody living in town did, [there's] overall benefit to [everybody], there should be equitable funding […] it's riding the whole cost of predator control back on to the landowners". This respondent, who was not planning to become engaged in the C2C efforts, expressed his perception that it was not fair that farmers had to pay dues that went toward predator control and had to follow-up with maintenance control after the initial knock-down when those in urban areas, who would enjoy the return of native birds, were not also being expected to contribute. Another survey respondent spoke to a similar concern when asked about his perspective on the C2C program. He wrote: "[It is] important for not only farmers but for general public to be aware of problem and act in [their] own lives accordingly to monitor and do something about numbers". Some respondents also discussed how they thought urban residents were not only free-riding on rural landowners' efforts but were also contributing to the problem by leaving unwanted pet cats in rural areas. Thus, participants believed that urban residents, not just rural landowners, should fulfill their responsibility to contribute to collective efforts.

Participants also spoke about their concern that it would be unfair if some landowners did not contribute resources after the initial knock-down when every landowner was expected to engage in maintenance control. This concern appeared to derive from landowners' experience with others not continuing maintenance control in the PCA program. As one participant wrote: "[in the PCA program,] some farms [are] not join[ing] in or claiming to do their own opossum control work [which is] not fair on the rest of the farmers". Many respondents spoke about the need for "enforcement" to ensure that everyone was being held accountable to conduct maintenance predator control. In response to survey questions about their experience with the PCA program, for example, numerous respondents said that the worst part of the PCA program was the "lack of enforcement on farmers who don't do maintenance" and the fact that "some neighbours [were] not doing their part and it's not being addressed". Interestingly, almost every respondent felt that overall the PCA program was effective at reducing possum numbers and enabling regeneration of native forest and reduction of tuberculosis in livestock; thus, these concerns about enforcement in the PCA program may have been most closely tied to perceptions of unfairness, rather than program success.

Discussion

Our study suggests that landowners have strong connections to native biodiversity, and a strong awareness of the socio-economic and environmental benefits that may accrue from a program to control invasive predators at a landscape scale, which may help motivate participation in coordinated control efforts. However, we also found that, when asked about a proposed coordinated invasive species control program, landowners engaged in a complex decision-making process with considerations that went well beyond just their environmental values and knowledge, risk perceptions, and like or dislike of invasive species, which have been the focus of previous work (Bremner and Park 2007; Estevez et al. 2014; Selge et al. 2011; Sharp et al. 2011). Landowners also consider the complexity of the local social and ecological context in which the program will unfold, including actions and responsibilities of the local community and the ecological balance among invasive species. These findings suggest that organizations managing coordinated invasive species control programs may benefit from devoting time and resources toward outreach and education that specifically address beliefs about social and ecological context, rather than focusing solely on providing subsidies or information about control tactics or the impacts of invasive species.

Our work identifies three specific ways in which landowners take into account their understanding of the local social and ecological context when evaluating the proposed invasive species control program. First, landowners take into consideration the local ecology and characteristics of other landowners in their community to make assumptions about the potential success of the C2C program; for certain landowners, these assumptions led to a concern that the program would not be efficacious. These findings support previous studies suggesting landowners' decisions to engage in conservation programs on private land may be influenced by their sense of efficacy (Corbett 2002). The findings also support previous experimental work, which has suggested that fear that a collective goal will not be achieved reduces cooperation in laboratory-based stimulations of collective action scenarios (Rapoport and Eshed-Levy 1989).

Landowners' concerns of program success have several implications for the design of coordinated control programs. First, these findings suggest that providing landowners with specific information on the potential for the program to be efficacious may enhance continued landowner engagement. Because respondents appeared to be concerned about both social and ecological factors influencing potential program success, outreach efforts could focus on providing landowners with information on why control strategies will be effective, how many others are expected to contribute, and how many others will need to contribute to achieve reductions in predators and increases in native flora and fauna (e.g., Glen et al. 2016). Such social persuasion, focused on providing information about why success is likely, has been found to enhance group efficacy in other collective action scenarios (Pescosolido 2001). In addition, landowners could be given a series of achievable proximal goals as the program proceeds; for example, a 15% reduction in invasive species populations within the first 3 months, followed by a 30% reduction in the following year. Landowners could then be informed when they have collectively achieved these proximal goals. Being assigned and achieving each successive proximal goal may enhance efficacy beliefs, as is suggested by previous social-psychology studies (Bandura and Schunk 1981; Locke and Latham 2002).

We also found that landowners took into account the social context by considering the extent to which others, including urban residents, would be doing their fair share if such a coordinated control program were to proceed. A loss of motivation in collective action scenarios due to a concern about others not doing their "fair share" has been referred to in the social-psychological literature as the "sucker effect" (Jackson and Harkins 1985; Robbins et al. 1995). This loss of motivation due to equity concerns is distinct from the previously discussed concern that not enough others will be involved to make the program successful (Robbins et al. 1995). The sucker effect has been found to result in reduced contributions to collective goods in experimental settings (Jackson and Harkins 1985; Kerr 1983) and has been suggested to demotivate engagement in environmental behaviors, particularly when powerful environmental organizations fail to meet their responsibilities (Barr et al. 2011).

Other studies examining landowner engagement in invasive species control on private lands have provided evidence for what may be the sucker effect; for example, Graham (2013) described how landholders may have been demotivated by observing a lack of commitment by a government council in controlling invasive serrated tussock (*Nassella trichotoma*) on roadsides. Our findings build on this work by suggesting that rural landowners may not only be demotivated by lack of engagement of other landowners or government agencies, but also by a perceived lack of contribution by urban residents.

These findings suggest that ensuring that urban residents and others benefitting from control programs contribute to efforts, possibly through taxes or voluntary contributions, may enhance sustained rural landowner engagement. The contributions of urban residents could be emphasized when conducting outreach to rural landowners, to reduce perceptions that others are not doing their fair share. In addition, while ecological modeling has demonstrated that not all landowners will need to be involved in C2C to achieve biodiversity benefits (Glen et al. 2016), our findings suggest

that continued monitoring and enforcement of all landowners in the program may be important for preventing a loss of motivation due to the sucker effect. The program could share the results of monitoring efforts with everyone in the community and ensure sanctions are taken against those landowners not complying. Ensuring the results of monitoring efforts are visible, and communicated frequently, may also encourage other landowners to engage in social sanctioning against non-compliant individuals or in praise of compliant individuals (Graham 2013). Increasing visibility of others' efforts or non-efforts, as well as facilitating communication among potential contributors, has been found to enhance cooperation in laboratory-based experiments of collective action scenarios (Janssen 2013) and may also be an effective strategy for invasive species control.

Finally, we found that many landowners had nuanced understandings of the complex ecological relationships in their area, often based on their own experience managing the land. These understandings led to a concern that the program would result in an upset of the ecosystem "balance", increasing other unwanted pests, such as rabbits. The concept of "balance" has been previously addressed in the invasive species control literature; for example, Fischer and van der Wal (2007) found that respondents who valued ecosystem "balance" were more likely to favor invasive species control. Interestingly, we found the opposite in our study, because concerns about ecosystem "balance" may actually demotivate participation if respondents are more concerned about ecological responses by other invasive pests than the impacts of the pests being controlled. These findings support previous work that has suggested that public attitudes toward invasive species are more related to the costs and benefits of the specific species and its management, rather than the inherent "non-nativeness" of a species (Selge et al. 2011). Thus, to gain public support, invasion biologists and managers could focus on the most important factors influencing attitudes rather than relying on an assumed general perception that all introduced species are "bad" and any type of management is "good" (Larson 2007).

Previous literature on landowner perspectives in New Zealand has also found that landowners may have concerns about the impacts of predator control on invasive rabbit populations and has sought to examine the scientific evidence for or against such concerns (Norbury and Jones 2015). This research found that predators typically have little effect on rabbit abundance compared with disease and burrow collapse, although they may have some influence on rabbit abundance under certain climactic and land use conditions (Norbury and Jones 2015). In addition, there is mounting evidence that selective removal of dominant predatory species such as feral cats and mustelids can result in meso-predator release, i.e., increases in the abundance of sub-ordinate predators such as rodents, with adverse consequences for native fauna (Pech and Maitland 2016). Therefore, it is possible that landowner concerns may prove accurate in parts of the C2C area. Controlled experiments are needed to determine the impact of predator control operations on rabbit and other pest populations given characteristics of the local environment. Ideally, participatory processes involving landowners could be used to develop experiments to examine potential unintended consequences and develop collaboratively a strategy for mitigating such consequences. Such a participatory process may foster the development of trust among landowners, scientists, and agencies, to enable landowners to feel that their concerns can and will be adequately addressed as the program unfolds (Gruber 2010).

While our study provides important suggestions for designing educational and outreach interventions for invasive species control, there are some limitations to our approach. First, we were only able to obtain responses from 23% of landowners in and around the C2C region, so it is possible there are additional perceptions toward the C2C program that we were unable to capture. For instance, we were unable to obtain survey responses from several landowners whom others claimed may not engage in the program, despite follow-up requests. While our sample captured the range of property sizes and diversity of land uses in the area, our surveyed population was more educated, older, and had a greater percentage of male respondents than the regional population. Furthermore, our sample did not allow us to examine how perspectives might differ by cultural or ethnic background. For example, only one property surveyed was owned by a Māori land trust. Previous studies have found that while there is no single Māori perspective on invasive species, some common concerns about invasive species control methods have been voiced by iwi (Veitch and Clout 2001); thus, future work should seek to understand these, and other, cultural perspectives in more depth.

Another limitation to our study is that our small sample size prevented us from being able to conduct multivariate analyses to examine which of the many motivations, perspectives, and barriers were the most important predictors of the likelihood of engaging in the C2C program. A commonly used rule of thumb is that a base of 50 observations plus an additional 8 observations per predictor are needed for multiple regression (Green 1991). Following this rule of thumb, our current sample size would only have allowed us to examine the relative importance of a maximum of two variables. Future studies with larger sample sizes may include questions on a variety of potential barriers and motivators in cross-sectional and longitudinal surveys of landowners to examine which factors are the most important

to landowner engagement over time. Such an approach could help agencies design coordinated control efforts and prioritize limited funds to enhance widespread engagement.

Nevertheless, our study is still useful because it highlights the fact that landowners develop nuanced perspectives toward coordinated invasive species control programs based on their localized understanding of the social and ecological context in addition to their desire to preserve native flora and fauna. Agencies and organizations seeking to expand coordinated invasive species control programs may benefit from addressing such localized understandings when implementing similar programs; for example, program managers could discuss with landowners potential factors influencing the success of the program, create proximal collective goals, investigate and address potential "knock-on" effects of control efforts, and develop mechanisms to enhance the equity and transparency of who contributes to collective efforts. Understanding and addressing the nuanced contextual factors influencing landowners' decision-making is increasingly important as efforts such as the Predator Free New Zealand movement seek to enhance native biodiversity and provisioning of ecosystem services at a landscape scale.

Acknowledgements We thank the Hawke's Bay Regional Council, particularly Dean Roughton and Campbell Leckie, for their invaluable guidance and support for this work. We also would like to thank Alison Greenaway, Pike Brown, and Nicole Ardoin for their assistance in the design of the survey. This work was funded by a National Science Foundation Graduate Research Fellowship (DGE-114747) to the first author and core funding to Crown Research Institutes from the Ministry for Business, Innovation & Employment.

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

References

Ajzan I, Fishbein M (1980) Understanding attitudes and predicting social behavior. Prentice-Hall, Englewood Cliffs, NJ, p 296

Aslan CE, Hufford MB, Epanchin-Niell RS, Port JD, Sexton JP, Waring TM (2009) Practical challenges in private stewardship of rangeland ecosystems: yellow starthistle control in Sierra Nevadan foothills. Rangeland Ecol Manag 62(January):28–37

Bandura A (1998) Personal and collective efficacy in human adaptation and change. Adv Psychol Sci 1:51–71

Bandura A, Schunk DH (1981) Cultivating competence, self-efficacy, and intrinsic interest through proximal self-motivation. J Pers Soc Psychol 41(3):586

Barker K (2010) Biosecure citizenship: politicising symbiotic associations and the construction of biological threat. T I Brit Geogr 35(3):350–363. doi:10.1111/j.1475-5661.2010.00386.x

Barr S, Gilg A, Shaw G (2011) "Helping people make better choices": exploring the behaviour change agenda for environmental sustainability. Appl Geogr 31:712e720

Bremner A, Park K (2007) Public attitudes to the management of invasive non-native species in Scotland. Biol Cons 139 (3–4):306–314. doi:10.1016/j.biocon.2007.07.005

Chen MF (2015) Self-efficacy or collective efficacy within the cognitive theory of stress model: which more effectively explains people's self-reported proenvironmental behavior? J Environ Psychol 42:66–75. doi:10.1016/j.jenvp.2015.02.002

Corbett JB (2002) Motivations to participate in riparian improvement programs. Sci Commun 23(3):243–263

Cowan PE (2005) Brushtail possum. In: King CM (ed) The handbook of New Zealand mammals, 2nd edn. Oxford University Press, Melbourne, pp 56–80

Dillman DA (2007) Mail and internet surveys: the tailored design method, 2nd edn. Wiley, Hoboken, NJ, p 544

Drescher M (2014) What is it like to take care of the land? Toward an understanding of private land conservation. Rural Soc 23 (2):117–132

Epanchin-Niell RS, Hufford MB, Aslan CE, Sexton JP, Port JD, Waring TM (2010) Controlling invasive species in complex social landscapes. Front Ecol Environ 8(4):210–216. doi:10.1890/090029

Estevez RA, Anderson CB, Pizarro JC, Burgman MA. (2014). Clarifying values, risk perceptions, and attitudes to resolve or avoid social conflicts in invasive species management. Conservation Biology 29(1):19–30. doi:10.1111/cobi.12359

Fiege M (2005) The weedy west: mobile nature, boundaries, and common space in the Montana landscape. West Hist Q 36(1): 22–47

Fisher NI, Lee aJ, JHJ Cribb, Haynes GD (2011) Public perceptions of foxes and fox eradication in Tasmania. Aust Zoo 35(3):576–589. doi:10.7882/AZ.2011.010

Fischer A, van der Wal R (2007) Invasive plant suppresses charismatic seabird—the construction of attitudes towards biodiversity management options. Biol Cons 135(2):256–267. doi:10.1016/j.biocon.2006.10.026

Ginn F (2016) Extension, subversion, containment: eco-nationalism and (post) colonial nature in Aotearoa New Zealand. T I Brit Geogr 33(3):335–353

Glen AS, Latham MC, Anderson D, Leckie C, Niemiec R, Pech RP, Byrom AE (2016) Landholder participation in regional-scale control of invasive predators: a spatial model for an agro-ecosystem. Biol Invasions, 1–10

Graham S (2013) Three cooperative pathways to solving a collective weed management problem. Autsralas J Env Man 20(2):116–129. doi:10.1080/14486563.2013.774681

Green SB (1991) How many subjects does it take to do a regression analysis? Multivar Behav Res 26:499–510

Greer G (2006) The economic benefits of the Possum Control Area program. AERU, Lincoln University, Lincoln, Unpublished Report for Hawke's Bay Regional Council

Gruber JS (2010) Key principles of community-based natural resource management: a synthesis and interpretation of identified effective approaches for managing the commons. Environ Manage 45:52–66

Hershdorfer ME, Fernandez-gimenez ME, Howery LD (2007) Key attributes influence the performance weed management programs in the Southwest United States. Rangeland Ecol Manag 60 (3):225–234. doi:10.2111/1551-5028

Howell aP, Shaw BR, Alvarez G (2014) Bait shop owners as opinion leaders: a test of the theory of planned behavior to predict pro-environmental outreach behaviors and intentions. Environ Behav 47(10):1107–1126. doi:10.1177/0013916514539684

Hu R, Gill N (2015) Garden-related environmental behavior and weed management: an Australian case study. Soc Nat Resour 29 (2):148–165. doi:10.1080/08941920.2015.1045646

Jackson JM, Harkins SG (1985) Equity in effort: an explanation of the social loafing effect. J Pers Soc Psychol 49(5):1199–1206. doi:10.1037/0022-3514.49.5.1199

Janssen MA (2013) The role of information in governing the commons: experimental results. Ecol Soc 18(4):4

Kerr NL (1983) Motivation losses in small groups: a social dilemma analysis. J Pers Soc Psychol 45(4):819–828

Klepeis P, Gill N, Chisholm L (2009) Emerging amenity landscapes: invasive weeds and land subdivision in rural Australia. Land Use Policy 26(2):380–392. doi:10.1016/j.landusepol.2008.04.006

Komorita SS, Parks CD (1994). Social dilemmas. Brown & Benchmark, Dubuque, IA

Larson BMH (2007) An alien approach to invasive species: objectivity and society in invasion biology. Biol Invasions 9(8):947–956. doi:10.1007/s10530-007-9095-z

Locke EA, Latham GP (2002) Building a practically useful theory of goal setting and task motivation. Am Psychol 57:705–717

Lofland J, Lofland LH (1995) Analyzing social settings: a guide to qualitative observation and analysis, 3rd edn. Wadsworth, Belmont, CA

McLeod LJ, Hine DW, Please PM, Driver AB (2015) Applying behavioral theories to invasive animal management: towards an integrated framework. J Environ Manage 161:63–71. doi:10.1016/j.jenvman.2015.06.048

Niemiec RM, Ardoin N, Wharton C, Asner GP (2016). Motivating resident engagement in invasive species control across private lands: social norms and community reciprocity. Ecol Soc 21 (2):30

Norbury G, Jones C (2015) Pests controlling pests: does predator control lead to greater European rabbit abundance in Australasia? Mammal Rev 45(2):79–87. doi:10.1111/mam.12034

Ostrom E (2000) Collective action and the evolution of social norms. J Econ Perspect 14:137–158

Pech R, Maitland M (2016) Conservation of native fauna in highly invaded systems: managing mammalian predators in New Zealand. Restoration Ecol 24(6):816-820

Pescosolido AT (2001) Informal leaders and the development of group efficacy. Small Gr Res 32(1):74–93. doi:10.1177/104649640103200104

Potts A (2009) Kiwis against possums: a critical analysis of anti-possum rhetoric in Aotearoa New Zealand. Soc Anim 17(1):1–20. doi:10.1163/156853009X393738

Prinbeck G, Lach D, Chan S (2011) Exploring stakeholders' attitudes and beliefs regarding behaviors that prevent the spread of invasive species. Environ Educ Res 17(3):341–352. doi:10.1080/13504622.2010.542451

Rapoport A, Eshed-Levy D (1989) Provision of step-level public goods: effects of greed and fear of being gypped. Organ Behav Hum Dec 44(3):325–344. doi:10.1016/0749-5978(89)90012-5

Robbins TL, Journal S, Mar N (1995) Social loafing on cognitive tasks: an examination of the "sucker effect". J Bus Pyschol 9 (3):337–342

Russell JC (2014) A comparison of attitudes towards introduced wildlife in New Zealand in 1994 and 2012. J R Soc NZ 44:136–151

Russell JC, Innes JG, Brown PH, Byrom AE (2015) Predator-free New Zealand: conservation country. BioScience 65(5):520–525. doi:10.1093/biosci/biv012

Seabrook-Davison MNH, Brunton DH (2014) Public attitudes towards conservation in New Zealand and awareness of threatened species. Pac Conserv Biol 20:286–295

Selge S, Fischer A, van der Wal R (2011) Public and professional views on invasive non-native species—a qualitative social scientific investigation. Biol Cons 144(12):3089–3097. doi:10.1016/j.biocon.2011.09.014

Simpson B, Willer R (2014) Beyond altruism: sociological foundations of cooperation and prosocial behavior. Annu Rev Sociol 41 (1):150504162558008. doi:10.1146/annurev-soc-073014-112242

Sharp RL, Larson LR, Green GT (2011) Factors influencing public preferences for invasive alien species management. Biol Cons 144(8):2097–2104. doi:10.1016/j.biocon.2011.04.032

Stokes KE, O'Neill KP, Montgomery WI, Dick JTa, Maggs Ca, McDonald Ra (2006) The importance of stakeholder engagement in invasive species management: a cross-jurisdictional perspective in Ireland. Biodivers Conserv 15(8):2829–2852. doi:10.1007/s10531-005-3137-6

Veitch CR, Clout MN (2001) Human dimensions in the management of invasive species in New Zealand. In: McNeely, JA (ed) The great reshuffling: human dimensions of invasive alien species. IUCN, Gland, Switzerland, pp 63–71

Yung L, Chandler J, Haverhals M (2015) Effective weed management, collective action, and landownership change in Western Montana. Invasive Plant Sci Manag 8(2):193–202. doi:10.1614/IPSM-D-14-00059.1